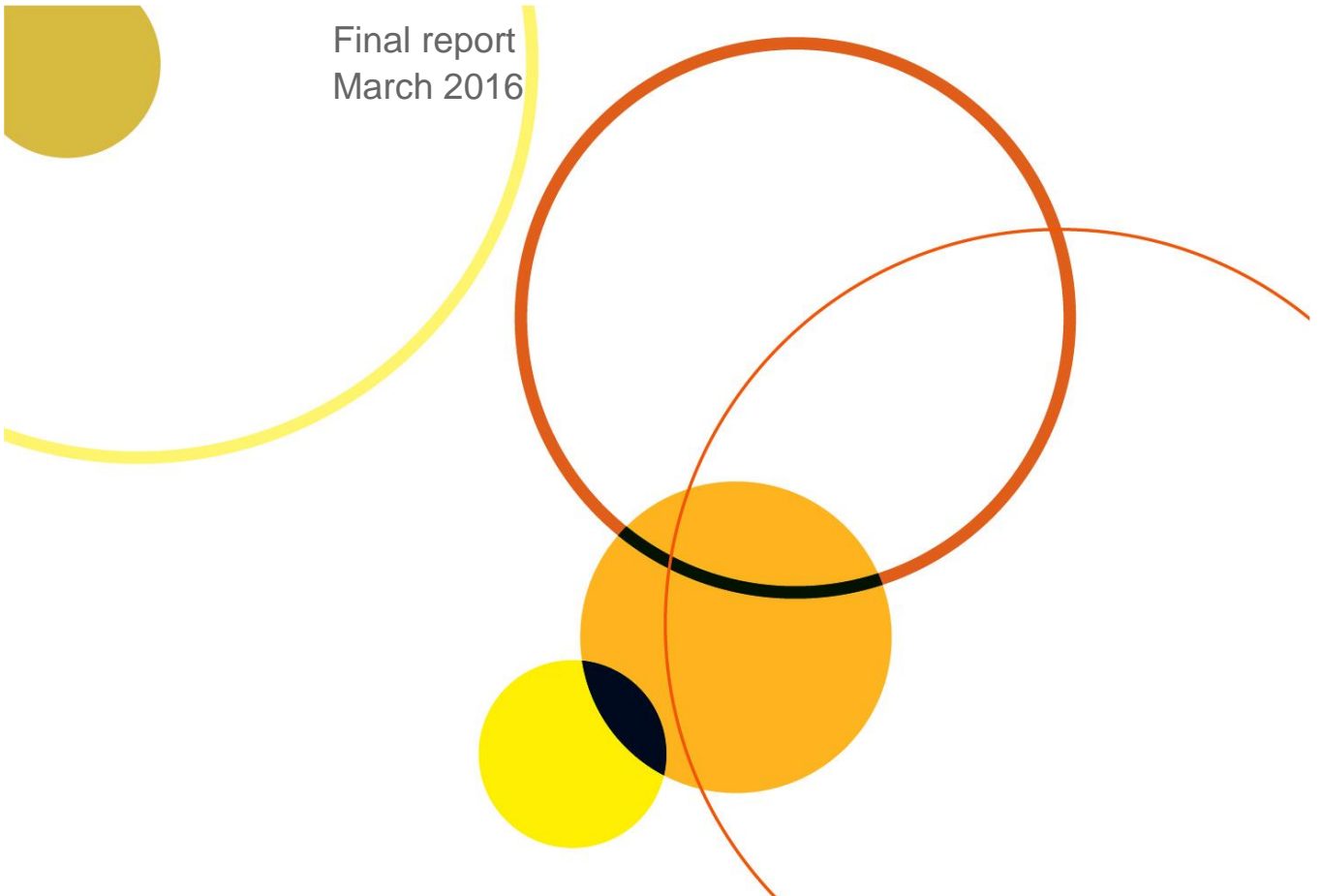:vivideconomics

RAMBØLL

Economic analysis of costs and benefits of approaches to enhancing the bargaining power of EU buyers in the wholesale markets of natural gas

Report prepared for DG ENER

Final report
March 2016

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Executive Summary

The impacts of collective bargaining and other approaches to improving buyer power relative to seller power

Objectives

This work assesses the effects of collective purchasing and other arrangements to improve outcomes for buyers in EU wholesale natural gas markets. In particular, it looks at schemes for the collective purchasing of gas and compares them with options for completing the internal market through investment in infrastructure and harmonization of market rules. It finds the latter to be more attractive. The work considers the conditions under which collective purchasing schemes might strengthen the bargaining power of EU companies. It examines the effects that these schemes and other arrangements would have on wholesale and retail gas prices and welfare, as well as security of supply. The compliance of such schemes with EU law and trade rules is beyond the scope of this work. The work was commissioned from Vivid Economics, Ramboll and Ecorys.

Policy options considered

The policy options compared with current market arrangements include: additional gas sellers, infrastructure, a less concentrated portfolio of sellers, and collective purchasing of strategic reserves, as a possible tool for managing security of supply events. These are now described in turn. First, **collective purchasing** brings together wholesale buyers of gas with the aim of increasing their bargaining power. This can take the form either of voluntary common purchasing of gas or of an arrangement that is mandatory for a group of buyers. These buyers are EU companies which import gas by pipeline or by liquefied natural gas vessels (LNG), or buy gas from domestic producers. The sellers are the producers of gas. Collective purchasing by a single buyer could operate at an EU-wide level or regionally.

The policy of additional sellers establishes conditions such that new sellers enter the market to increase competition between sellers, reducing their individual bargaining power. Such additional sellers could include new importers from LNG-exporting countries, importers by pipeline, or new domestic producers. The conditions to promote seller entry to the market could include actions such as enhanced import infrastructure, greater interconnection between Member States, harmonised market rules and the presence of deep and liquid hubs. In some cases, where a high proportion of demand is satisfied by long term contracts, a shift to greater reliance on short term contracts could create space for new sellers to enter.

The policy of reducing the concentration of a portfolio of sellers facilitates access by smaller incumbents and new entrants. Similar to the policy of additional sellers, it could be put into effect by action to identify and remove barriers to entry where the number of sellers supplying a Member State is currently low, for example, one, two or three sellers. There are a number of potential measures that could be taken, including improvements to infrastructure, the introduction of market-based network codes, the expansion of hubs to improve price transparency, the introduction of open tenders for contracts of a variety of length, changes to market rules in line with the EU's market liberalisation and Energy Union objectives, adjustment of supply contract terms and conditions to suit new entrants and capacity building among smaller

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sellers, perhaps including via co-investment upstream. In this and the previous policy, infrastructure development encompasses greater interconnection within a region, which allows the seller base to be pooled, greater connection to other markets, which enables access by new sellers, and linking of pricing to neighbouring hubs, as well as strategic reserve storage where feasible and relevant for an individual Member State.

In the analysis, Europe is divided into five regional gas markets. The five geographic regions are the Baltics and Finland, Central and Eastern Europe, the South, the North West, and the South East. These regions are chosen because of limited infrastructure capacity between the regions and characteristic sources of supply, market structure and other market arrangements such as hub and oil-indexed pricing. These differences lead to a standard deviation of 2012-2013 average prices across countries of around 14 per cent, with a range from €38/MWh in Lithuania to €21/MWh in Denmark. For example, the North West has LNG import capacity, domestic production in the North Sea, pipeline links to Norway, a larger number of both sellers and buyers, and liquid gas hub trading (NBP and TTF). In contrast, Central and Eastern Europe has only recently developed its first LNG import capacity and has little domestic production, but has strong infrastructure links east with Russia, with national monopoly buyers and no significant hub trading. South Europe has the most diversified seller portfolio of all, due to LNG and multiple pipeline connections.

The distribution of observed market prices and characteristics, combined with economic theory of how markets work, suggest several possible channels for lowering prices in currently high-priced regions of the EU. The channels with the greatest potential for enhancing buyer welfare through lowering prices and increasing consumption are: additional sellers; physical and market infrastructure such as pipes, LNG terminals, hubs and market rules to extend the geographical scope of markets. The creation of strategic reserves or other safeguarding measures may also have a role to play in some circumstances. Two further channels: the diversification of sellers by means of shifting market share from large to small sellers, and price reductions achieved by the restriction of consumption, offer smaller welfare benefits and may be less feasible. A voluntary single buyer operating within a region could potentially play a role and need not be ruled out.

Associated with these channels are several candidate actions to enhance welfare. Encouraging market players to use gas hub pricing as relevant price benchmarks for long-term gas contracts could address the information channel and would be a solution compatible with market liberalisation. Meanwhile, additional sellers could be encouraged by expanding the international connectivity of the gas network. It is clear that most of these channels are aligned with the objectives of internal market rules and competition, with the exception of the single buyer or other collective purchasing, which may conflict with these objectives in times of normal market operation. Having said that, there may be circumstances in which there is a case for collective action in preparation for the emergency of a supply shock. In summary, it is apparent that harmonisation of market rules, greater transparency and further reinforcement of the European grid have a much greater positive impact on welfare, through competition and market contestability, than collective purchasing could ever have.

Previous published work on competition in European natural gas markets focuses only on seller power. The literature review undertaken in this study reveals an established academic literature on competition in gas markets in Europe, employing numerical models to explore a range of market scenarios with small numbers of sellers and a large, atomised number of buyers, and by assumption the number of

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buyers has no impact on market prices. It shows that, in theory, sellers with market power could profitably act to influence prices by constraining supply. Incumbents may also act to retain their market shares by discouraging new entry, by selling most of their output under long term contract, by imposing destination clauses preventing re-sale, and by using other contractual conditions which new entrants would find it hard to comply with. The literature does not address the quantitative estimation of the effects of buyer power. A review of joint purchasing schemes in other sectors, such as healthcare, where buyers club together to negotiate with sellers, reveals that these appear to play an intermediation role, creating economies of scale and specialisation, thereby reducing administrative costs, with an absence of firm evidence that they are able to exercise bargaining power. They do not act to restrict demand. The efficiency benefits from joint purchasing arise where the participants are small, and would not apply to EU wholesale gas markets, where buyers are large. This study breaks new ground by building a model which integrates both buyer and seller power in a market, Vivid Economics' Buyer Power Model (BPM). This allows an indicative quantification of the economic impacts of potential seller *and* buyer power remedies. Previous modelling approaches are unsuited to such questions because they focus solely on seller power.

Economic impacts and findings on policy options

Normal market operation

The evidence suggests that there is no significant net benefit from introducing a mandatory single buyer in wholesale gas markets. First, there are relatively few examples of collective purchasing in gas or other sectors other than on a voluntary basis. In these examples, the collective buyer appears to act as an intermediary and there is no published evidence that the collective purchaser wields buyer power to counteract the bargaining strength of sellers with large market shares. Second, the theory itself and the theory based modelling of the effects of collective purchasing across the various EU regions, indicates that in those regions where seller power is high, the political costs of driving prices down would be high, and a single buyer would not have the political capital to exercise its market power. Whereas a dominant seller may easily choose to restrict supply, a collection of buyers cannot restrict consumption among their customers. The modelling shows that there are much more effective and politically attractive means to reduce prices and erode seller power, which do not take a mandatory single buyer to deliver them. Nevertheless, voluntary cooperation might be feasible under full scrutiny of competition law and even without a formal European Union regulator's mandate.

Mandatory collective purchasing faces major practical difficulties, imposes costs and is in competition with alternative policy options. It is unlikely that a mandatory single buyer would attract sufficiently broad political support at European level, given the likely opposition of sellers to the scheme, but it might receive some political support within the regions standing to benefit most from it. The institution would at least struggle and may well find it impossible to implement restraints on consumption, but it could have success in other ways, enabling more effective negotiation, seller entry and seller diversification. A mandatory single buyer imposes costs by impairing the efficient functioning of markets insofar as it reduces transparency, withdraws liquidity and stifles competition. On the other hand, the same outcomes that a single buyer might enable could also be achieved through other means, by expanding the interconnection of infrastructure, by supporting trading of gas via hubs by encouraging market players to use gas hub pricing as relevant price benchmarks for long-term gas contracts, and by enabling information sharing on buyer negotiation, all of

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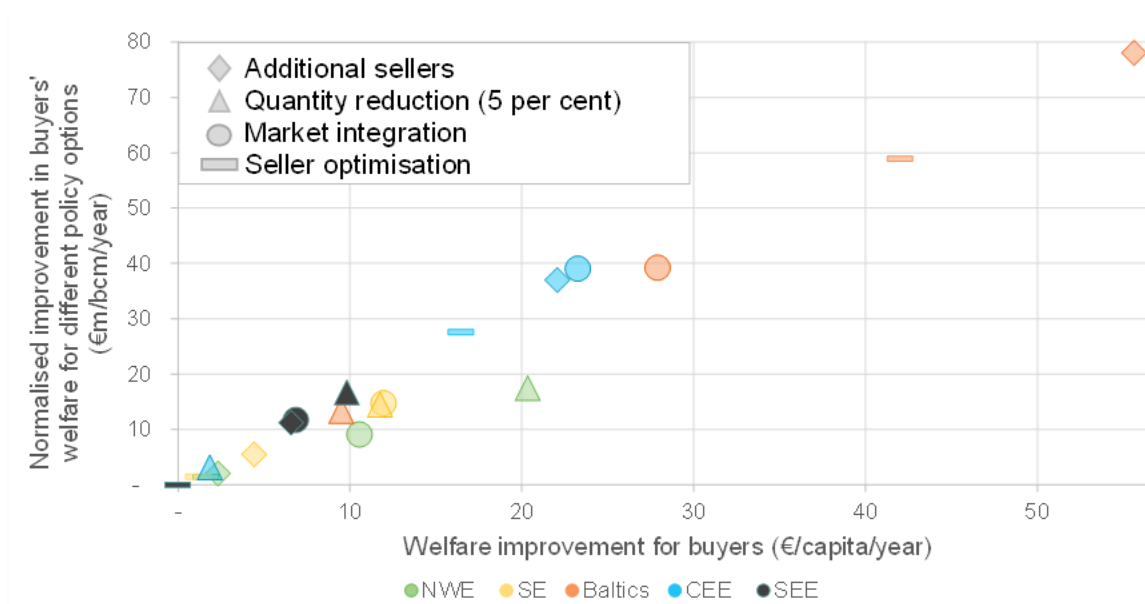
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which need not involve collective purchasing. The information exchange involved in the last two options, information sharing on buyer negotiation and collective purchasing, may however restrict or weaken competition, in particular in downstream markets. The only mechanism which could not be achieved outside collective purchasing is restraint on consumption, but the practical barriers to a single buyer delivering this appear insurmountable. Overall, the conclusion is that collective purchasing at best is not more effective in raising European welfare than alternative policies and at worst is much less desirable than those other policies.

Mandatory collective purchasing is likely to substantially reduce trading liquidity on gas hubs. There is a mix of spot, short term and long term contracts between sellers and buyers in the European gas markets. Unless the long term contracts contain re-opening clauses – which are triggered by collective bargaining or resultant price changes – they will remain in place until expiration or renegotiation. This will dampen the immediate effect of the options explored above on consumer prices. However, over the last ten years, the liquidity of European gas markets has improved considerably, as gas hubs have achieved critical scale, as infrastructure has expanded the scope of the market, and as market liberalisation has increased the number of market participants. This liquidity, together with falling oil prices, has facilitated a move to hub-based contracts from the standard oil-linked contracts; it, together with high gas prices in the EU, has also encouraged the landing of LNG cargoes in Europe, raising the diversity of supply. The options of increasing interconnection and seller numbers and diversity would further these trends. Collective purchasing, however, would push against the trends. It could have a substantial detrimental effect on the hub infrastructure, by reducing the number of participants on gas hubs, diminishing their liquidity. If collective purchasing were to be introduced in North Western Europe or South Europe, there is a strong risk that it would make these regions a less attractive destination for spot LNG cargoes and diminish their supply diversity. If collective purchasing is introduced elsewhere in Europe, it may also impede the development of new gas hub trading there and even if hubs themselves are unlikely to form, it would reduce market liquidity and depth.

Voluntary collective purchasing, if it provides competitively priced gas supplies to the market, could have a positive impact on trading, including on has hubs. This being said, any such mechanism would have to act in full compliance with competition rules.

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Figure 1.   **Summary of impacts by region and channel of influence**

Note 1:	The size of the markers reflects volume of gas consumption in the region. Welfare gains is relative to current market outcomes.
Note 2:	NWE quantity reduction triangle appears to be an outlier on the x-axis scale as a result of the normalisations employed. NWE's per capita gas consumption is more than 40 per cent greater than that of the four other regions. NWE has average welfare gains in terms of euro/bcm; however, since it uses a large amount of gas per person, absolute welfare gains per person are large. In the figure, this means that results for NWE are shifted to the right.
Note 3:	The quantity reduction tends to have stronger welfare gains for markets in which the Herfindahl index is already low and in those where the bargaining powers of sellers and buyers are well balanced. In such cases, a quantity reduction transfers even more bargaining power to buyers, which helps buyers disproportionately. It also negatively affects sellers given that the market is already competitive, but this is not shown in the figure.
Source:	Vivid Economics calculations based on Eurostat, IEA, Platts and Thomas Reuters data

Additional sellers and market integration are far more valuable in the welfare they create for buyers than other channels. This study uses economic models to quantify the impact of additional sellers and of market integration. The quantitative estimates show that, in two regions, the Baltics and Central Eastern Europe, these two channels are relatively much more valuable than other channels. This is shown by the small blue and orange markers, which lie in the top half of the chart, showing higher value. The additional sellers channel creates around twice as beneficial an impact as market integration, and market integration is between twice and four times as beneficial as reduction single buyer's consumption restriction. The other regions experience quite small relative impacts per person or unit of consumption from any of the channels. This leads to the conclusion that additional sellers and market integration would be worthwhile pursuing in the Baltics and in Central Eastern Europe but are a lower priority elsewhere.

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The literature confirms that a larger number of sellers could have a strongly beneficial impact in terms of prices and welfare, especially in the Baltics and Central Eastern Europe. Experience recorded in the literature from the beneficial effects of competition in many markets, indicate that a larger number of sellers can reduce prices substantially. Such additional entry of sellers could take a range of forms in practice, including access to LNG sellers through new LNG import terminal infrastructure, or enabling of west-east gas flows as part of the completion of the internal energy market, and even by creation of stronger intra-regional interconnection so that buyers within each country of a region have access to the full pool of sellers operating in the region.

Improvements to information could enhance welfare. When buyers share information via market infrastructure such as an exchange or hub, for example, market prices, trends in demand, sources of gas, and who is willing to buy and sell, or they share information by purchasing collectively, they reduce the information asymmetry between themselves and sellers. Some of the benefits of transparency could also be achieved without a collective purchasing arrangement. For instance, encouraging market players to use gas hub pricing as relevant price benchmarks for long-term gas contracts. Other option may be for buyers to independently agree to share the information. They may also sharpen their negotiating position in the process, for example, by obtaining details of the terms of contracts being struck in the market. While commercially sensitive, such information sharing may help to level the playing field with large gas sellers, which already have high levels of information on market conditions. This can address a further market failure (asymmetry of information) and thus increase the quantity of gas purchased and lower prices for gas buyers. However, the collaboration does not improve information flow between buyers and sellers, so transparency in this dimension is unaffected. Moreover, there is a potentially negative implication of information sharing amongst gas buyers: it might harm the incentive to compete further downstream at the retail level. As a result, the potential benefits of improved negotiation and transparency through market infrastructure (for example, gas hubs and exchanges) or at least by using gas hub pricing as a benchmark in long term contracts appear to be large for some countries in the Baltics and Central Eastern Europe.

Collective purchasing arrangements have been seen to give rise to efficiency gains when they lead to cost savings thanks to economies of scale. Most examples of these have been voluntary arrangements. **The special feature of *mandatory* collective purchasing agreements is that they may also confer a degree of buying power that would give buyers the ability to reduce consumption and thus push down prices.** In this case, the single buyer exercises its market power by controlling the buy side of the market, and thus demand. This would not be compatible with the market liberalisation objectives of the Energy Union and is likely to contravene competition law. The practical arrangements for the exercise of market power would be very difficult and the political capital expended enormous. Although it might achieve more modest gains through small adjustments to consumption, even then, it would be charting new territory, so the gains which it might target would not be assured. Having said that, there may be alternative policies, such as energy efficiency, which deliver welfare benefits through a reduction in consumption without relying on collective purchasing and while being in line with the direction of EU energy policy. The Baltics and Central and Eastern Europe would stand to gain by far the most, relatively speaking, because their sellers currently have the most bargaining power, with Russia having almost all the seller market share. However, there are four issues, some of which would reduce the estimated welfare improvements through the collective purchasing route. First, the reduction in the number of independent market players would create detriments to market liquidity and depth, inhibiting more transparent pricing, making it harder to foster competition among sellers and buyers. Second, as mentioned, it is a demanding requirement to have such a degree of influence over

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consumption. Third, although buyers stand to gain, the single buyer would attract particularly strong opposition from sellers, both within and outside the EU. Countries with a large indigenous gas production such as the Netherlands, UK and Denmark stand to lose from a single buyer policy, because their sellers may experience lower prices. A single buyer policy may also be challenged as reducing competition among buyers. Fourth, there are alternative options that are likely to be more effective, more feasible, have a stronger track record of success and enhancing global welfare.

Operation under security of supply events

The collective purchasing of strategic storage is the main focus of analysis of this study when it comes to operation under security of supply constraints. It is one of several tools available to mitigate the impact of security of supply risks, such as: the purchase of options on LNG shipments, swap agreements or the introduction of interruptible supply contracts. Strategic reserves may also be a substitute for commercially-operated storage, where strategic reserves deliver services beyond those offered by commercial storage operators and strategic reserves receive a mandate that avoids direct competition with commercial storage operators. This mandate might restrict reserve operation to times of emergency and might proscribe the level of reserves to be held, limiting duration and size.

In the scenarios of a supply outage, price rises could be large and threaten economic growth. While it is more difficult to model a short term supply shock while exploring changes in relative bargaining power, the long run effects of a supply shock shed light on the short term effects. It is clear that a hypothetical partial Russian outage would lead to strong price rises in most of the EU regions but in particular in the Baltics and Central and South Eastern Europe. By contrast, its impact on Western European markets would be muted, because they are not so heavily dependent on Russian sources, and also because they have the ability to source gas from other sellers, including in the form of LNG. In contrast, a hypothetical full outage of Qatari LNG would have no direct impact on Eastern European markets, as these have not relied on LNG to date. The effect on prices in Western European markets is also limited and in fact similar to the effect of a 50 per cent Russian outage. The modelling graphically shows the security of supply benefits of seller diversity in the Baltics and Central Eastern Europe regions, and its twin benefits of reducing the volumetric magnitude of the outage and the mitigation of the market power of the dominant seller. Similar twin benefits would be generated by the operation of a strategic reserve or other safeguarding policies in these regions. Neither of these options requires a single buyer, but the strategic reserve is likely to be funded by placing an obligation on either sellers or buyers, or both, typically the former.

While there is no prior international experience with strategic reserves in natural gas markets, the collective purchasing of strategic storage might be effective in mitigating the price impact of supply outage. First, the results show that an illustrative scenario of a partial Russian supply outage would lead to strong price rises in the Baltics and Central Eastern Europe. By contrast, its impact on the North Western and South Europe markets would be muted, because these regions are not heavily dependent on Russia, and have the ability to source gas from other sellers. In the Baltics and Central Eastern Europe, strategic storage could mitigate price rises over a temporary period by offsetting the loss of gas. Second, the results show, using 2013 data, that an illustrative full outage of Qatari LNG would have no direct impact on Eastern European markets, as these have not relied on LNG to date, and have limited impact on prices in other parts of Europe, because of their current seller diversity and low dependence on Qatari gas. Eastern Europe has recently

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begun to take delivery of LNG through Lithuania, so this situation has changed, but has yet to feed through into reported data. Third, strategic storage has costs, both in providing the storage and potentially in displacing other providers of less market intrusive security of supply services. Fourth, strategic storage could be subject to free-riding whereby some buyers contribute nothing but enjoy its price stabilising benefits. This may make it necessary for Member States to place an obligation on suppliers to contribute to strategic storage. In conclusion, the balance of costs and benefits would have to be considered further before a judgement on its net merits could be reached. In conclusion, there may be a case for strategic storage in the Baltics and Central Eastern Europe.

Conclusion

Seller market power appears to be causing high prices and forgone consumer welfare, during normal market conditions, especially in the Baltics and Central Eastern Europe. During a supply shock, these adverse impacts on consumers are amplified. It is clear that there are potentially substantial benefits from additional sellers, better negotiation and better interconnected and integrated markets, all of which are well aligned with the direction of European gas policy and consistent with the development of a well-functioning market. The evidence strongly supports these policy options.

There are also the options of voluntary or mandatory collective purchasing. The first of these looks potentially feasible but carries with it some detrimental effects. The second of these presents larger costs and probably insurmountable practical difficulties. Voluntary collective purchasing during normal market conditions or during a supply shock could have a positive impact of limiting upward pressure on prices, such as additional sellers and long term contracts and appears to be an effective means of remedying seller market power during supply shocks, while partially offsetting the shock itself. It is not the only measure to address security of supply and it may not be the most attractive, but it merits further exploration. During normal market conditions there is a wider range of factors which attenuate seller market power. Voluntary collective purchasing could be one of them, but not the prime one due to potential adverse effects. The potential adverse effects of mandatory collective purchasing, a single buyer, appear to be much more serious. This is because in normal conditions the market can generate deep and liquid price signals for matching supply and demand during normal conditions and there are no external costs of action. Collective purchasing can undermine these price signals. The same is not true of supply interruptions where the markets can fail to price in interruption risk and individual players may not act in society's best interest. Cooperation between countries and between sellers would be beneficial, as stated in Recommendation 9 of the European Commission's 2014 gas stress tests (European Commission DG Energy, 2014). Indeed, while it would be theoretically possible for a single buyer to counteract seller market power, the feasible, politically reasonable impact that a single buyer could have by wielding demand-side market power would be small. Although it could act in other ways to improve negotiation, access to information or infrastructure, these outcomes can be delivered by other means.

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1 Introduction

1.1 Objectives of the study

The study estimates the impact of various policy measures in wholesale gas purchasing, reporting whether they would strengthen the bargaining power of EU wholesale gas buyers. It assesses whether they would lead to lower prices and greater security of supply for EU consumers, and finds which measures might provide the best net economic impact for the EU. The assessment considers several schemes for collective purchasing and compares the effect of the degree of dependency on individual suppliers across all parts of Europe. It considers the impacts on wholesale and retail prices, market concentration, liquidity and economic welfare, among other aspects.

1.2 The study partners

The study was carried out by a consortium of leading consulting firms in Europe in the field of evaluations of energy markets and energy market modelling. The consortium companies have long and respectable credentials in similar projects. Ramboll led the assignment, supported by Vivid Economics, with Ecorys administering the project and fulfilling the quality assurance role.

Ramboll Denmark A/S (Ramboll) is an independent consulting company founded in 1945. It provides engineering, consultancy, product development and operation services within the areas of: Buildings, Transport, Environment, Energy, Oil & Gas, Telecom and Management Consulting. Ramboll employs more than 12,500 experts and has a significant presence in Northern Europe, North America, India, Russia and the Middle East.

Vivid Economics is a leading strategic economics consultancy with global reach. It strives to create lasting value for its clients, both in government and the private sector, and society at large. It is a premier consultant in the policy-commerce interface and resource- and environment-intensive sectors, where it advises on the most critical and complex policy and commercial questions facing clients around the world.

ECORYS' expertise cuts across sectors that depend on energy, ranging from various industrial sectors to transport and housing and ECORYS maintains a tight network of contacts with key stakeholders in these sectors. This, in combination with its thorough understanding of the supply side of energy and its extensive experience in the market analysis of network sectors, equips it to respond to a wide variety of project situations in the gas market field.

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1.3 Background

1.3.1 The political context

The EU has an 'ambitious project to build a resilient energy union with a forward looking climate change policy' (Juncker, 2014)**.** The secure supply of energy is one of the main pillars of the energy union (Šefčovič, 2014). Recent tensions between Russia and Ukraine have confirmed that secure supplies of natural gas to the EU should not be taken for granted. Several EU Member States and Energy Community countries, in particular in the Baltic region and South-Eastern Europe, are particularly vulnerable, as shown by the recent stress tests on the security of gas supply (European Commission DG Energy, 2014) . This is notably because they source all, or almost all, their gas supplies from one single supplier. As most of the vulnerable countries are poorly connected to the EU gas market, they currently have no or little few alternatives in case of a supply crisis or a price increase of their single supplier.

Several EU leaders have called for 'strengthening the bargaining power of Member States and of the EU vis-à-vis external suppliers', and in particular, examining schemes of 'pooling supply capacities and engaging in coordinated energy purchasing' (Buzek & Delors, 2010) (Tusk, 2014). Several collective purchasing options were put forward in recent political discussions, including in the context of emergency situations.

1.3.2 The gas market context

The gas sector in Europe has undergone significant changes over the last 10 years. From being dominated by large national incumbents, gas consumers in the EU now enjoy a much larger selection of both shippers and suppliers. While legislation, such as the third package, has improved market transparency and liquidity in North Western Europe, other parts of the EU are still faced with few or only one real supplier. These countries face negotiation with main suppliers and pay wholesale gas prices that are higher than in the rest of Europe. For example, the average 2013 wholesale gas price in the Baltics, where Gazprom was the only seller, was €36 per MWh whereas in North Western Europe it was only €26 per MWh. The effects of sellers' bargaining power come with large welfare costs to European consumers.

Interconnection and diversification of sellers within the European gas network has been and remains a policy target for the EU (European Commission, 2014). In 2014 Lithuania inaugurated the LNG import facility 'Independence', at about the same time that there was an immediate decrease in gas prices. Historically, however, the transmission systems in these countries have been part of the Soviet network and the Baltics originally sourced their gas from Russia, having the effect of locking in the Baltics to Russian gas supply. In addition, the legacy infrastructure enables a threat of anticompetitive pricing by Russia, which it could use to deter new entrants if it wished. The EU has, through various programmes and financing, sought to create additional gas infrastructure, enabling access to other sources of supply for these countries. In certain cases these are only slowly being translated into projects because regional disputes regarding location of infrastructure have delayed implementation.

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1.4 Description of tasks

The work builds on the economic theory of strategic decision-making and applies it to the EU wholesale natural gas market. It analyses the current functioning of the EU gas market and assesses the bargaining power of both sellers and buyers across the EU. It then estimates the impact of several design options to enhance the bargaining power of EU buyers. The Commission specified the following tasks:

1.4.1   Task 1: Literature review

Ramboll prepared a literature review which spans academic and grey literature, examining EU gas market modelling and a wider literature on collective purchasing. It looks for theoretical discussion of the mechanisms by which collective purchasing has an impact on the welfare of consumers, and empirical evidence on the effects of similar previous schemes in gas or other markets, in particular looking at the impacts on prices, transparency of markets and security of supply. It also reviews previous modelling of wholesale gas markets in the EU to identify insights relevant to the modelling in this study (European Parliament, 2015) (European Commission, 2015). The literature review can be found in Section 2.

1.4.2   Task 2: Assessing the current bargaining power of EU companies

Vivid Economics delivered a qualitative and quantitative assessment of the bargaining power of gas sellers and buyers in the EU. It takes into account market diversification, embodies the asymmetry of information present in observed market outcomes, dominance of suppliers, total volumes purchased and the size of the market. The bargaining positions of buyers are compared across regions and markets especially in terms of observed price levels, but also commenting on market liquidity and security of supply. The assessment of the current market is presented in Section 4.

1.4.3   Task 3: Development of a model capable of assessing collective purchasing

Vivid Economics developed a model soundly based in economic theory, capable of reflecting strategic behaviour, monopolistic and oligopolistic structures, and purchasers' power present in natural gas markets today. The Vivid Buyer Power Model draws on information which is either in the public domain or was already available in DG ENER (Eurostat, 2015a). The model also allows an examination of negotiating capability, which can arise from asymmetric information, while other aspects of asymmetric information are discussed qualitatively, outside the model. A description of the economic framework and the modelling approach is given in Section 5.

The model allows distinct representation of five main EU regions. In each, it reports the impact of different policy options on price, market concentration and welfare. It also reports import dependence and the impact of interruptions. The effect of policy measures on gas market liquidity is discussed qualitatively outside the model.

1.4.4   Task 4: Impact of policy options for enhancing the bargaining power of EU gas buyers

Vivid Economics assessed the impacts of policy options on wholesale prices and welfare using its Buyer Power Model. The work covers short, medium and long-run effects, but there is a focus on the long-run when reporting results.

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The principal policy option is a mandatory single buyer but voluntary aggregation of demand is also a possibility. For the mandatory single buyer, several mechanisms are explored: market integration within a region giving all buyers access to all sellers within a region, a restraint on gas consumption, solicitation of additional sellers, and encouraging additional supply from sellers with minority market shares, which is referred to as 'seller portfolio optimisation'. These policy options are presented in Section 3. The quantitative impact estimates are listed and discussed in Section 6. Section 7 discusses aspects of impact that can only be assessed qualitatively.

1.4.5 Task 5: Assessing policy options in the context of secure supply of energy

The study includes a quantitative analysis of how policy options would perform in the face of unexpected security of supply events involving upstream gas sellers to the EU. Two severe outage scenarios are tested, one involving a loss of half of gas imported from Russia and other involving total loss of LNG imports from Qatar. The sensitivity of the resulting market impacts to additional sellers is presented in Section 5.5.

1.4.6 Task 6: Analysing the practical implementation issues of the design options

The study includes a discussion of the practical arrangements for organising collective action and shows estimates of the effects of the policy options in the event of a supply outage. The work considers the feasibility of the options and the barriers which may prevent their effective implementation. The legal and competition aspects of the arrangements are outside the scope of this work and are not discussed. The practicalities of the options are considered in Section 8. Section 9 draws together conclusions.

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2 Literature review

A survey of market power studies in the European gas market

2.1 Objective and scope

The primary objective of the literature review is to present analysis of literature relevant to the introduction of collective purchasing strategies designed to enhance the bargaining power of European wholesale gas buyers. The secondary objective is to support the modelling exercise by providing insights from previous models and empirical evidence. The review also elicits the price elasticities of demand and supply that will be used in the buyer power model. The review seeks evidence relating to three policy options: (1) a single buyer; (2) the voluntary aggregation of demand; and, (3) an increase in the number of sellers. In the quantitative analysis (1) and (2) are conflated, though the feasibility of their implementation is discussed separately.

The structure of this section is as follows:
– the first part of the review looks at the theory of purchasing strategies;
– the second part examines the examples of the policy options from the power, gas, and health care sectors: it reports the success factors and difficulties of implementation and comments on their **transferability to the European gas market**;
– the next section summarises the key points arising from both theory and examples;
– the final sub-section presents empirical evidence on price elasticities.

The literature review followed a structured approach. Articles were collected from academic databases and journals, combining key word searches and exclusion criteria, followed by data coding and extraction of findings. The review includes around 40 studies from academic peer-reviewed journals covering energy and industrial economics. In addition, reports from the following organisations were examined: DG Energy, Eurogas, Natural Gas Europe, International Gas Union, Gas Regional Initiative, Gas Infrastructure Europe, European Federation of Energy Traders and International Energy Agency.

2.2 A definition of buyer power

Buyer power refers to relative market power that buyers have over sellers (Noll, 2005). Buyer power arises from monopsony (one buyer) or oligopsony (a few buyers) and is characterised by the ability to reduce demand in order to secure price reductions (Blair & Harrison, 1993). In the context of energy markets, the definition of buyer power provided by Inderst and Mazzarotto (Inderst & Mazzarotto, 2008) is 'the bargaining strength that a buyer has with respect to the sellers with whom it trades'. Two strategies for enhancing buyer power are increasing buyer size and increasing the number of sellers with whom the buyers trade (Cabrera, 2009). Buyer power is usually associated with buyers of large size or buyers who act jointly, in the presence of diversified sources of supply (Dobson, Clarke, Davies, & Waterson, 2001).

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Figure 2. **Effect of buyer power**
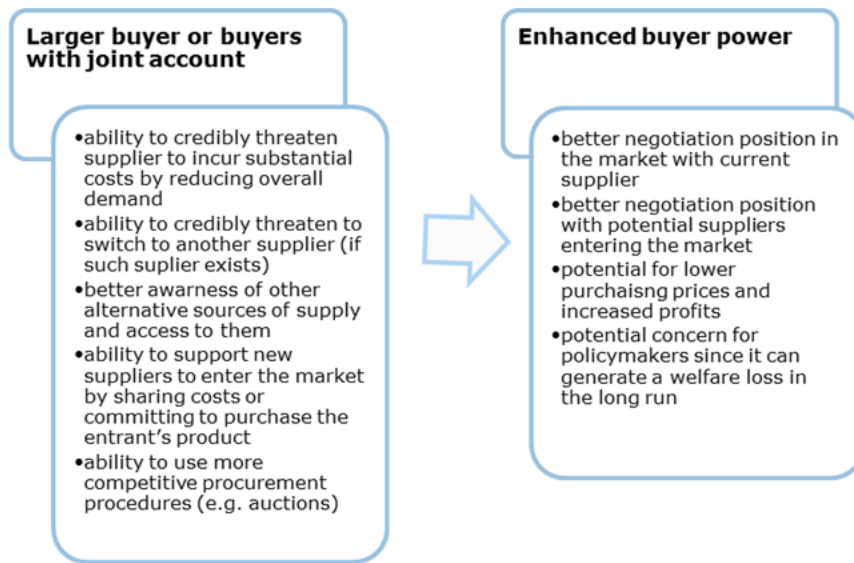
An alternative strategy for increasing buyer power is to impose trade quotas (Ikonnikova & Zwart, 2014). Quotas on bilaterally traded quantities between a buyer and a seller can make buyers collectively better off in specific circumstances. This is an example of the consumption restriction channel described in Section **Error! Reference source not found.**. Quotas impair sellers' pay-offs in negotiation with alternative buyers, which can outweigh the adverse effect on buyers whose trade is restricted. Policy design is especially important here, with policies that restrict the aggregate exposure of all buyers to a given dominant seller being ineffective (Ikonnikova & Zwart, 2014). **This option does not show promise for application in the EU, see discussion in Section 7**.

Another option is fiscal support to buyers to enhance their financial strength. For example, this could take the form of provision of government-backed guarantees for long term contracts. Recent studies in oil and gas show that subsidy of energy production can have negative effects that offset any benefits. First, there is the burden on government budgets and the marginal cost of taxation. Second, subsidy can distort consumption, leading to inefficiency (Davis, 2013) (Schwanitz, Piontek, Bertram, & Luderer, 2014). Based on the experiences in oil, set out in the literature, it is clear that subsidies in the natural gas sector are not a solution for enhancing welfare in the long run. Neither quota nor budgetary subsidies are viable options for enhancing wholesale gas buyer power.

Seller diversification and greater competition between buyers would enhance buyers' market position. Boots, Rijkers & Hobbs (2004) recommend seller diversification and generally greater competition between buyers. Using numerical simulations, they show that collective purchasing, that is, monopsonistic buying has a negative impact on overall welfare. These policy options are explored in the modelling in Section 5 within the present study. Inderst and Wey (2007) show the theoretical result that a merger between buyers to

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enhance their bargaining power against sellers is optimal only where sellers' unit costs rise with their production volumes.

2.3 Lessons from economic theory

Economic theory offers lessons on the policy options considered in this study. It shows the importance of information in preventing price discrimination, it contains examples in which buyers have pooled their resources to collectively purchase infrastructure, it sends a strong message on the benefits of additional participants in concentrated markets and it confirms the consumption restriction mechanism by which a Single Buyer may operate, as well as the effect of relative bargaining power on the distribution of rents. The original focus of this study is on collective purchasing and in particular, a single buyer. The literature supports the use of collective purchasing to commission infrastructure. It also supports the hypothesis that collective purchasing can influence the price if it can also control consumption. That is, that the aggregation of demand allows buyers with collective market power to reduce the price of purchases by restricting their demand. In principle, the buyer can be at any level of the production chain, purchasing primary inputs, intermediate inputs, or being the final consumer (Jacobson & Dorman, 1991). It applies in any situation where buyers either singly or jointly recognize the impact of their purchasing on the market price (Perry, 1978).

2.3.1 Chipty and Snyder's model

Collective purchasing confers bargaining power in normal markets, where a seller's marginal costs of production increase as quantity increases. Chipty & Snyder (1999) examine the effect of a buyer merger on its bargaining position. They conclude that joint purchasing improves the buyers' bargaining position, to the advantage of buyers' welfare, in most normal markets.

They come to this conclusion for normal markets because the marginal costs of gas sellers increases with quantity. Gas production technology is characterized by large fixed costs of drilling wells and constructing pipelines. Marginal costs are increasing since cheaper gas fields are exploited first and more expensive fields are developed later (Ruschau & Al-Anezi, 2001).

2.3.2 Inderst and Wey's model

In contrast to negotiations with smaller buyers, the outcome of negotiations with a single buyer or larger buyers is affected by the price of the alternative supply options available to those buyers. Unlike the model by Chipty and Snyder (1999), this model can accommodate more than one seller. The model assumes that joint purchasing does not affect consumption: it holds demand constant. Collective purchasing still affects the parties' bargaining power and, consequently, the distribution of rents. The authors conclude that if sellers' unit costs increase with quantity, buyers will merge; otherwise they will stay separated. There does not appear to be any firm empirical evidence as to whether this condition holds in gas markets. Inderst and Wey (2007) propose that a joint buyer's negotiating position can be significantly strengthened by diversification of sellers.

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2.3.3 Cournot-Nash models

A comparison of modelled and real world data indicates that the European natural gas market is best represented by Cournot competition. The scholars behind GASMOD, Strategic Model of European Gas Supply, present a model of the European natural gas supply which is structured as a two-stage game of successive natural gas exports to Europe and wholesale trade within Europe, accounting for infrastructure capacity (Holz, Von Hirschhausen, & Kemfert, 2009). It has endogenous determination of domestic production and infrastructure capacity. The model seeks to identify which sellers confer supply security and the benefits of infrastructure enhancement. The model compares three possible market scenarios: Cournot competition in both markets, perfect competition, and perfect competition downstream with Cournot competition upstream market. The comparison with real world data indicates that the current state of the European natural gas market is best represented by Cournot competition.

GASMOD computes the highest prices, lowest quantities and lowest welfare in the scenario where both upstream and downstream markets are oligopolistic, illustrating the welfare-reducing effect of market power both upstream and downstream. Whereas the scenario of perfect competition is only simulated to benchmark the results of the Cournot scenario, the scenario of perfect competition on the downstream market in the presence of an oligopoly on the upstream market requires closer attention. The authors find that this case has an unambiguous welfare outcome. It does not support the thesis that an oligopolistic downstream market, that is, the presence of larger buyers or collective purchasing, is the best response to an oligopolistic upstream market. GASMOND results point to the benefit of diversified sellers.

This result is supported by the GASTALE model (Boots, Rijkers, & Hobbs, 2004). Simulations of the model show that, with oligopolistic sellers, monopsonistic buying has a negative welfare effect. The authors recommend seller diversification and also conclude that greater competition between buyers would have positive welfare effects.

Demand aggregation, in the form of collective purchasing, can increase bargaining power, and through the power to reduce demand, can lead to agreement of lower prices with sellers. Joint purchasing may take place where unit costs are increasing, as observed in Europe. However, there are welfare costs from increasing market power among buyers and for this reason most authors have preferred a strategy of diversification of sellers.

2.4 Case studies of strengthening buyer power

2.4.1 Joint ventures in wholesale gas market: evidence from Japan

The most widely discussed joint purchasing example in wholesale gas markets is in Japan. The agreement is between Japan's two major electricity producing companies, Tokyo Electric Power Co. (TEPCO), the world's second-biggest LNG buyer, buying about 25 million tonnes a year and Chubu Electric Power Co. (CEPCO), the third-biggest, buying around 14 million tonnes (Reuters, 2015), concluded in October 2014. The companies established a joint venture, named JERA Co, for the procurement of fossil fuel resources, primarily liquefied natural gas (Inajima & Urabe, 2015), expecting to jointly purchase between 35 and 40 million tonnes a year of LNG (Reuters, 2014). The new firm, which became operational in March

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2015, is now the world's largest private purchaser in global LNG market, with a projected annual demand of about 54 bcm (around 39.4 million tonnes) of LNG, creating bargaining power to secure cheaper deals for immediate delivery instead of being locked into the industry norm of long-term contracts (Genoese, Dimitrova, & Egenhofer, 2014).

Joint purchasing seeks to mitigate the high costs borne by Japanese electricity companies since the Fukushima crisis. From this time, the companies began to replace some nuclear capacity with gas-fired power stations (Natali, 2014). Over the past decade, Asian markets have usually provided the most lucrative business opportunities to LNG exporters, with Japanese consumers purchasing LNG at the highest prices. The TEPCO-CEPCO joint-purchasing venture was formed with an aim of securing price discounts from current and emerging LNG exporters, such as the US and Australia. Even though the joint venture has only recently started executing its joint purchasing scheme, Naomi Hirose and Akihisa Mizuno, Presidents of TEPCO and CEPCO respectively claim 'Leveraging your size, you can definitely negotiate for better conditions'.

Some buyers expect to press sellers for more flexible contractual terms. Some energy experts in Japan are convinced that similar joint ventures will appear in the future : Singapore's Pavilion Energy has already expressed interest in collaborating with the two firms on LNG purchases (Genoese et al., 2014). However, it is yet to be seen whether joint Asian buyers will be able to secure more favourable terms than those that have already been offered to Asian and European buyers of US LNG export projects, by Cheniere Energy and others.

CEPCO and TEPCO have opted for a private solution in the form of a joint venture, not a publicly governed purchasing agent. The Joint Venture has a self-sufficient business culture, corporate structure enabling independent business management and sufficient financial strength to garner trust in the global market (Chubu, 2015). Scholars have suggested that in order to decide whether such a private sector solution could potentially work in Europe, the following questions would have to be answered (Genoese, 2014):

– Would a joint company be able to accumulate a substantial amount of natural gas demand?
– Would all companies participating in the joint procurement experience cost reductions on their purchases?
– Is collective purchasing practically feasible in the near future, given existing long-term contracts and reserved transmission capacity in Europe?

The opinions provided by scholars suggest that answer to first question is yes: Central and Eastern European member states (including the Baltic States and Finland) import around 52 bcm of natural gas from Russia, compared to 54 bcm in Japan's case (Genoese et al., 2014). This amount corresponds to a trade value of approximately €16.4 billion (British Petroleum, 2015). This accounts for a significant accumulation of demand.

On the question of contracts, most gas imported to Europe has historically been under long-term contracts of around 20 years duration, with prices typically indexed to oil. However, long term contracts contain clauses to renegotiate the price indexation formula within certain limits at regular intervals. It has been suggested that collective procurement might create price re-negotiation leverage (Behrens & Wieczorkiewicz, 2014). Moreover, purchased quantities could be rerouted within a group of participating

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buyers to reduce volume risk. It has also been suggested that by jointly procuring, firms operating in Central and Eastern Europe would be able to compete more effectively with the larger buyers in Western Europe (Genoese, 2014). Based on recent projections, the majority of contracts in Central and Eastern European member states will expire in the next ten years although, because of slack demand and take-or-pay clauses, some volumes have been deferred or banked as make-up gas, to subsequent years (Genoese, 2014). Indeed, there has already been a significant shift away from long-term contracting to hub-based pricing in large parts of EU, which now accounts for over 50 per cent of gas imports at an EU-wide basis and around 90 per cent in North West Europe (IGU, 2014).

2.4.2 The effects of the diversified portfolio of sellers

In Lithuania, gas buyer Litgas has recently renegotiated its price formula for Gazprom deliveries following the opening of the LNG terminal 'Independence', located near Klaipėda. Lithuania secured a 23 per cent price reduction from Gazprom following the construction of the terminal (Inajima & Urabe, 2015). Before that, Lithuanian prices for Russian gas were 36 per cent higher than the German border price (based on an assessment relying on publically available sources European Commission, 2014, see also https://ec.europa.eu/energy/en/statistics/market-analysis). LNG terminals offer access to an enlarged number of sellers (Dorigoni & Portatadino, 2008) and the Lithuania case illustrates the sizeable gains that might be available, even if formally most imports remain governed by long-term contracts for another decade. At the same time, however, two other factors may have contributed to the reduction in Lithuanian prices. The first is that local industrial buyers had been substituting from gas to biomass; the second is that the ongoing EU antitrust case against Gazprom may have played some role.

Up to the mid-2020s, European companies are contractually obliged to import at least 115 bcm/year of Russian gas, approximately 75 per cent of the 2013 import level (Dickel et al., 2014). This figure reduces to around 65 bcm by 2030. Diversification of sellers may involve substantial additional infrastructure costs in the form of LNG import terminals and pipelines, or investments in alternative energy sources and energy efficiency measures (Dickel et al., 2014). The rapidly growing projections for North American LNG exports are promising, but remain uncertain in their long-term contribution (Goncalves & Melling, 2014). According to Dickel et al. (2014), while most scholars agree that there is limited scope for significantly reducing overall European dependence on single seller gas before the mid-2020s, countries in the most vulnerable regions, like the Baltic States and South-Eastern Europe, which are highly dependent on Russian gas, could substantially reduce their dependence on Russian gas by the early 2020s, through a combination of LNG supplies and investments in infrastructure.

2.4.3 Single buyers in electricity

The literature on single buyer models in the electricity sector has been fairly negative on the performance on such models in the past. They can lack transparency, lead to stranded investments and deter competition. In addition, there is little evidence that single buyers are better able to manage the underlying risks of the electricity market. In the EU, it is unlikely that a Single Buyer would be compatible with the rules of the internal EU market.

The motivation for group purchasing in the electricity sector is to manage electricity price risk (Castalia Strategic Advisors, 2013). It offers the buyer lower volatility of electricity prices, but not

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necessarily a lower average price. The authors survey studies from 19 jurisdictions. Of these, eleven have a single-buyer model: Brazil, China, India, Indonesia, Japan, Mexico, Malaysia, Ontario, Pakistan, South Africa and Vietnam. Brazil and Ontario also have functioning wholesale markets while other countries, most notably, China, Japan, Mexico, Malaysia and Vietnam, are currently undergoing liberalization reform of their electricity markets, seeking to establish competitive wholesale market structures. The single-buyer models are of two types:

– A vertically-integrated company (VIC) that controls all parts of the value chain (generation, transmission, distribution, and retail), but which puts some of the newly required generation capacity up for tender to independent power producers (IPPs) operating in the private sector. This model was found in nine of the 18 jurisdictions, but two of these, China and Japan, have little or no competition for generation.

– Capacity markets where the markets for generation capacity and production of energy are separated. These are found in Brazil and Ontario.

The authors find no evidence for lower electricity prices or costs associated with a single-buyer and in some cases prices were higher. Examples of rising prices were found in Ontario and Brazil. A World Bank paper by Arizu, Gencer, & Maurer (2006) states that single buyer models can suffer from lack of transparency and from inflexibility. The World Bank authors suggest that single buyer models in general hamper competition and reform in the power sector.

According to work cited in Arizu, Gencer, & Maurer (2006), competitive bidding between sellers for power purchase agreements reduces prices by 25 percent and increases transparency (Bacon & Beasant-Jones, 2002). The authors of CAS (2013) identify competition as one of four ways to drive down prices, but these are not exclusive to the single buyer model:

– sharing information on demand and supply to improve the planning of capacity;

– using procurement methods which increase competition between sellers;

– use of market mechanisms to create incentives to reveal information;

– disintermediation, allowing direct sales by sellers to final consumers.

Single Buyers may need to be subject to appropriate incentive frameworks in order to perform well. Another example is provided by Zamin & Ibrahim (2013). They argue that governments can provide incentives to single-buyer models through Incentive Based Regulation (IBR). IBR allows the generator and the single buyer to pass through variations in fuel costs and other generation specific costs that are beyond their control. On the other hand, an incentive framework is put in place to measure the operational performance of the generator and the single buyer. It allows adjustment of prices, if circumstances legitimately change by a significant amount, for example by more than 0.5 per cent of annual revenue. If performance is below target, a lower price is charged. Performance is measured as:

– variation between the least cost generation plan and actual generation; and

– the timely settlement of invoices to the generator and compliance with Single Buyer Rules.

2.4.4   Voluntary buyer aggregation in US health care

Joint purchasing in US health care has existed for 100 years, and illustrates the scale efficiencies that come from pooling resources when individual buyers are small, which are less applicable in the case of natural gas markets. Hospitals and other health care Group Purchasing Organizations (GPOs) engage in

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voluntary group purchasing to reduce costs and to gain access to improved market information, but they do not do so all the time (Schneller, 2000). Cleverly & Nutt (1984) find that purchasing alliances between primarily hospitals paid 12 to 26 per cent lower prices than those hospitals in a control group that were not part of a purchasing alliance. Similarly, Muse's estimations based on aggregate national savings to the US health care system, generated by GPOs, find 10 to 15 per cent price savings on supply purchases, plus reductions in labour costs and time efficiencies (Muse & Associates, 2000). Most recent calculations on actual heath care expenditures (Dobson DaVanzo & Associates, 2014) also confirm such effects, finding 10 to 18 per cent reduction in supply related purchasing costs in GPOs. A study (Schneller, 2009) estimates that GPOs generate $36 billion of price savings for the U.S. health care industry, including significant labour savings due fewer individual negotiations with sellers. However such benefits would likely not translate to wholesale gas markets, because the EU gas markets are populated by a fairly small number of large players. Large players do not benefit further from scale in purchasing through aggregation in the same way that small players do.

Regarding data from the satisfaction surveys, hospitals and other health care organisations have historically expressed their satisfaction with GPO services, and there continues to be large membership of several GPOs. For example, Burns and Lee (2008) conduct a survey amongst the 7 purchasing alliances in the United States, representing about 93 per cent of hospital purchases at the time (Burns, 2014). Around 80 per cent of respondents bought more than half of their commodities and/or pharmaceutical products through an alliance. This percentage was much smaller for purchased services (22%), expensive physician preference items (30%), and capital equipment (34%), reflecting that survey respondents did not perceive GPO prices to be the lowest for these product branches. GPOs might be less successful in product branches where physician preferences for products and sellers vary widely and cannot be easily standardised. They have faced pressure from members to focus more on achieving the best price by entering into high volume contracts and also pressure to allow members flexibility to buy as much or as little as they want through the GPO (Burns, 2014)

2.4.5   Conclusions on evidence from practically implemented purchasing designs

The review of joint purchasing schemes revealed a variety of levels of satisfaction with them. Although is it difficult to compare them across markets, the most positive results were found where the buyers voluntarily aggregate their purchasing. The mandatory single buyer model attracted mostly negative reviews based on its implementation in the electricity sector.

The single buyer model has been criticized for its failure to reduce prices for buyers, lack of internal transparency and stranded investments. These problems were associated with context specific problems in the electricity sector. These problems may not occur to the same degree in the gas market.

The voluntary aggregation of demand shows positive aspects in examples in the health care sector and gas market. The literature reveals positives aspects, although the outcomes of the joint venture agreement in Japan are largely based on forecasts and not evaluated benefits. The voluntary aggregation in the health sector has a much longer history and shows lower prices of purchased goods and high satisfaction from participating buyers. The role includes the development of product standards, despite the heterogeneity of

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health products. Joint purchasing in natural gas would not include such costs of coordination over product standards.

Finally, an increased number of sellers finds wide support in the literature. It also benefits from a recent promising example, in the form of the new Baltic LNG terminal, which appears to have reduced seller power.

2.5 Price elasticities

In the past decade a number of studies have been carried out on price elasticity of the European gas market. In order to supply the model with the best and most accurate estimates for the price elasticity, a literature review has been conducted. A total of 11 papers were reviewed, the most relevant findings from which are summarised below. Elasticities are provided in terms of aggregated price elasticities for the whole geographical area covered by the study.

A comprehensive study was done in 2004 using data from 1978 to 1999. It calculated both long and short run elasticity and it also showed that the price elasticity had been falling over recent decades (Liu, 2004). This paper has been widely acknowledged and used as a reference in most subsequent papers. However, it is preferable to use price elasticity estimates based on recent data. For this reason we did not include in the final review papers which do not address price elasticity for the period after 1999.

Since the study focuses on the wholesale market, we also excluded the wide range of literature focusing on residential price elasticity. It is possible to refer to, for instance, recent and comprehensive studies of household natural gas demand elasticities with an ARDL model (Bernstein & Madlener, 2011) and a time series model (Dilaver, 2010). As noted in (Sønstebø, 2012), some studies found differences between residential and wholesale price elasticities, but overall such differences are not found to be statistically significant. The literature exhibits some differences in the way price elasticities for natural gas are analysed on the residential and wholesale markets. In particular, while studies on the residential market report both country and regional elasticities, studies of the wholesale market provide regional elasticities.

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Table 1.   **Sources of elasticity estimates**

Paper and focus	Elasticity measures	Data year	Geographical scope	Elasticities
Wholesale gas export from the US to Europe (Sønstebø, 2012)	Average long and short run elasticities for both supply and demand	1978-2002	European members of the OECD	Short run supply [0.1] Long run supply [0.8] Short run demand [-0.1] Long run demand [-0.8]
Industry complementarity model for European countries (Egging, Gabriel, Holz, & Zhuang, 2007)	Single average price elasticity	2004	34 European countries, including Russia, Turkey and other non EU countries, 34 in total.	Long run demand: Industry [-0.4] Power generation [-0.75]
GASMOD model for gas supply (Holz, von Hirschhausen, & Kemfert, A Strategic Model of European Gas Supply (GASMOD) , 2006)[1]	Average long run demand elasticity	Assumed elasticities based on previous papers and expert knowledge	17 European countries including Turkey and the Balkan countries	Demand elasticity Western Europe [-0.7] Eastern Europe [-0.6] A higher price elasticity, 0.05 higher in absolute values, was estimated in countries where natural gas does not have a large share in energy consumption (Spain/Portugal, Sweden/Finland, Poland, Balkans and Greece)
Dynamic panel data elasticity for natural gas using OLS and GMM (Liu, 2004)	Average demand elasticity in short and long run using different estimation methods	1978-1999	European members of the OECD	GMM estimate: Short run [-0.067] Long run [-0.243] OLS estimate: Short run [-0.035] Long run [-1.251]
Wholesale gas export from the US to Europe (Sønstebø, 2012)	Average long and short run elasticities for both supply and demand	1978-2002	European members of the OECD	Short run supply [0.1] Long run supply [0.8] Short run demand [-0.1] Long run demand [-0.8]

Note: *OLS = ordinary least squares, GMM = generalised method of moments*

Source: *Ramboll*

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[1] The exact same average demand elasticities were also used in a more recent study on wholesale elasticities (Holz, Modeling the European Natural Gas Market - Static and Dynamic Perspectives of an Oligopolistic Market, 2009).

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3 The policy options and channels of influence

This section introduces the policy options assessed in this report. These options were defined in discussion with DG ENER; they should not be taken to be an exhaustive or definitive list of possible EU policies in the natural gas market. They encompass components of the European Union agenda such as interconnection infrastructure, market liberalisation and transparency. As well as the quantification of price and welfare impacts wherever possible in Section 5, there is a qualitative analysis in Section 6, which considers the impact of improvements in informational transparency in the EU wholesale gas markets, among other things. Issues of practical feasibility are discussed in Section 8.

3.1 Six channels of influence

EU policy already delivers welfare improvement through the promotion of competition. The processes of market liberalisation and investment in infrastructure have been helping to lower wholesale gas prices, raising consumer welfare. The EU has improved contestability by applying market rules such as third party access to infrastructure and markets, prohibition of the destination clause and encouragement of reselling, all of which prevent sellers from price discriminating between buyers. The EU has also facilitated investment in grids and interconnection, by coordinating parties who would benefit from Projects of Common Interest. The channels described below may complement the EU's current policies, provided they work with and not against the market, competition and trading rules.

Potential improvements in welfare might be realised through six channels of influence. The six channels of influence are:
– negotiation;
– market integration;
– additional seller(s);
– seller portfolio optimisation;
– consumption restriction;
– collective purchase of strategic reserves, as one possible option to mitigate security of supply risks

In the *negotiation* channel, the existing buyers or a single buyer adopt the best negotiating strategies of existing buyers. The buyers currently experiencing higher prices adopt these leading strategies, either acting on their own behalf or through the agency of a single buyer which negotiates on their behalf.

Policy action to collate information from all participating buyers might help buyers to adopt the most effective negotiating tactics. Alternatively, a single buyer might use its size to increase investment in negotiation by finding out more about the circumstances of the sellers from which it purchases. Its access to information allow it to strike a harder bargain with sellers. If buyers have information on all competing sellers in the regional submarkets, they may use that information to negotiate better prices within regions.

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The different prices currently paid by buyers might move towards the lowest prices in those regions, although complete convergence may be prevented by infrastructure bottlenecks and divergent market rules. It is possible that improved negotiation could be achieved by using gas hub prices as references in contractual negotiations or through the involvement of a single buyer. It would not be lawful for buyers to exchange information in a manner which might enable them to collude or operate a cartel.

There is a *market integration* channel where a single buyer or the existing buyers can bring prices paid by member countries in the regional groups to the price implied by the market-wide seller side HHI. Currently some countries are paying prices in line with their specific (seller-side) HHI, and in some cases this leads those countries to experience relatively high prices. These high prices might be reduced if the regional group formed an integrated market, leading to a more diversified set of sellers. Such pooling would only be possible if the market regulation and physical infrastructure allowed it. This would allow every buyer access to every seller and every seller access to every buyer. This would reduce market power and bring pricing closer to the perfect competition level. Although this is something a single buyer could do, it may be possible to achieve alternatively through greater market infrastructure, both physical interconnection, regulatory and commercial arrangements.

In the *additional seller* channel, additional sellers enter the market because new infrastructure gives them physical access or because terms and conditions are offered which those sellers find attractive. An increase in the number of sellers is achieved by the entry of additional seller(s) into some or all regions of the EU wholesale gas market. The extra seller(s) could be via LNG imports, local production, or by pipeline imports. For example, the completion of the EU internal energy market will facilitate the West-East and North-South redirection of gas flows, which could effectively bring extra sellers into some regions. The analysis here considers the impact of a single additional seller with the same market share as Qatari LNG, for the purpose of illustrating the impact. Clearly, the effects of more sellers or sellers of other sizes will have a different scale of impact. It is beyond the scope of this report to identify the reason why there are not already more sellers in the markets.

In the *seller portfolio optimisation* channel, the existing buyers or a single buyer skew their purchases in favour of smaller sellers in order to reduce the overall market concentration amongst sellers. This has the effect of shifting market share from away from relatively large sellers, and thus reducing the level of market concentration (as measured, for example, by the Herfindahl index). The analysis examines the impact of this optimisation process on prices and welfare.

In the *consumption restriction* channel, the single buyer consolidates the demand of all its member buyers then restricts that demand. The single buyer is vested with powers to reduce consumption by its members and it uses these powers to reduce demand and thus extract lower prices from sellers. In order to do this, the single buyer will need strong commercial agreements with buyers, policy support from governments of participating countries, and potential exemptions from competition or other areas of policy. It might in practice be impossible to implement both politically and legally. The way in which it might operate, potential effects of concentrating wholesale gas markets in the EU and potential problems with the feasibility of this channel, are discussed in Section 7.

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Figure 3.   **Channels of influence on outcomes in normal market conditions**

negotiation	market integration	additional seller(s)	seller portfolio optimisation	consumption restriction
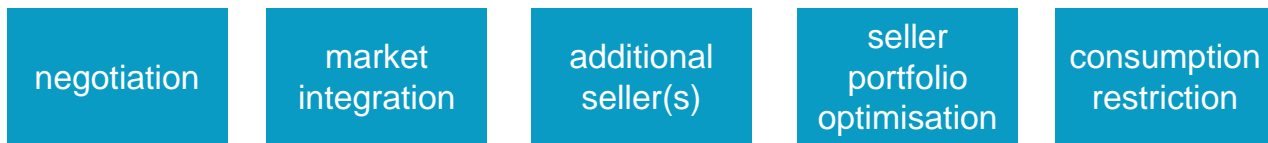
Source: Vivid Economics (2015)

In the *collective purchase channel*, countries group together to coordinate the provision of strategic reserves which are deployed during security of supply events. This allows the countries to achieve economies of scale, to match the financial contributions and benefits from each of them, and to select the optimal size or service capability of the assets. The operation of strategic storage is similar to that of an additional gas supplier in that it also involves an additional player, when acting as a public enterprise, or additional capacity for existing players, when acting privately. The reserve only supplies gas under stress conditions, not under business-as-usual conditions.

The action of these channels and the routes by which they lead to consumer benefits, are shown in Figure 4.

Figure 4.   **Policy options and their market impacts**

Source: Vivid Economics

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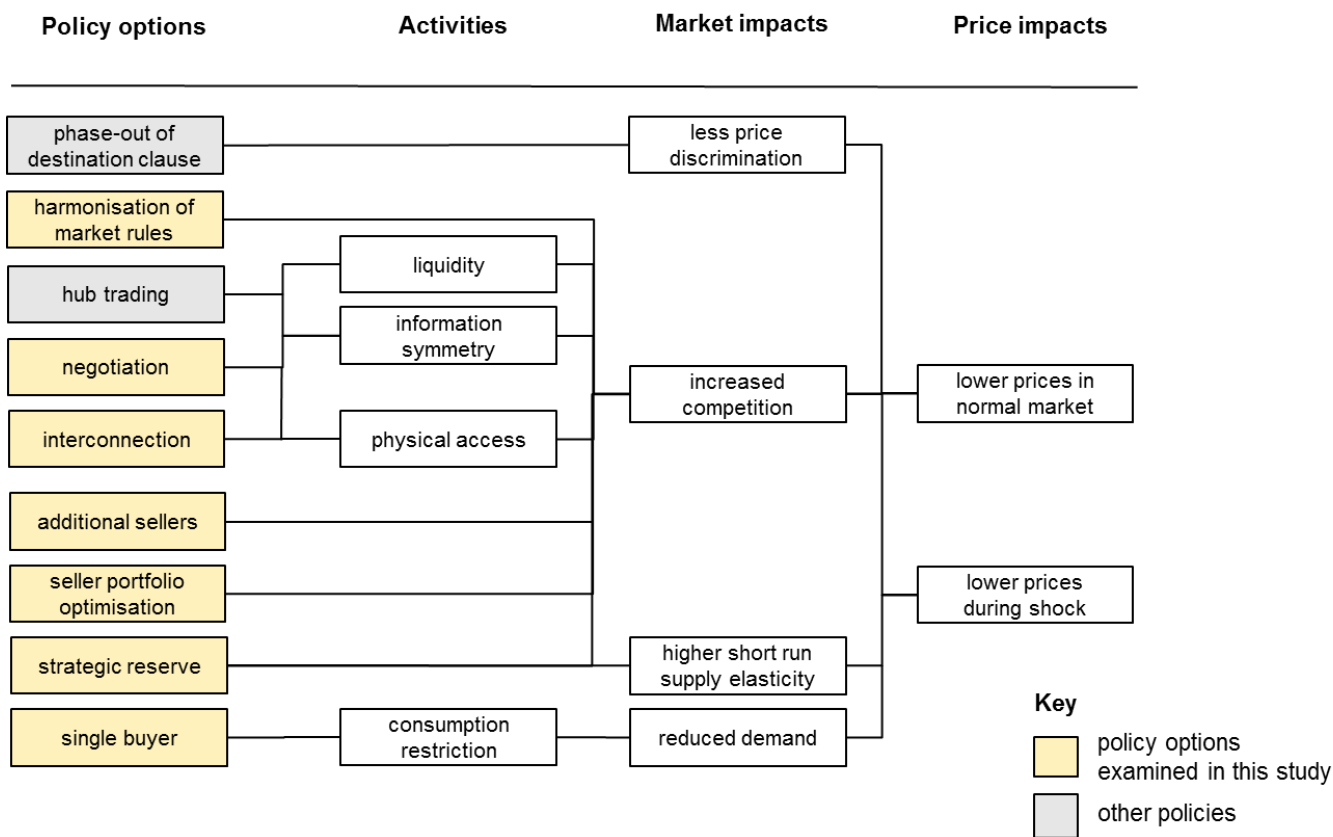
3.2 The single buyer

If a single buyer or buyers were to be created, they could take one of two forms: mandatory and voluntary.

3.2.1 Mandatory single buyer

Under a mandatory single buyer, all existing gas buyers would be required to combine their demands to form a single buyer that engages in collective purchasing on their behalf. This means establishing a reselling entity, capable of acting as an intermediary, buying gas and selling it on to existing buyers. There would be commercial, financing, legal and coordination costs in setting up a new intermediary. Such a single buyer could be formed either in some or all of the five regional groups within the EU, or on an EU-wide basis comprising all 28 Member States. Both of these options are considered in the modelling results. Assuming it is practically feasible, a mandatory single-buyer arrangement would be attractive if it makes participating Member States better off in terms of their economic welfare. Welfare is defined in Section 4.5.3.

3.2.2 Voluntary regional aggregation

Voluntary regional aggregation is the voluntary participation version of the first option. It considers aggregation of buyers at the regional level within the EU, but it takes this aggregation to be voluntary, so a buyer will only choose to enrol if it will reduce its costs of gas purchase. The modelling explores whether individual countries have an incentive to support this policy option. So long as voluntary action complies with market and competition rules, it would be permitted under current EU law.

3.3 Market definition

Market definition and the existing distribution of market structure play an important role in shaping the economic outcome. This section discusses current gas prices, traded quantities and present buyers' and sellers' market shares in each regional group. The concentration of market shares is given by the Herfindahl index and the ratio of Herfindahl indices for sellers and for buyers, showing which parties enjoy greater bargaining power.

3.3.1 Regional groups

For the purpose of this study, the EU is divided into five regional groups as shown in Table 2. Regional groups were chosen based on geographic consideration, market structure and gas interconnection infrastructure. For example in the Baltics market, until 2014, all countries had Russia as a single supplier, until an LNG terminal was added to the high-pressure grid of Lithuania. North Western Europe is the largest market and comprises countries that are highly integrated through a well-connected transmission system. The countries within a group are treated like a market for the purposes of modelling, but in practice there may be reasons why a region does not function as a market, such as infrastructure bottlenecks and regulatory differences. An indication of function is that the more a group functions like a market, the lower the range of prices present within the group. The groups were chosen in order to illustrate the policy options and their impacts and they were selected by the project Steering Group, the selection was not an output of or

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influenced by the modelling process. The analysis is sensitivity tested to an alternative definition in which the whole EU is a single market.

Table 2. **The EU divides into five regional groups**

Baltics	Central Eastern Europe	North Western Europe	South Eastern Europe	South Europe
Estonia (ES)	Austria (AT)	Belgium (BE)	Bulgaria (BG)	France (FR)
Finland (FI)	Czech Republic (CZ)	Denmark (DK)	Croatia (HR)	Italy (IT)
Latvia (LV)	Poland (PL)	Germany (DE)	Greece (EL)	Portugal (PT)
Lithuania (LT)	Slovakia (SK)	Ireland (IE)	Hungary (HU)	Spain (ES)
	Slovenia (SI)	Luxemburg (LU)	Romania (RO)	
		Netherlands (NL)		
		Sweden (SE)		
		UK (UK)		

Source: *Vivid Economics*

3.4 Market statistics

3.4.1 Price and quantity analysis

The EU average wholesale gas price over 2012-2013 is €28/MWh with a highest average price of €36/MWh in the Baltics regional group and a lowest average price of €26/MWh in the North Western market. Countries in the Western Europe regional group make up over 80 per cent of total EU consumption. Based on data from the IEA, the average EU gas consumption for the years 2012 and 2013 stood at 453bcm, of which 404bcm was imported by the Member States (MS), and of that number 322bcm was imported from outside the EU. The share of LNG imports was 13.6 per cent while gas imported by pipeline made up the rest. Russia is the largest exporter to the EU with a share of 29 per cent of gas imports for the years 2012 and 2013, followed by Norway (24 per cent), Algeria (10 per cent) and Qatar (6 per cent). Within the EU, The Netherlands is the largest producer of natural gas, at 15 per cent of EU consumption.

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Figure 5. **Gas average prices and traded quantities in EU regional groups**
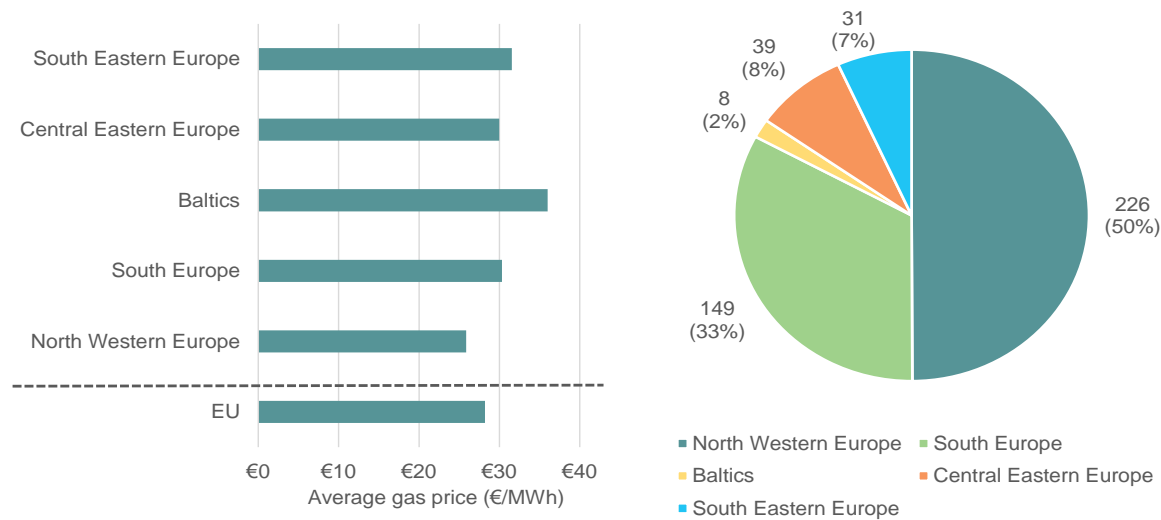
Note: Average prices are calculated as the consumption weighted average of country prices in the years 2012 and 2013.

          Quantity consumed is the average market total quantity over the years 2012 and 2013.

Source: Vivid Economics based on IEA, Eurostat and Platts data

Gas prices data for individual Member States show a more dispersed distribution with the price range extending from average prices of €22/MWh for Denmark to €38/MWh for Lithuania. The equally weighted average price is €29.8/MWh and the standard deviation is €4/MWh, while the volume-weighted average is €28/MWh. Figure 6 shows the dispersion of prices in regional groups. Gas prices in the South Europe regional group are spread across the four interquartile ranges of the price distribution. All prices in the South Eastern Europe and the Baltics markets are above the median price, with the exception of Finland, whereas Sweden is the only country that pays a higher than median price in the North Western Europe market. The dispersion of prices within regions clearly indicates that the regions individually are not all fully functioning as markets.

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Figure 6.   **Gas prices dispersion across Member States**
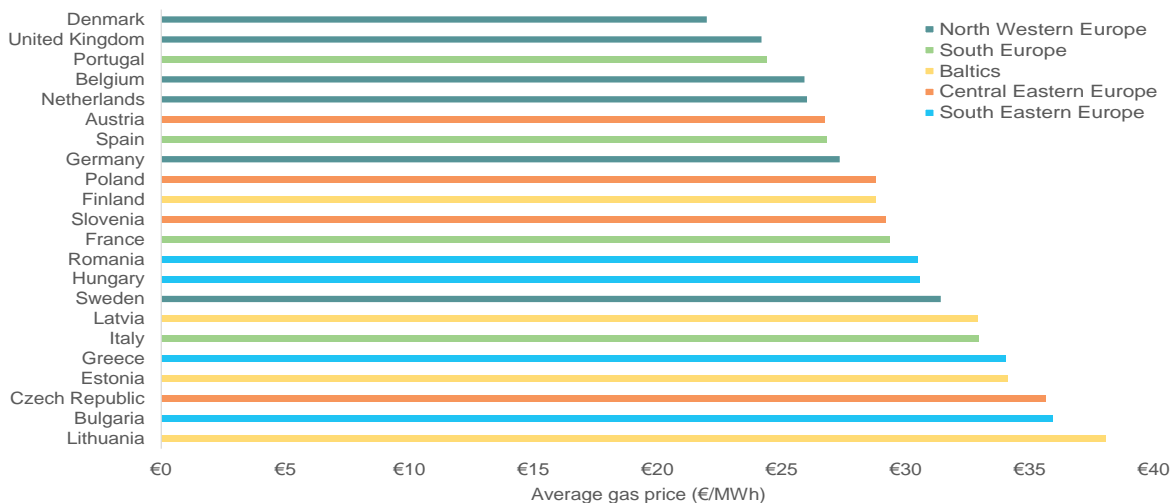
Note:	*For most MS prices are the average over 2012 to 2013 period. For Denmark, Finland, Slovenia and Sweden 2014 prices are used. There are no price data for Croatia, Ireland, Luxemburg and Slovakia.*
Source:	*Vivid Economics based on Eurostat and Platts data*

3.4.2   Market concentration

The biggest country in each regional group accounts for around 40 per cent of demand. Figure 7 shows that in each regional group there is a large country with approximately 40 per cent pf demand for the regional group. The North Western Europe market is the largest market, in which two countries, Germany and UK, account for 70 per cent of total gas consumption. They represent 35 per cent of all EU gas consumption. Italy and France are the next largest consumers in the EU and account for most of demand in the South Europe market. More than three quarters of total EU demand is consumed by six Member States.

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Figure 7. **Countries' shares of regional groups and the EU**
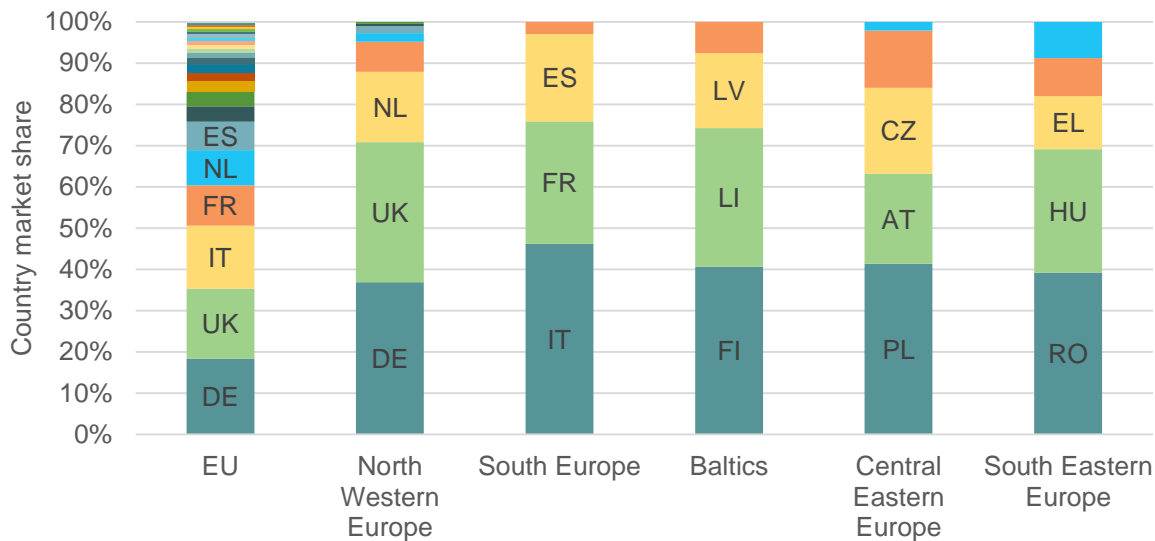
A comparison of the buyer and seller Herfindahl indices (HHI) reveals the relative bargaining power of market participants. Market concentration is usually calculated only on the seller side, but in this analysis, both seller and buyer HHI are calculated. Whichever side of the market has the higher concentration, the higher value of HHI, enjoys more bargaining power.

The buyer Herfindahl index ranks the Baltics and Central Eastern Europe markets as the most concentrated markets. The buyer concentration is calculated using the number of firms buying gas in each regional group. The North Western Europe market is the least concentrated market, with the largest number of buyers, while the Baltics is the most concentrated. Buyers in the Baltics market have higher market shares compared to the rest of the EU. The South Europe market is also concentrated on the buyers' side, since the three largest buyers in France, Italy and Spain account for 65 per cent of the market. The data indicate that South Eastern Europe has low concentration, but this does not allow for the fact that there is limited interconnection between countries in that regional group, so the group does not behave as a single market. **Russia has the largest seller share in three regional groups as well as being the largest seller in the EU, accounting for a quarter of EU supply**. Figure 8 depicts the share of sellers by country in the regional and EU markets. The North Western Europe market has the lowest dependence on Russian supply, where it makes up 17 per cent of total supply. The Baltic market has the most concentrated sellers, with Russia being the sole seller. These are 2012 and 2013 data. An LNG import terminal opened in June 2014 in Lithuania, post-dating the data set used here. The seller Herfindahl index indicates that the most dispersed market is the South Europe market (but in reality, it is not an integrated market and is more concentrated than the HHI suggests) followed by the North Western Europe market and the South Eastern Market, while the Central Eastern Europe market is relatively more concentrated on the seller side and the Baltics is the most concentrated.

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Figure 8. **Seller shares by country of origin across regional groups and the EU at the country level**
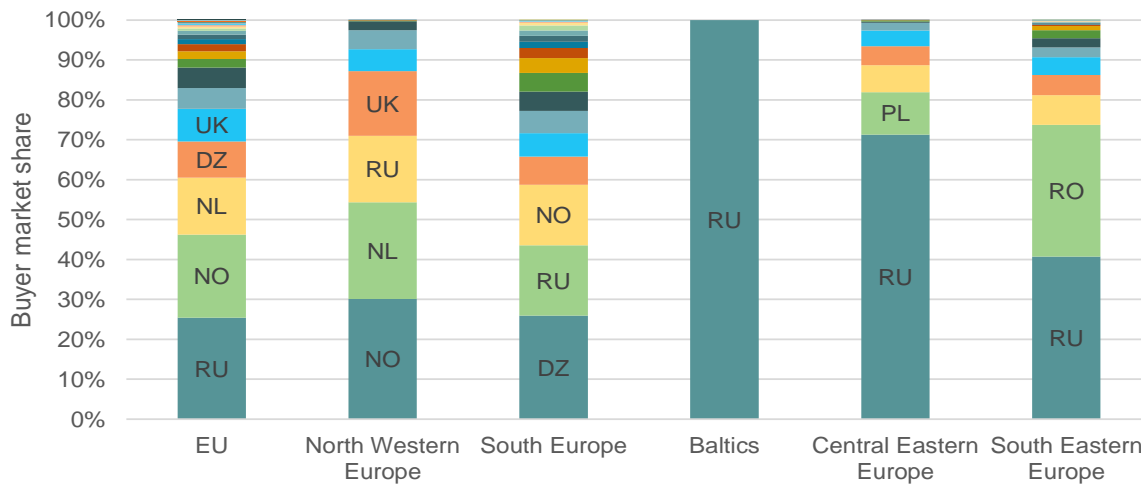
Note: Gas produced in PO and RO is not exported.

Source: Vivid Economics based on IEA, Eurostat and Platts data for 2012-2013 period

Across the five regional EU gas markets considered in this study, higher gas prices are observed in markets with a higher concentration of sellers. The correlation between sell side concentration, or seller power, and regional group prices holds for all five regional groups and reflects standard economic theory such as the Cournot model of oligopoly. Overlaid on this pattern is substantial price dispersion across countries within regional groups, with a standard deviation of 4.15 (€/MWh) across the EU, see Figure 9. The prices at country level exhibit the same relationship with seller concentration, indeed the Ordinary Least Squares regression fit between price and sellers' Herfindahl index (HHI) is quite good, with an R^2 of 0.53. In other words, over half the variation in gas prices across is explained by differences in seller concentration alone. As expected, the Baltics pay more for their gas, and the data reveals that Italy, Greece and Bulgaria are paying more than expected and some countries such as Portugal, Austria and the United Kingdom are paying much less than expected.

For all countries the deviation of actual prices from expected prices above is less than +/- 22 per cent, and for 16 out of the 19 countries for which there is data, prices deviate by no more than +/- 10 per cent from their expected values. The differences between the expected prices controlling for seller concentration and the actual price are shown for each country in Table 3. The case of Italy represents an outlier in that it has a highly diversified portfolio of suppliers yet its price level is 16 per cent higher than predicted. The precise reasons for this have not been analysed in the literature; a possible explanation is that Italy appears to have lagged behind North western European countries in developing a regulatory framework to underpin hub trading (Miriello and Polo, 2015). There have been some concerns over the quality of competition in the Italian gas market since the 2000s, as suggested by competition cases initiated by the European Commission.

The dispersion of prices across countries within regional groups shows the degree of integration of these markets. Figure 9 shows that the North West European market is highly integrated, since the price paid by individual countries is close to the weighted average market price. In contrast, the South East European market shows a high degree of dispersion across countries. Furthermore, the average market price

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in the South East European market is 10 per cent higher than the expected price from the HHI. This indicates that the regional group is poorly integrated. Improved negotiation and greater market integration would reduce the price down to a level close to the lowest price paid in the market, and will allow countries to trade at a price consistent with market-wide HHI and not the country specific HHI, as it is currently the case.

Figure 9.   **Country price (2012-2013) vs Herfindahl index for gas sellers to each country**
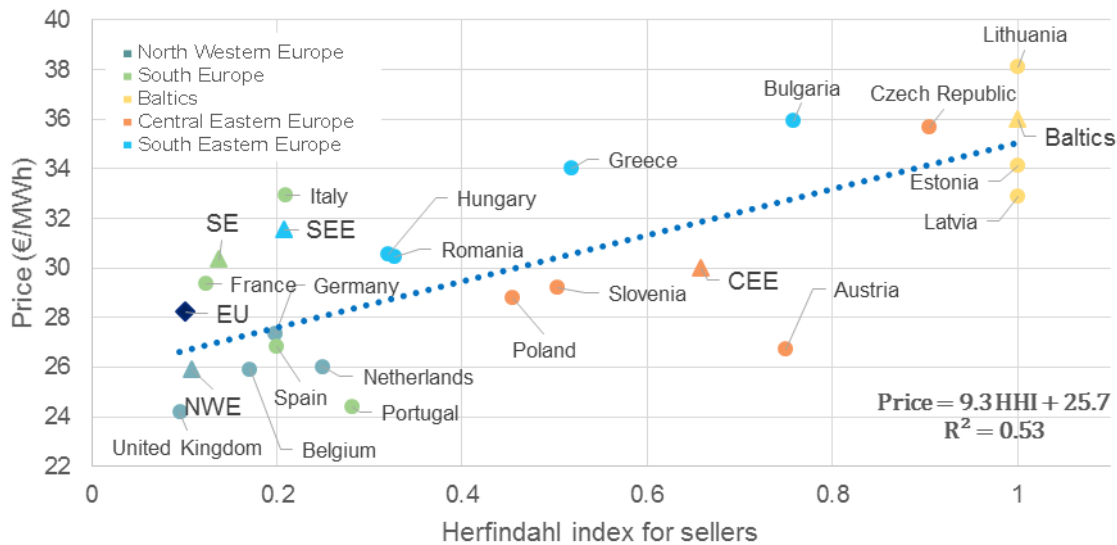
Note: *1. The Czech Republic has recently undergone structural changes in its gas market. The 2013 price and HHI shown in graph are not representative*

2. It is possible that the HHI of a region is lower than the constituent countries. A different monopolist in each country will give an HHI of 1 per country; however, in the region this means there are different sellers so an HHI less than 1

3. Price data for Sweden, Denmark, Finland, Croatia, Ireland, Luxembourg and Slovakia is not available for the 2012-2013 time frame, hence these countries are omitted

Source: Vivid Economics based on SPD Frontier, Eurostat, Reuters and Platts data

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Table 3.   **Seller side HHI and expected country gas prices**

Country	HHI	2012 – 2013 avg price (€/MWh)	Average price predicted by HHI (€/MWh)	Deviation relative to expected price (€/MWh)	Deviation relative to expected price (per cent)
EU	0.15	28.22	27.13	1.09	4%
North West Europe	0.21	25.88	27.68	-1.80	-7%
South Europe	0.14	30.33	27.04	3.30	11%
Baltics	1.00	36.00	35.07	0.92	3%
Central Eastern Europe	0.53	29.97	30.66	-0.69	-2%
South Eastern Europe	0.29	31.56	28.40	3.15	10%
Austria	0.75	26.74	32.70	-5.95	-22%
Belgium	0.17	25.93	27.31	-1.38	-5%
Bulgaria	0.76	35.93	32.78	3.15	9%
Croatia	0.60		31.29		
Czech Republic	0.91	35.66	34.14	1.52	4%
Denmark	0.26		28.11		
Estonia	1.00	34.14	35.02	-0.88	-3%
Finland	1.00		35.02		
France	0.12	29.35	26.87	2.48	8%
Germany	0.20	27.35	27.56	-0.22	-1%
Greece	0.52	34.03	30.54	3.49	10%
Hungary	0.32	30.57	28.69	1.88	6%
Ireland	0.12		26.85		
Italy	0.21	32.94	27.67	5.28	16%
Latvia	1.00	32.90	35.02	-2.12	-6%
Lithuania	1.00	38.09	35.02	3.07	8%
Luxembourg	0.32		28.68		
Netherlands	0.25	26.03	28.03	-2.00	-8%
Poland	0.45	28.80	29.95	-1.15	-4%
Portugal	0.28	24.39	28.34	-3.95	-16%
Romania	0.33	30.47	28.76	1.71	6%
Slovakia	0.96		34.64		
Slovenia	0.50	29.19	30.40	-1.21	-4%
Spain	0.20	26.84	27.58	-0.74	-3%
Sweden	0.28		28.29		
United Kingdom	0.09	24.19	26.60	-2.41	-10%

Note: *Average price is predicted from the simple regression: $Price_i = 25.7 + 9.3\ HHI_i$. The regression explains 51 per cent of the variation in EU gas average prices. If Italy and Greece are excluded from the regression then 74 per cent of the price variation is explained by the seller side HHI.*

Source: *Vivid Economics based on SPD Frontier, Eurostat, Reuters and Platts data for the 2012-2013 period*

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There are five other channels through which the price can be reduced in addition to the quantity reduction channel. First and second, improved negotiation and market integration can bring down the price payed by buyers in individual Member States by moving them to the regression line or to the minimum observed price in the regional group. Third, countries can pay prices that are consistent with the market-wide HHI. Most countries will move down and to the left in Figure 9, and thus will pay a lower price implied by the fitted line. The fourth and fifth channels involve reducing the HHI for the regional groups by a combination of additional sellers and seller optimisation policies.

Table 4.   **Seller side HHI and regional minimum gas prices**

Country	HHI	2012 – 2013 avg price (€/MWh)	Minimum regional price	Deviation relative to minimum price (€/MWh)	Deviation relative to regional minimum price (per cent)
Austria	0.75	26.74	26.74	0.00	0%
Belgium	0.17	25.93	24.19	1.73	7%
Bulgaria	0.76	35.93	30.47	5.45	15%
Croatia	0.60				
Czech Republic	0.91	35.66	26.74	8.92	25%
Denmark	0.26				
Estonia	1.00	34.14	32.90	1.24	4%
Finland	1.00				
France	0.12	29.35	29.07	0.28	1%
Germany	0.20	27.35	24.19	3.15	12%
Greece	0.52	34.03	30.47	3.56	10%
Hungary	0.32	30.57	30.47	0.10	0%
Ireland	0.12				
Italy	0.21	32.94	29.07	3.87	12%
Latvia	1.00	32.90	32.90	0.00	0%
Lithuania	1.00	38.09	32.90	5.19	14%
Luxembourg	0.32				
Netherlands	0.25	26.03	24.19	1.84	7%
Poland	0.45	28.80	26.74	2.06	7%
Portugal	0.28	24.39	24.39	0.00	0%
Romania	0.33	30.47	30.47	0.00	0%
Slovakia	0.96				
Slovenia	0.50	29.19	26.74	2.45	8%
Spain	0.20	26.84	26.84	0.00	0%
Sweden	0.28				
United Kingdom	0.09	24.19	24.19	0.00	0%

Note: *Minimum regional price is the highest of the competitive price and the lowest price paid in the regional group.*

Source: *Vivid Economics based on SPD Frontier, Eurostat, Reuters and Platts data for the 2012-2013 period*

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Table 4 shows that, across the five EU regional group, the median premium paid for gas above the minimum price is 7 per cent. However, there are outliers with the Czech Republic paying 25 per cent more than the lowest price in the region, Bulgaria paying 15 per cent more and Lithuania paying 14 per cent more. Italy, Greece and Germany also pay a premium over the minimum price.

3.5 Trends in patterns of trade

There has been a global trend of increased trade in gas and diversification of sellers supplying regions of the world. There have been active policies of diversification in countries such as Japan, South Korea and China. Over the last couple of decades, seller numbers have risen in Europe and other major gas importing countries. However, as is indicated by the dispersion of gas prices presented earlier, some European regions have high seller concentration.

The past ten years have seen a significant change in the patterns of gas trade globally. The shipping of LNG, for example, has enabled Japan to grow from importing from nine countries in 2003 to 17 in 2013. China had built up its seller base to 11 countries in 2013. This exerts competitive pressure on individual sellers from within those countries. It is possible to approximately compare the competitive pressure for sellers in the various destination countries they sell to, simply by examining sellers aggregated by country. Let us compare two countries exporting to the EU, one a pipeline and LNG exporter, Russia, and the other an LNG exporter, Qatar. As a whole, Russia faces more competition in selling to the EU than it experiences in supplying many of its other customers in the Former Soviet Union, as shown in Figure 10. The Baltic region has some similarity with the FSU states in terms of its seller diversity.

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Figure 10.   **Russia faces little seller competition in many of the markets in which it operates**
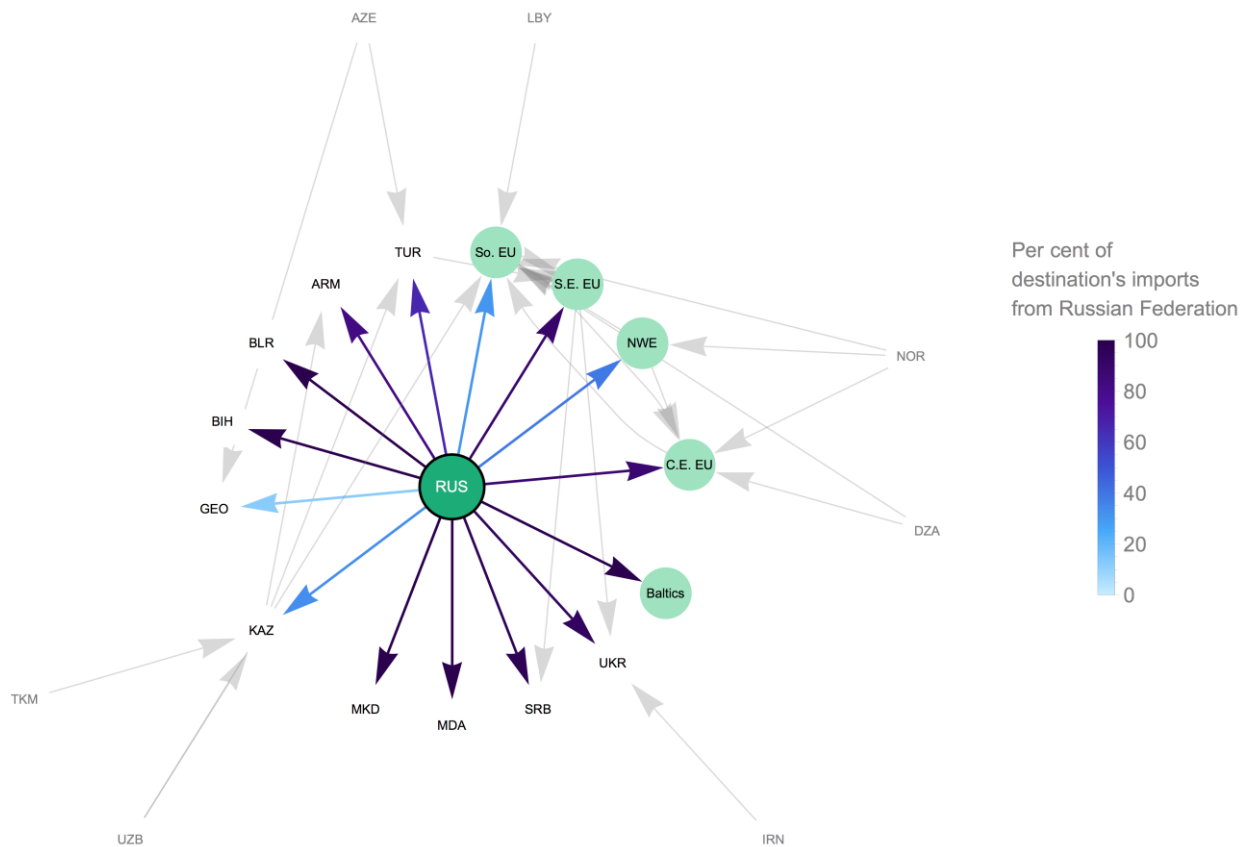
Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

Qatar, the world's largest LNG exporter, faces a moderate amount of competition in selling to the EU.
The EU is roughly in the middle of the pack of destination countries for Qatar's gas in terms of the amount of competition from other gas sellers. Unsurprisingly, Qatar faces much more competition in the Americas than it does in the EU, in the sense that it accounts for a smaller fraction of imports. But it even faces slightly more competition in the Asian market of Korea, Japan and China, as shown in Figure 11. This suggests that there is scope to create greater competition for importers to Europe and especially those parts of Europe where the seller base remains quite concentrated.

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Figure 11. **Qatar faces more competition in selling gas in the Americas and Asia than it does in the EU and Middle East**

Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

Over time, seller diversity in the EU has increased as shown in the following Figures.

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Figure 12. **From 2003 (top chart) to 2013 (bottom chart) the seller base of the EU has diversified**

Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2002-2003 and 2012-2013 periods

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The seller diversification and competition for importers is much greater for some parts of the EU than for others. This can be seen clearly presented in the form of web diagrams, shown in Figure 13 to Figure 17 even though these are compiled using country trade data rather than firm-level seller data. There is huge variation from the concentrated position of the Baltics in the 2013 data exhibited here, to the highly diversified seller base of South Europe.

Figure 13. **The Baltics, had until this year a single country source of sellers, Russia, which has many other customers**

Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

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Figure 14.   **Central Eastern Europe has a partially diversified base of countries of origin of sellers**
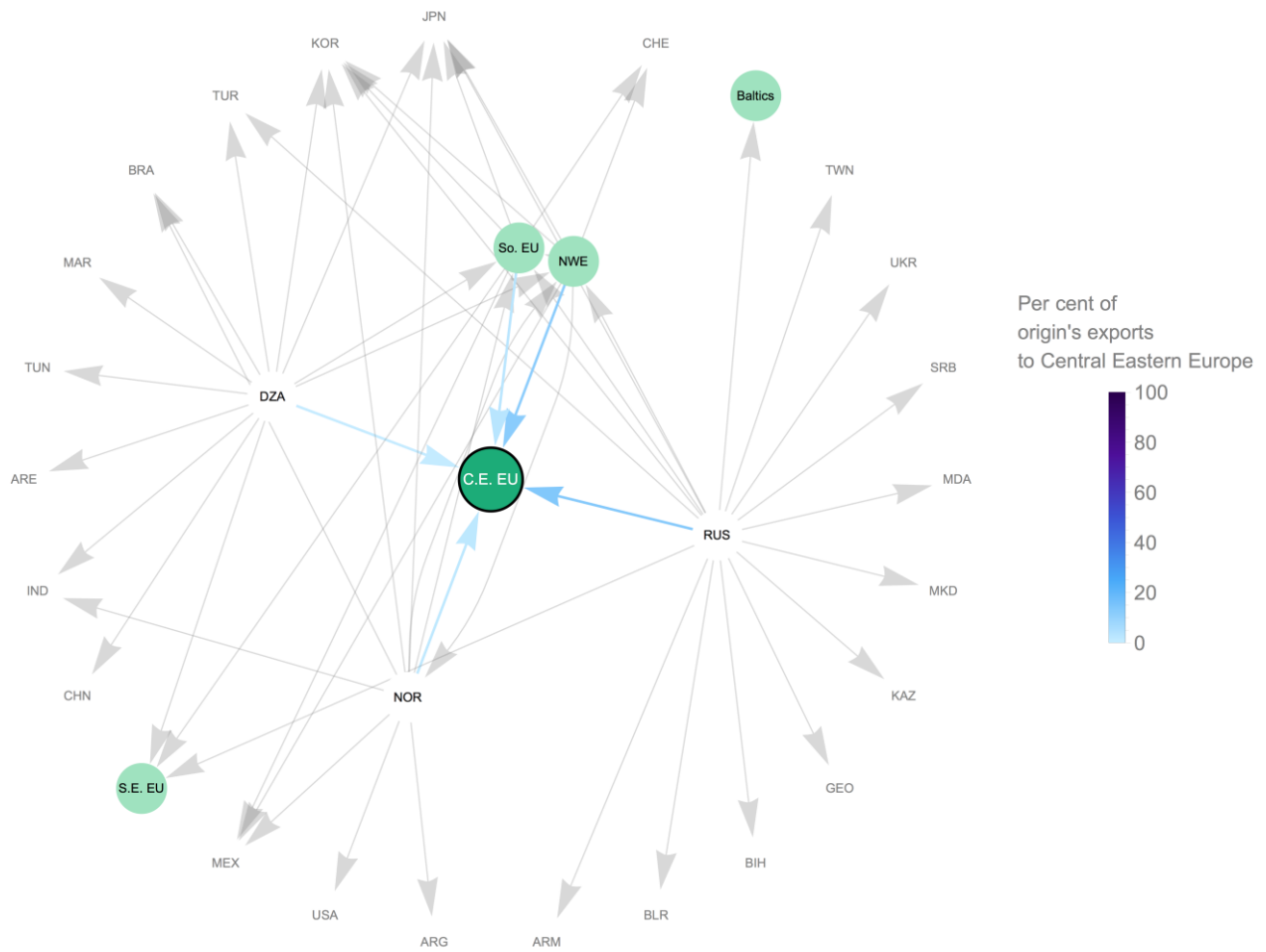
Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

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Figure 15. **South Eastern Europe depends on very few countries of origin of sellers**

Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

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Figure 16. **North Western Europe enjoys a more diversified base of countries of origin of sellers**
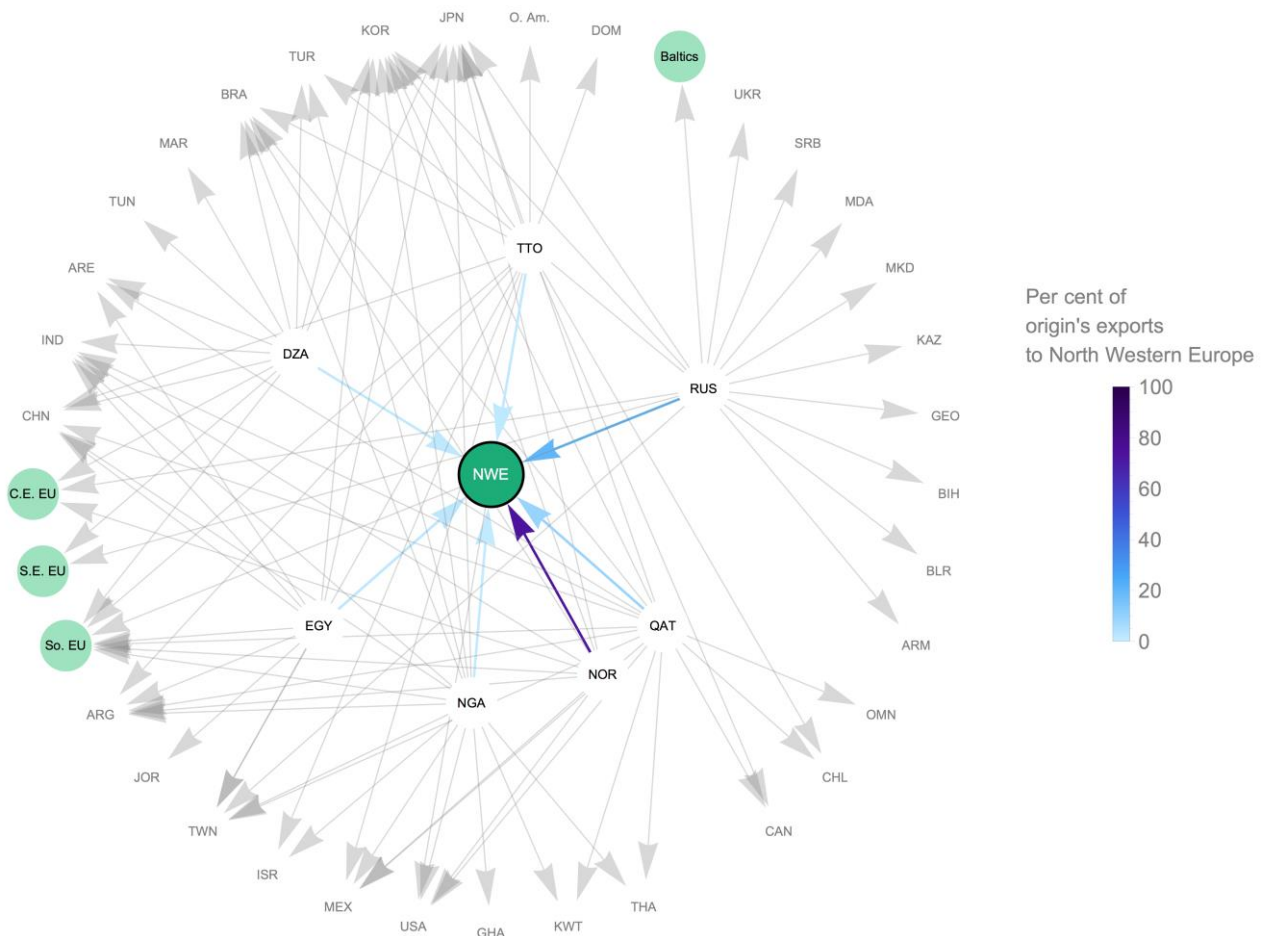
Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

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Figure 17. **The most diversified of all is the seller countries of origin of South Europe**
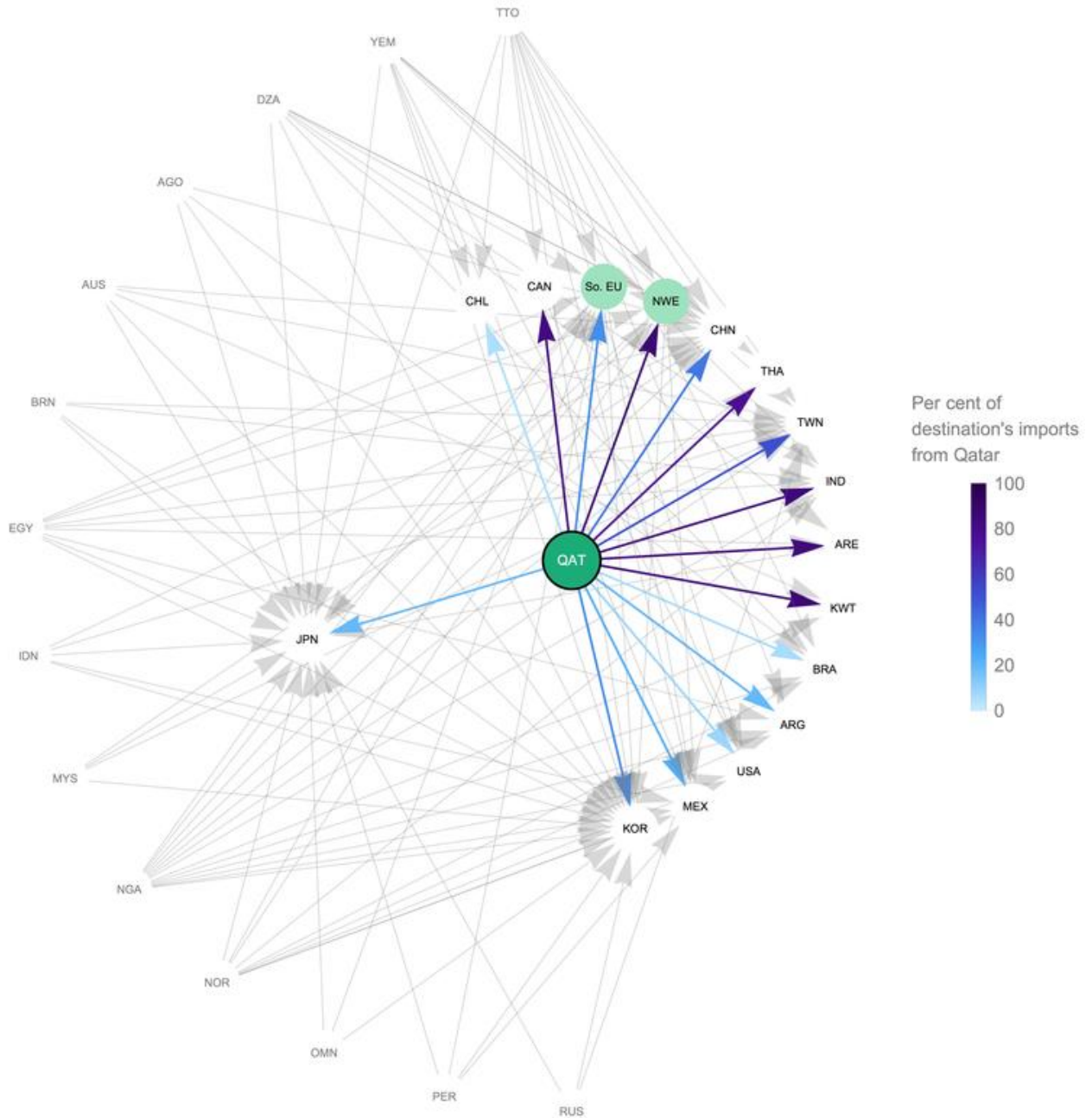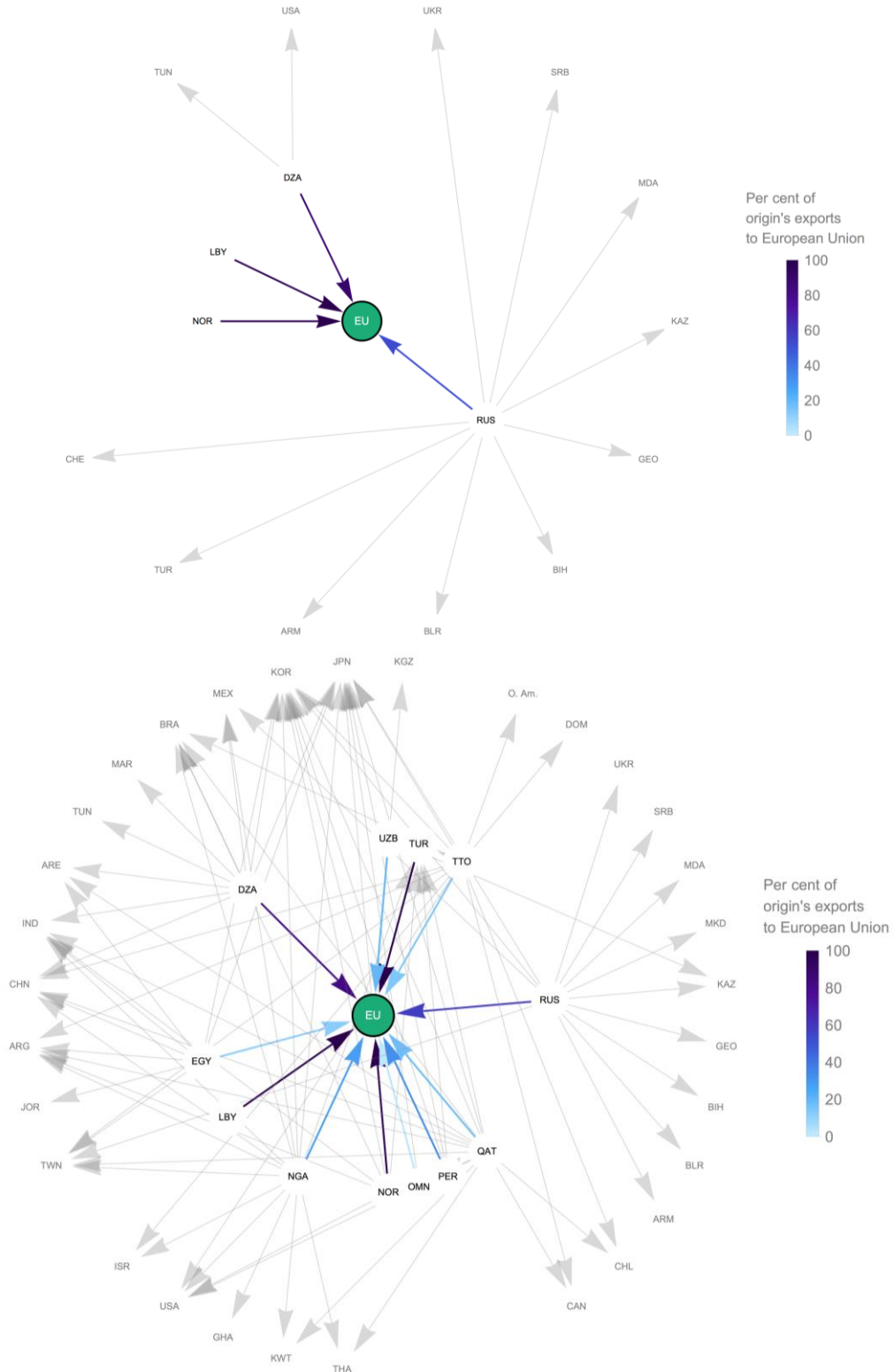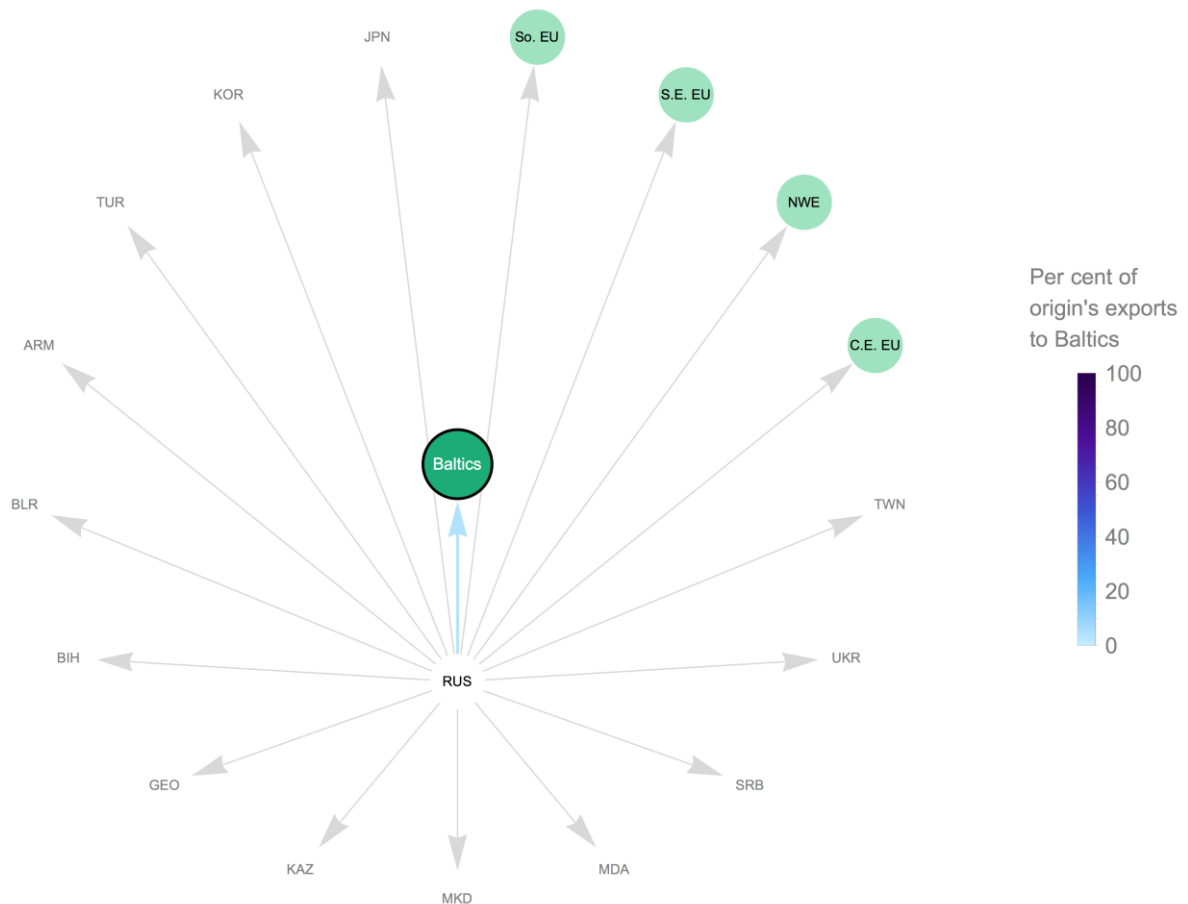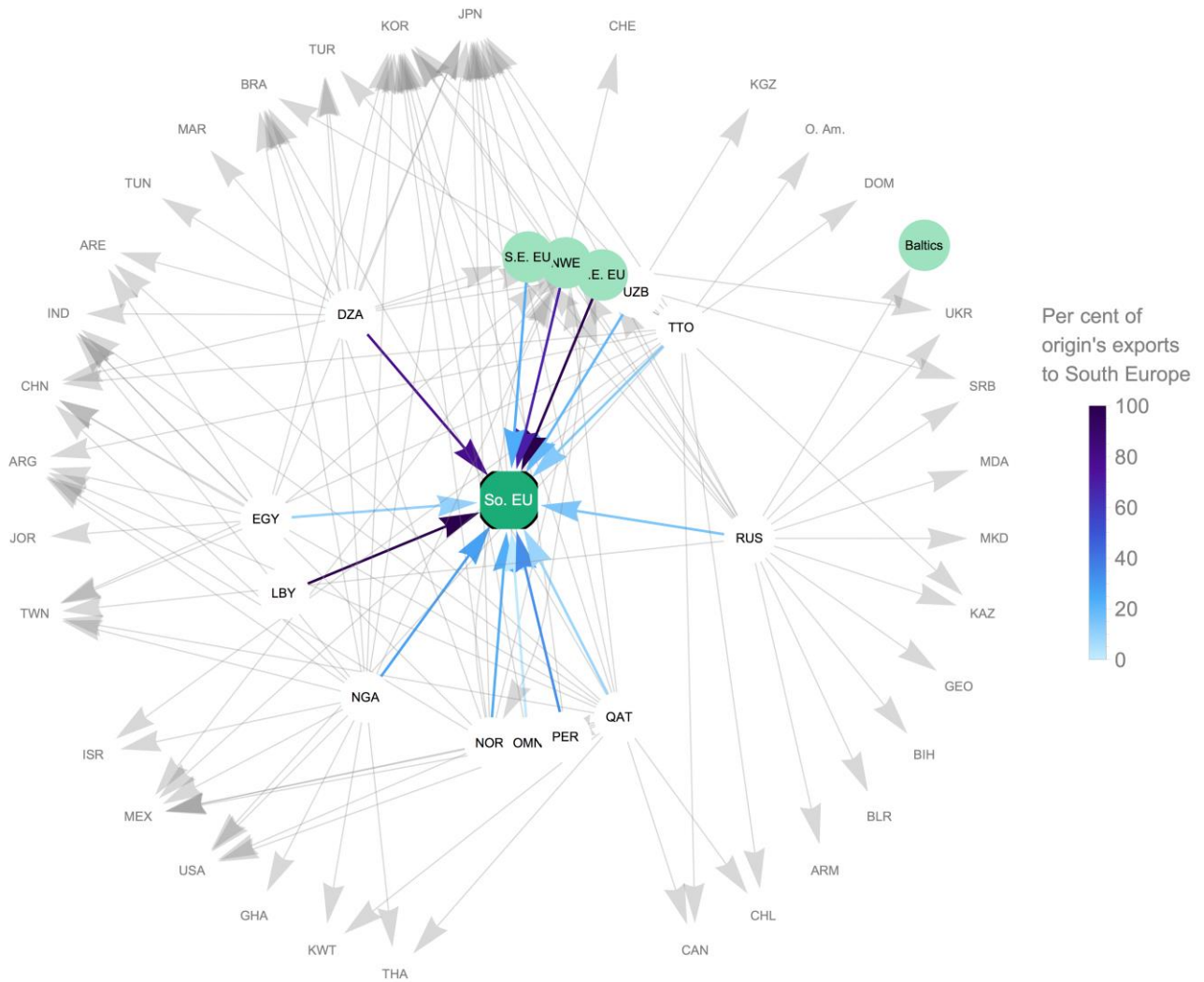

Note: Each arrow indicates the existence of exports. The colour of the arrow signifies the importance of the export in the importing countries' total gas mix.

Source: Vivid Economics based on IEA data for 2012-2013 period

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4 Economic framework and model

This section begins by discussing the economic principles underlying the market impact of collective purchasing arrangements, based on the economic theory of competition. It then describes the setup of the Vivid Buyer Power Model, and how the different policy options were modelled.

4.1 The effect of market structure

4.1.1 Explanation of observed variation in market prices

In a perfectly competitive market, in which neither any individual buyers nor any sellers have market power, the intersection of the demand and supply curves determines the equilibrium market price. At this equilibrium, the market price equals the unit cost of the producer supplying the marginal unit of gas. With an upward-sloping supply curve, producers with marginal costs that are lower than this market price make an economic profit.

The reality of the EU gas market reflects elements of both seller (oligopoly) power and buyer (oligopsony) power, and the balance between the two is critical to understanding price outcomes. Market power of sellers creates an incentive to restrict supply to raise price; market power of buyers creates an incentive to restrict demand to push the gas price down.

If buyer power exceeds seller power, the net effect of these two forces is to push price below the perfectly competitive level. Using the above argument, this price lies below the marginal cost of the producer who would have been the seller of the marginal unit of gas under perfect competition. As a result, some production is priced out of the market due to buyer power. This inefficiency is the result of buyers' market power. However, producers with sufficiently lower costs still remain profitable despite the lower price. This result is analogous to the standard monopoly result that consumers with a sufficiently high willingness-to-pay still purchase a good even if it is sold above marginal cost.

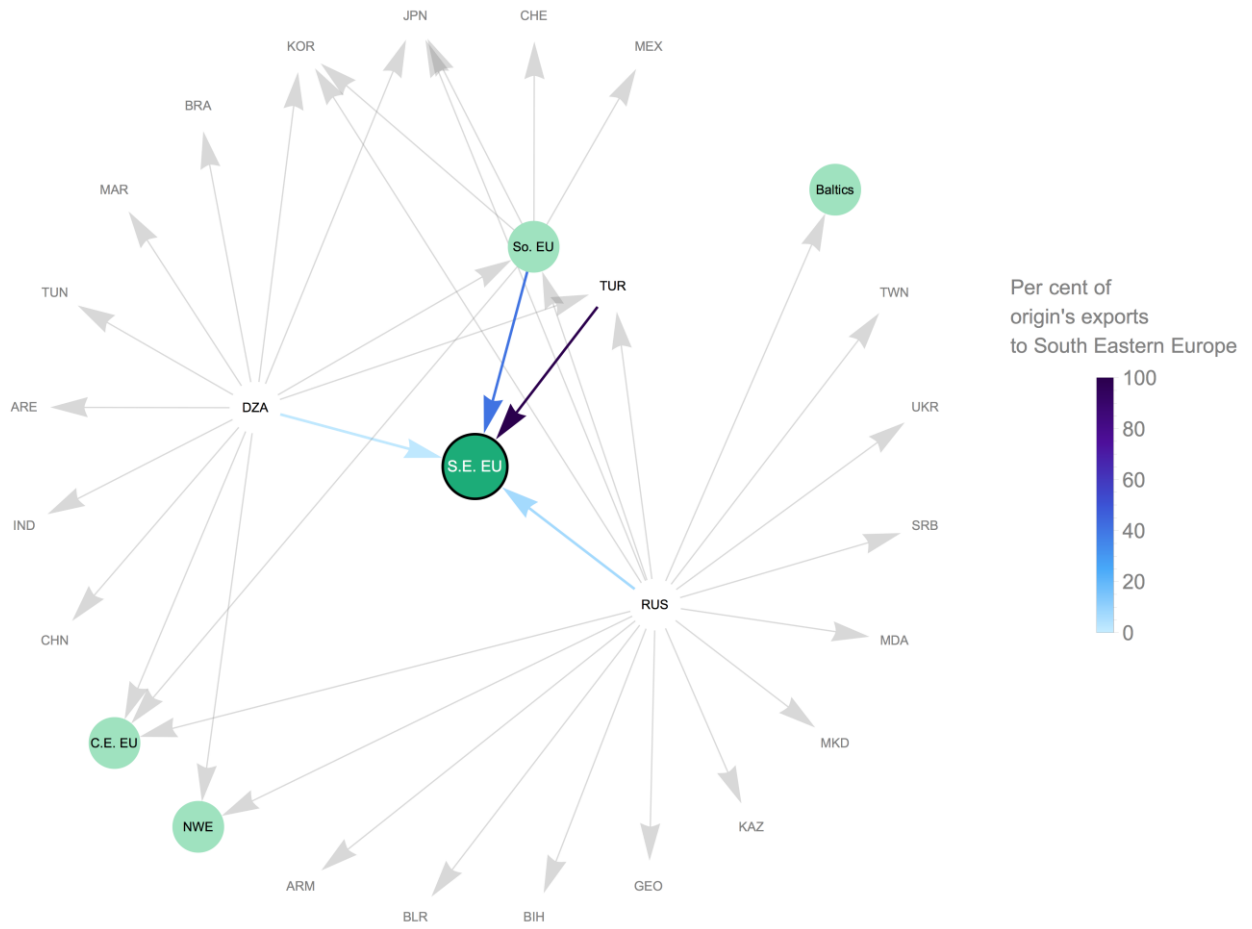**The analysis shown in Figure 18 suggests that observed prices in the eastern European markets are higher than they would be under a competitive market structure.** Correspondingly the traded quantities are lower than the competitive market scenario. Markets in Western Europe are more balanced with prices and quantities close to the estimated competitive levels. The observed average price in the Central Eastern Europe market is 30 per cent higher than the estimated competitive price, however the South Eastern Europe market has an average price only 8 per cent higher than the competitive outcome. The Baltic market has a much more extreme departure from the competitive outcome, with the price being 63 per cent higher and the quantity being 50 per cent lower. However, it seems likely that in reality, the difference is not so great and that these differences are over-estimates. It seems likely that the market is already contestable and this has somewhat counteracted the power of the principal seller, Gazprom. The Western Europe and Southern Europe markets have prices in line with competitive market outcomes.

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The deviations from competitive market prices are explained by the balance of power between sellers and buyers. In the Baltics, Southern and Central and Eastern Europe regions, sellers enjoy more market power than buyers. This is shown by the position of those regions above the diagonal line in Figure 18. The diagonal line marks balanced market power. The further away from the origin, the greater the market concentration.

Figure 18. **Buyer and seller Herfindahl indices for each region & the EU**
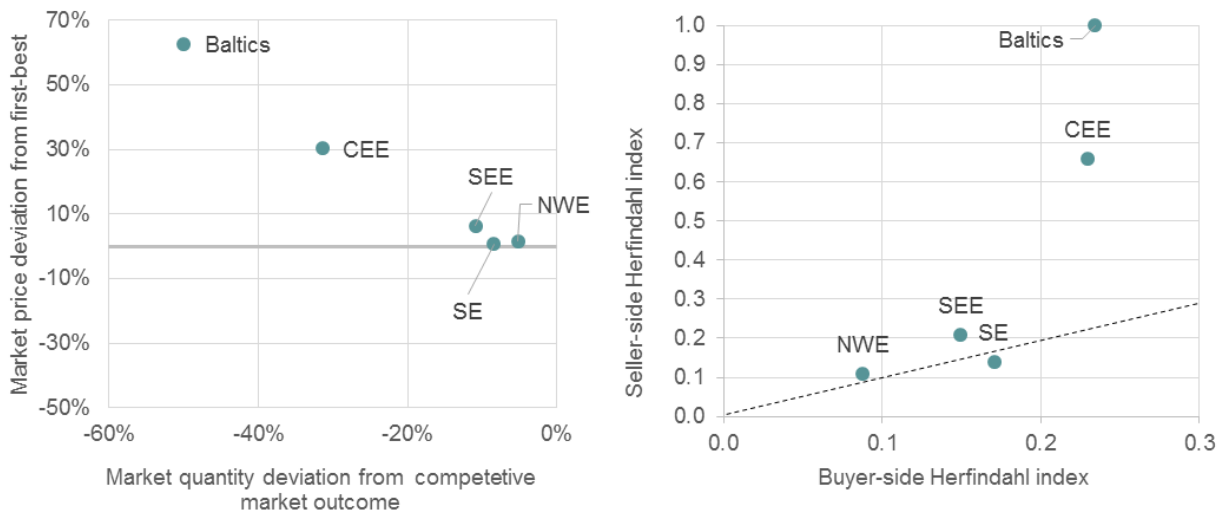
Source: *Vivid Economics based on SPD Frontier, Eurostat and IEA data*

4.1.2 Explanation of way in which the channels have impact

When a buyer is a poor negotiator, sellers notice that the buyer is ineffective at harnessing the effect of competition or is poorly informed about supply costs, and sellers do not lower their prices. Not only might the buyer fail to ask other sellers to bid for its contract, thereby fostering some competition, but also the buyer might be unaware of the production costs of the seller and therefore of its negotiating position. For example, a gas buyer that does not have its own production operations may not understand the cost structure of the sellers. Furthermore, a buyer who is a poor negotiator may simply not stand its ground in negotiations. As a result of any of these factors, even though the seller would be willing and able to reduce its price, it does not do so. It is able to price close to the demand curve shown in Figure 19.

Additional sellers or seller portfolio optimisation result in increased competition between sellers. This causes the market price to move downwards from the demand curve towards the supply curve, as sellers cede margin in exchange for sales. As competition between sellers intensifies, the price each receives more closely resembles the marginal cost of production, which is reflected in the supply curve. For illustration, in a world of many atomistic buyers forming the demand curve, this brings the price down from the monopoly Point C in Figure 19 along the demand curve towards Point A. If there are enough additional sellers, the market outcome moves all the way down to reach the supply curve at Point A. Point A represents the outcome where there are many buyers and many sellers, labelled perfect competition. This outcome produces

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the greatest possible economic welfare for buyers. In North West Europe, for example, there are already many buyers and sellers and the price is close to Point A (as noted in Section 3).

Figure 19. **The additional sellers and seller portfolio optimisation channels of influence can move the market outcome from point C (monopolist) towards point A (perfect competition) to the benefit of buyers**
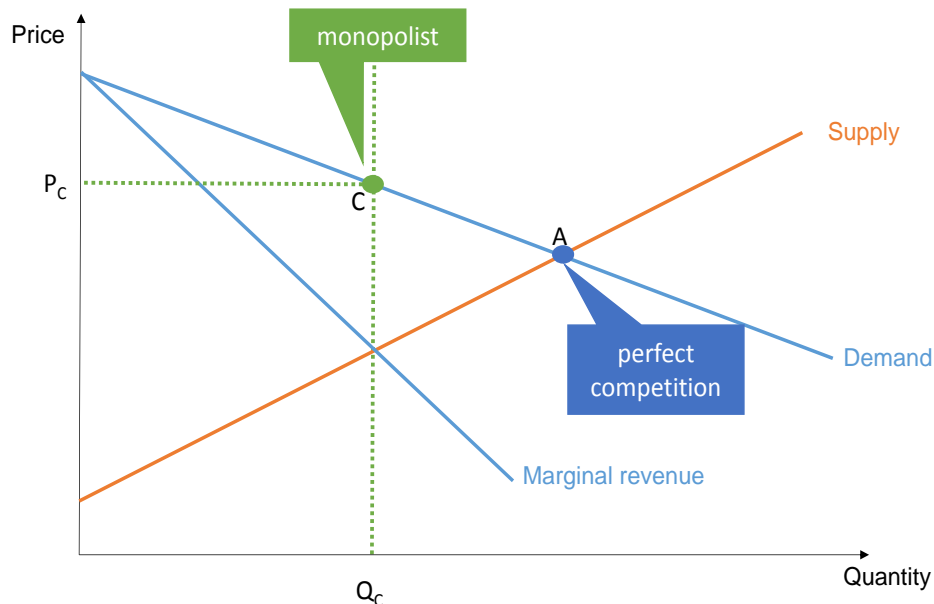
Source: Vivid Economics (2015)

When a single buyer faces a monopolist or a very concentrated seller market, a range of outcomes are possible. A single seller, a monopolist, would like to maximise its profits by setting output at the quantity where its marginal revenue equals supply. Marginal revenue is the additional amount of revenue the seller receives when it sells one additional unit of output, adjusting for the slightly lower price that an extra unit would entail. In pursuing maximum profit, it restricts its output to below the quantity at perfect competition and chooses Point C. It benefits more from the higher margin it gains than it loses from the reduced volume of sales. Similarly, a single buyer, a monopsonist, would like to maximise its welfare by buying a quantity where its marginal factor costs equals willingness to pay (the demand curve). The marginal factor cost is the additional expenditure it makes when it buys one more unit for consumption. This causes it to restrict its consumption to below the quantity at perfect competition and chooses Point B as shown in Figure 20. It benefits more from the lower price than it loses from the reduced volume of consumption. When there is market power in the hands of both the seller(s) and buyer(s), the outcome depends on their relative market power and their negotiating skill.

For example, if a single buyer and a single seller interact, then they would trade the heavily restricted quantity Q_D shown in Figure 20. A range of outcomes is possible in terms of price, as shown by Line D; it includes all prices at which both seller and buyer would be willing to trade. A drawback of economic theory is that, for given demand and supply curves, it does not uniquely pin down where exactly on this interval the market outcome will lie. The actual market outcome will be determined by their relative negotiating skills.

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The outcomes for all combinations of buyer and seller policy thus involve quantities anywhere between Q_D and the competitive outcome at Point Q_A, and prices anywhere along Line D.

In summary, the following characteristics determine the final market outcome:

– *Buyer and seller power*: relative pricing power is determined by market structure, that is, the distribution of market shares amongst sellers and buyers, where greater concentration amongst sellers generally confers more power on them, and likewise for buyers.

– *Buyer and seller behaviour*: behaviour is driven by the objectives of the firms and the resources available to them to pursue those objectives, to maximise profits or sales (for sellers), and to maximise welfare or consumption (for buyers). For example, a buyer which does not have the ability to control its own consumption, cannot pursue a welfare maximising strategy. Similarly, a group of sellers who wish to operate a cartel, as is seen in OPEC, cannot control output unless they have a means of disciplining members.

– *Buyer and seller negotiating skill*: negotiating skill is affected by the information available to the negotiator, and the negotiator's experience, incentives and commitment.

– *Shape of the demand and supply curves*: steeper sloping (more inelastic) curves create greater potential reallocations of surplus (margin) with smaller changes in quantity, characteristic of the short run. Shallow sloping (more elastic) curves create less opportunity for surplus (margin) reallocation but larger changes in quantity, typical of the long run.

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Figure 20. **The consumption channel of influence moves the market outcome towards Point B, while the negotiation channel determines where prices lie on the interval given by the Line D**
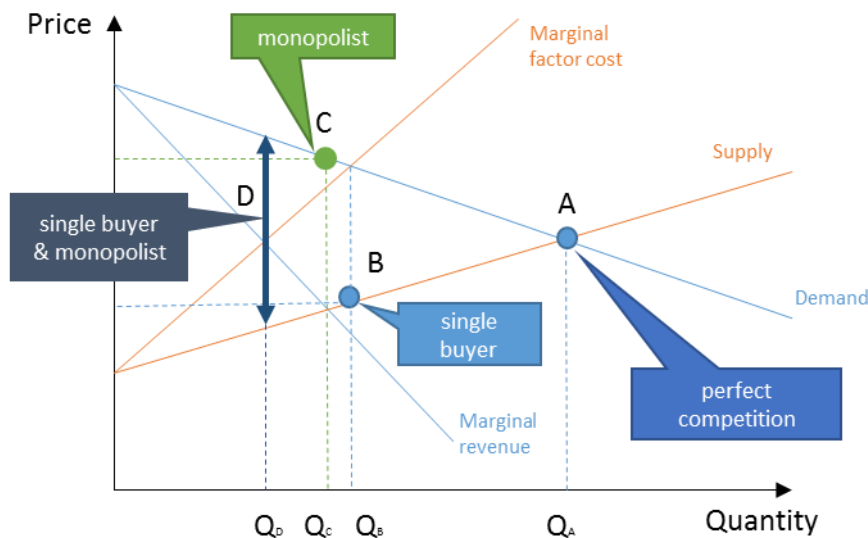
Source: Vivid Economics (2015)

When a single buyer faces several or many sellers and it has the ability to control consumption, then it can maximise its own economic welfare by restricting demand and thus reducing price. In doing so, the welfare lost through reduced consumption is more than compensated for by a reduced price paid for remaining consumption, so its overall welfare rises. This economic principle is clear in theory yet, in practice, it is often difficult for a single buyer to implement such a policy of consumption restriction, especially where it involves large cutbacks among its individual constituent buyers. Such practical barriers to implementation are further discussed in Section 7.

4.2 Approach to the model

The Buyer Power Model is a quantitative representation of competition in industrial markets in which both buyers and sellers may possess market – or bargaining – power, applied to the EU gas market. It is based on the economic theory of imperfectly competitive markets, in which some or all players behave strategically. It is capable of representing all market structures ranging from perfect competition to pure monopoly and pure monopsony. There is a description of the model in Appendix 2.

The approach includes the case of bilateral oligopoly in which both buyers and sellers have some degree of bargaining power, which is particularly relevant for natural gas in large parts of Europe. The model shows how the gains from gas trade are split between the buy-side and the sell-side; that is, where the market price lies in the continuum between sellers' marginal costs and buyers' willingness-to-pay. As noted above, this split is determined by the number of players and industry concentration on each side of the market, as well as demand and supply conditions. The model can assess how the split is affected by policies

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aimed at raising buyer power in the EU gas market, namely by establishing a mandatory single buyer or voluntary regional demand aggregation and options which diversify supply. The data used in the model allow for fairly simple calculations to assess the scope for improved buyer negotiation. The method is similar to those commonly used in merger and competition analysis in the sense that they can be used to test scenarios with different market shares of participants.

The features of the model capture the essential economic elements of the EU gas market as a whole, including the differences in market structure across individual countries and regions within the EU. The model separately represents the main EU regions such as South-Eastern Europe (SEE), Central-Eastern Europe (CEE), North-Western Europe (NWE), Southern Europe (SE) and the Baltics (B). The modelling results are differentiated across regions. In this way, the model generalizes from the stylised cases of perfect competition, monopoly and monopsony to capture real-world market structures.

The model is set up in a way that makes it less data-intensive than other models of the EU gas market, for example, the large-scale models found in the academic literature (Egging & Gabriel, 2006) (Egging, Gabriel, Holz, & Zhuang, 2008) (Holz & von Hirschhausen, Christian Kemfert, 2008)**.** This enables the quantitative analysis to be performed on a tight schedule, and should make it easier for policymakers to understand the essential economics at work. The model starts off from the observed outcome in the EU gas markets, for instance on prices and quantities. It then estimates the underlying demand and supply conditions which delivered this outcome, given the observed market structure.

4.3 Assumptions underlying the model

The modelling approach rests on a number of assumptions, all of which are standard in the economics literature. While these assumptions cannot be relaxed within this exercise, the project does explore some of them qualitatively, as indicated. Table 5 summarises the assumptions.

Table 5. **Assumptions underlying the Vivid Buyer Power Model**

Assumption	Description
Partial equilibrium	The model is based on a partial equilibrium system of equations; it is not a general-equilibrium model that is able to capture interactions between the gas market and the rest of the economy. The model therefore runs with the 'all else equal' assumption that conditions, for example, in labour and financial markets as well as other commodity markets, such as the oil market or the EU Emissions Trading Scheme, do not vary with gas market policy. This assumption means that the model cannot perform a full-fledged welfare analysis, which would have to take into account such higher-order impacts on other parts of the economy, but it can still obtain estimates of welfare impacts.

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Profit maximization	The model assumes that the players represented in the model, that is, gas buyers and sellers, are rational economic actors who maximize their respective payoffs. For sellers, this corresponds to maximizing the economic profit from selling gas, that is, the difference between revenues and cost. For buyers, this comes down to maximizing net utility, trading off the utility derived from gas consumption against the cost of buying the gas. Moreover, it is assumed that individual actors initially do not coordinate their actions; the impact of such coordination, amongst buyers, is explored as part of the analysis.
Law of one price	The model assumes that the law of one price holds within each market considered in the analysis. In other words, there is a single price in a market at which all trade between buyers and sellers occurs. The model does not allow, for example, for a seller of gas to discriminate between buyers within the same market by offering gas at different prices. This is accounted for off model. Implicit to the law of one price is that any such price differences would be efficiently arbitraged away by gas traders.
Pricing mechanisms	The model does not explicitly feature long-term contracts between gas buyers and sellers. It does not distinguish between gas sales by long-term contract and those that take place in short-term or spot markets (gas hubs). The results from the model can be interpreted as arising from a mix of short-term and long-term pricing. The model takes the price of gas in different contractual arrangements to be identical in each market. Implicit in the analysis is that either not all trade is by long-term contract, or that at least some contracts are renegotiated over time.
Market liquidity	The model focuses on market outcomes in terms of gas prices and quantities, including import and export volumes, and the market shares of individual players. It does not incorporate a notion of 'liquidity' in the EU gas market, as could be measured, for instance, as the churn ratio or bid-ask price spreads at one of the European gas trading hubs. Liquidity effects are discussed qualitatively outside the model. In the model, all trade in a market takes place at the (single) prevailing market price; no additional trade beyond this occurs because there is no buyer-seller pair in the market that can agree on it.
Isoelastic demand and supply functions	The model uses demand and supply functions with an elasticity parameter that does not change with quantity. Empirical estimates of wholesale gas market elasticities are used, taken from the literature review in Section 2.5. Since the elasticity estimates from the literature vary quite widely, the model results are sensitivity tested to a range of elasticity values.
Demand function capped from above	In order to be able to compute welfare, the demand function is assumed to be capped at a very high price. This means buyers are not willing to pay prices higher than the cap. The cap is set at €60/MWh. This means the welfare figures are arbitrary but the differences in welfare between the policy scenario and the baseline are valid, so only the difference estimates are presented in the results. The differences do not change when varying the price cap. A consequence of this is that welfare changes cannot be expressed as a percentage change, so the absolute welfare change is normalised by initial quantity instead, when it is presented in the results.

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4.3.1 The role of asymmetric information in the empirical implementation of a model

The Vivid BPM indirectly incorporates the impact of asymmetric information in the initial setting without policy. In practice, the EU gas markets may be characterized by some of the large sellers having superior information to buyers on cost conditions. The key point is that the impact of such asymmetries will be observed in past market outcomes on prices and trade volumes. Further discussion of asymmetric information is presented in Appendix 1. The empirical implementation in Vivid's model uses this observed market data on prices and quantities for calibration, and estimates the degree of market power held by individual buyers and sellers. Although the impact of asymmetric information is not directly modelled, it is built into the calibration.

Vivid's model does not estimate the sources of this market power; these could include asymmetric information but also financial constraints, political considerations, and other barriers to entry. Moreover, Vivid's model assumes that the law of one price holds in each regional group, while in practice buyers may be paying somewhat different prices, and asymmetric information may play a key role in creating and sustaining such price dispersion.

4.4 Data

Data for the descriptive statistics and model come from a variety of international databases. The data entering the model is shown in Table 6. Gas production, consumption, import and export data are sourced from the IEA energy balances database. Assessments and estimations of gas prices for EU Member States were provided by the European Commission and were classified into gas-on-gas competition and oil indexation, for both pipeline and LNG transport modes. The definition of a market quantity and price requires aggregation by Member States and averaging over Member States and time. The market traded quantity is defined for regional groups by adding Member States' traded quantities, averaging these quantities for the years 2012 and 2013. Regional group prices are defined as the quantity weighted averages of Member States' prices in each region, again averaged over the period 2012 to 2013. **Note that by aggregating quantities and prices, no claim is being made that the regional groups function as regional markets**.

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Table 6. **Overview of data for Vivid Buyer Power Model**

Variable	Unit	Sources
Market prices	Euro/production unit	Eurostat Comext, Thomson Reuters and Platts
Sales of gas by country (pipeline and LNG)	Production unit	Eurostat and IEA
Supply shares (HHI)	Unit-less	SPD Frontier
Gas consumption, production, import and export by country	Production unit	IEA
Price elasticities of demand and supply	Unit-less	Literature review (see Table 3)
Number of conveyors in EU MS	Unit-less	Eurostat
Market shares of gas buyers and sellers	Per cent	Eurostat, IEA and Vivid own calculations

Source: Vivid Economics (2015)

Regional groups are defined with respect to the buyers and sellers engaging in trade in those markets. Sellers are firms selling into regional groupings, for example, Gazprom (Russia) and Sonatrach (Algeria) are sellers in the South European Market. Buyers, on the other hand, are defined as all the major gas conveyors operating in the regional group. Conveyors can be both importers and indigenous producers. Indigenous producers are assumed to be vertically integrated, making them buyers as well. Within each country, a number of firms act as independent buyers in the market. For example, if there were four countries in a region each with three buyers, the total number of buyers in the regional group would be assumed to be 12.

The quantity data captures total quantity traded, taking into account imports from outside the region and intra region trade. It is less clear to what extent the calculated average prices fully reflect the actual mix of short and long run contract prices in the regions and thus the true average prices paid by Member States. There may be restrictions of trade within regions due to infrastructure bottlenecks, contractual commitments and conflicting rules.

4.5 How each policy is modelled

4.5.1 Estimation of impacts on market structure, prices and welfare

The model begins by estimating the degree of market power held by each individual gas buyer, and gas seller in the market. This comes in the form of estimates of the profit margins achieved by these players. In a market where buyers and sellers behave strategically, each player is faced with a trade-off between buying or selling at their optimal levels and reducing traded quantities to obtain a better price. Both buyers and sellers have an incentive to reduce their traded quantities so that they can influence the price. However, their ability to do so depends on their market share. At one end of the spectrum a single buyer has substantial market power and a reduction in quantity demanded will have a large impact on the price, leading to significant departure from the perfect competition outcome. At the other end of the spectrum, a small

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buyer will not affect the market price by reducing its quantity. These results are aggregated up to obtain an index of the overall balance of power in the market and its current split between buyers and sellers. This characterisation then forms the benchmark, or baseline scenario, against which buyer power policies can be tested.

The policy options considered in this study change the competitive conduct of gas-market players. The six policies have the following effects:

– *negotiation*: those buyers who currently pay higher prices within a regional group, learn from their more capable peers within the market, then achieve the same low prices as their best-performing peers;

– *market integration*: countries develop stronger infrastructure and market arrangements within a region to create an effective single geographic market in the region, giving each country access to all sellers;

– ;

– *additional sellers*: the addition of new sellers creates additional competition for incumbent sellers and weakens their bargaining power;

– *seller portfolio optimisation*: a strengthened market share among smaller sellers makes them more effective in containing the pricing power of the biggest sellers, keeping prices down;

– *consumption restriction*: collective purchasing leads newly-formed single buyers to trim consumption, forcing sellers to accept lower prices and consumers to accept lower consumption;

– collective purchase: countries coordinate to organise improvements in infrastructure or the building and operation of strategic reserves.

The Buyer Power Model uses shifts in the market shares of individual players to impute changes in the bargaining power of other powers and translates these into market outcomes. The model uses shifts in the market shares of individual players on the sell side, through seller diversification policies, to estimate similar benefits in buyer market power. It uses similar shifts in the market shares of individual players on the buy side, through collective purchasing, to estimate benefits to buyer market power. The model yields quantitative results on changes in wholesale market price and total sales, changes in profit margins and changes in buyer and seller and overall welfare. Figure 21 provides a visualization of the analysis.

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Figure 21. **Equilibrium effects of collective purchasing expressed as a sequence of modelling steps**

1. Initial market equilibrium:
   • Price, output, market shares, margins

2. Change in number of buyers through aggregation of selected buyers

3. Equilibrium price and quantity changes, accounting for supply and demand conditions

4. Revised market equilibrium:
   • Price, output, market shares, margins

5. Repeated for a range of parameter assumptions
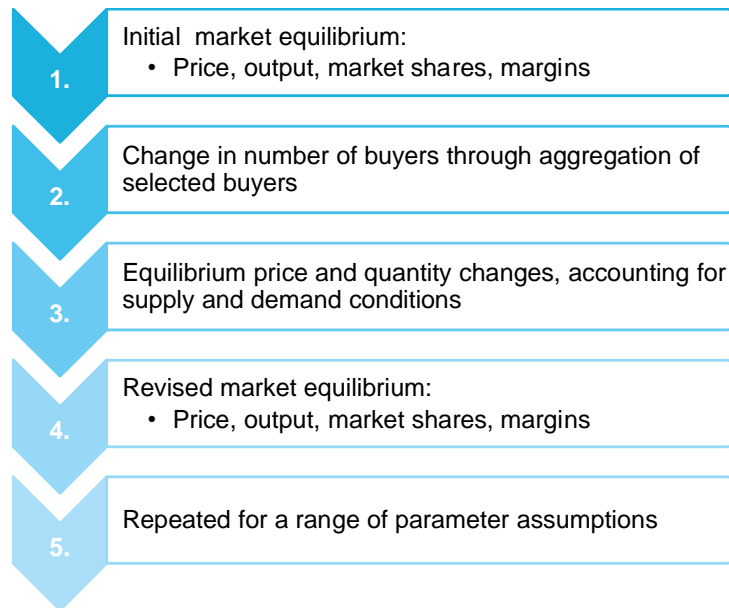
Source: Vivid Economics (2015)

The model is also used to examine the impact of buyer power in the abnormal market conditions of a supply security event. This is simulated through an unforeseen supply outage of an upstream seller of gas to the EU. Two outage scenarios are tested, one involving a loss of half of gas imported from Russia and other involving total loss of LNG imports from Qatar. Such an outage could be due to the political situation in a gas-exporting country, or due to transport problems, for example, with the loss of key pipelines or LNG shipping routes. The extent to which the impact of the outage is affected by the policy options is estimated.

4.5.2   Impact on gas hubs and liquidity

The value added by a hub increases with the number and diversity of participants, and is observed through greater contract innovation, depth in futures markets and lower transaction costs. Around half of European gas contracts are currently traded through hubs (IGU, 2014), though the figure is increasing and global experience is of a tendency for hubs to attract an increasing share of trade over time. One of the factors which has favoured the growth of hubs in Europe since the late 2000s is that prices determined by gas market fundamentals (supply and demand) dropped below the prices in legacy long term contracts. This created an incentive for gas buyers to switch to hub based pricing. Relatedly, hub prices are generally better able to respond to gas market conditions, as they are based on gas market fundamentals rather than dynamics in the crude oil markets. In this sense, they can allow for more tailored risk management by gas buyers and sellers.

Collective purchasing reduces the effective number of buyers, so it seems likely that a single buyer would reduce the liquidity of hub trading and thus the volume of contracts traded on hubs. Hubs are more effective the larger the number of participants there are trading on the hub. By aggregating buyers off the hub, the effectiveness of the hub could be compromised. On the other hand, if the collective purchaser buys through the hub, and acts by promoting new sellers or a lower concentration of sellers, a single buyer

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might support hub activity. The overall outcome might be determined by the way in which a single or aggregated buyers behave: deciding to sell on a hub or elsewhere, selling in large blocks or running more disaggregated continuous market operations. For some of the smaller, less liquid hubs, a large shock reduction in liquidity might be sufficient to jeopardise their viability. These issues are discussed outside the model, in Section 6.2.

4.5.3 Welfare change

Welfare is calculated as consumer surplus and producer surplus, normalised with respect to market quantity and per capita so as to allow comparisons across regions. The change in welfare is the difference between the surplus before and after the policy measure has been adopted, for each market participant. To make welfare numbers comparable across regions and countries, absolute welfare is normalised by the initial market quantity, before the policy is implemented.

4.6 Calibration

The model is calibrated to European gas market data on prices and market structure. First, empirical data on prices and market shares are fed into the model. Empirical estimates of wholesale gas market elasticities are also used, taken from the literature review in Section 2.5. However, the elasticity estimates from the literature vary quite widely, so the model results are sensitivity tested to a range of elasticity values. Second, the characterisation of buyer market shares is complicated by relationships between associated firms for companies which operate as international groups so it is necessary to assume that firms operate independently in each Member State. Since the model is calibrated to current market conditions, it embodies current levels of information asymmetry between participants which will be reflected in these outcomes. It cannot quantify the effect of changes in information transparency brought about by policy options, other than the maximum scope for improved negotiation.

Elasticity parameters for both demand and supply were calibrated in line with the literature review, summarised in Table 1. The long run demand elasticity for all regional submarkets except the Baltics and Central Eastern Europe is assumed to be 0.7. For the Baltics, the elasticity is assumed to be 1.1; this is necessary since the Baltics market is dominated by a single seller and an elasticity less than unity would violate the optimality condition for a monopolist. The elasticity for Central Eastern Europe is calibrated to 0.9 to yield more realistic results; the most basic comparator is the price. Using an elasticity of 0.7, the modelled first best price for Central Eastern Europe is lower than the first best price for the more competitive North West Europe region. This is avoided by increasing the elasticity to 0.9. The supply elasticity is set at 0.8 in all regional groups. **The model uses long run parameters as these are better suited to (re)optimizing buyers and sellers. In the short run, demand and supply are likely to be less elastic**.

To calibrate the model, the market quantity and price are calculated as the aggregates and averages of quantities and prices observed in EU Member States over the period 2012 to 2013. Data on EU member state pipeline traded gas and LNG production, consumption, import and export was used to calculate the quantity bought and sold by each member state and quantity sold by countries outside the EU. Within each regional group, buyers' and sellers' shares in the market were calculated using the quantities bought and sold

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by each market participant. Sellers are defined at a country level, whereas buyers are defined at the conveyor company level. The quantity bought by a country was assigned to a number of conveyors. Price data for each member state is calculated as the average price by type of traded gas. Finally the market price is defined as the quantity weighted average of country prices in each regional group. Note that the regional groups are not all regional markets, because of infrastructure bottlenecks and differences in market regulation between their constituent countries.

The Baltics market is modelled as a contestable market, instead of a pure monopoly. The Baltics market has changed in 2014 with the inauguration of the first LNG terminal in Lithuania. This is evidence that the Baltics market is contestable, that is, there is potential for new sellers to enter the market. Russia has an incentive to ward off potential entrants and it may choose to set prices at a lower level than would prevail in a monopoly market. This is introduced in the modelling by assuming the existence of another seller, such that the implied perfect competition price is not lower than the perfect competition price in North Western Europe.

4.7 Caveats

While the models do allow one to find the magnitude of price and quantity changes; integrate empirical data; and explicitly account for strategic interactions between buyers and sellers, rather than relying on aggregate relationships, the necessary input assumptions and their associated uncertainty do present a number of limitations that mean modelling results need to be interpreted carefully.

The modelling results may give upper bound estimates of the impacts of policy options because the results are long-term, not immediate impacts. The model allows for full capital adjustment; that is, the focus of the models is long term, in the order of years.

In addition, the models assume that the market is in equilibrium before changes are introduced. This implies that all firms are optimally responding to the production strategies of their competitors, and that, in the absence of a cost shock, firms would not adjust their production plans. This may not be the case in reality; firms may be in the midst of expanding or reducing capacity.

Other mitigating factors might include supply chain relationships which encourage stickiness, and product heterogeneity which results in less competitive markets than assumed within the model. Another general factor increasing the scale of the results is the models' assumption that goods are homogenous within each sector, that is, importers are providing perfect substitutes for domestic production. For wholesale gas this seems to be a robust assumption. Furthermore, to some extent any residual concern is mitigated by the calibration of the model to observed market prices. Observed prices incorporate the effect on the strength of competition from seller-buyer relationships, product variation, local geographic restrictions, access to customers and other aspects of product heterogeneity.

The model does not account for general equilibrium considerations, especially those in world energy markets. Factors affecting the European gas market could have knock on effects on world energy prices and ultimately bear on policy choices affecting the optimal energy mix in EU Member States. Whereas model

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results occurring close to current market conditions are robust, the model is less able to provide accurate estimates when considering larger shocks or policy actions leading to outcomes far from current equilibrium.

Finally, the model takes as inputs the elasticities of supply and demand as well as current buyers' and sellers' shares. It does not allow for spill-over effects between markets. Although the law of one price is assumed to hold within a regional group, the law of one price can be violated between markets.

4.8 The short run and long run

The model is static: that is, it estimates impacts in equilibrium. It can show how short and long run impacts may differ by employing suitable short or long run elasticities for supply and demand. These elasticities are obtained from the empirical literature on EU wholesale gas markets. The interpretation of these short run and long run elasticities is set out below.

4.8.1 Definition of the short run

In the short run, the set of players interacting in the wholesale gas market is fixed, that is, there is no entry or exit of individual buyers or sellers. The short run can be thought of as lasting between one and two years. The short run price elasticities faced by individual gas sellers incorporate the extent to which gas volumes have been sold by way of long-term contracts. Such long-term contracting tends to lower the short run price elasticity of demand because it makes overall demand less sensitive to price (Allaz & Vila, 1993). Sensitivity analysis for the short run modelling results is conducted by considering a range of values for the elasticities of demand and supply, guided by the literature.

4.8.2 Definition of the medium run

The medium run is interpreted as the transition from the short run to the long run. Some gas market players and other market arrangements may thereby be able to respond more quickly than others, depending on their levels of commitment to the initial market configuration.

4.8.3 Definition of the long run

In the long run, individual buyers and sellers can choose to enter or exit the wholesale gas market if participation is no longer profitable. The long run can be thought of as being five or more years. Long-run price elasticities of demand and supply are higher than those for the short run. On the demand side, this reflects greater scope for substitution, for example, more flexibility in energy sources, and on the sell side more flexible supply options including the development of European shale gas, LNG import routes and new pipelines. In the long run, the mix of hub trading, short-term, and long-term contracts can fully adjust, for example, as historical contracts expire.

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5 Quantitative impact assessment

Estimates of the price and welfare impacts of policy options

5.1 Additional sellers

Seller diversification, by weakening the dominance of any single seller, tends to reduce market prices. Seller diversity can be increased by introducing new sellers and by raising the market shares of smaller sellers. By increasing the number of sellers, the market power of large sellers is reduced and more of their revenues are put at risk if they try to restrict capacity and keep prices up. This is a well-established effect across many product markets, and the results of modelling the effect for the wholesale gas market, shown in this sub-section, indicate that it would be effective in those wholesale gas markets where there is currently a concentrated sell side. The greater the increase in number of sellers, the greater the benefit in eroding the market power of incumbents, but as each new seller is added, the incremental benefit diminishes. In this analysis the aim is not to identify an optimal policy to increase seller diversity but rather to assess the potential size of impact of it so that it can be compared with other policy options. The introduction of additional sellers is not the only policy to reduce prices to consumers. Some other policies, such as improvements to infrastructure, harmonised market rules and non-discriminatory pricing may lead to seller diversification, but they may also make the market more contestable, or may make competition between existing sellers more effective.

New sellers could be new to an individual regional group without necessarily being new to Europe overall. The behaviour of the new sellers may be much less important than the fact of their presence, although, naturally, their behaviour may also make a difference. Indeed, even the threat of their entry has some benefit in terms of the pricing pressure this imposes on incumbents; such an effect may already be present in the Baltics. So it is possible that by making a market more contestable, incumbents will behave more competitively, hoping to dissuade potential new entrants from making the investment to enter the market. The new sellers could be existing sellers to Europe who begin to sell into new regions or they could be new sellers to Europe. Either would have an effect on prices.

There are two ways in which new sellers might be encouraged: reducing transaction costs and improving market access. The first encouragement would be to reduce transaction costs for sellers. There are at least three types of transaction costs they face: search costs, compliance costs and commercial risk. Compliance costs could be reduced by offering technical assistance on compliance with regulation, or by simplifying and harmonising regulation; and commercial risk could be reduced by improving contractual terms and conditions, such as requiring less collateral or being more flexible about contract length and volume commitments, or by marking price to standard gas contracts thereby facilitating hedging of risk. There are substantial benefits from market rules: removing contractual restrictions on cross-border connections; removing clauses which lead to foreclosure, which is an abuse of market power; and, increasing transparency in pricing and contract terms, leading to more consistent access to information across market players. The second way to encourage new sellers is to remove physical access barriers by building interconnection capacity between regions, allowing sellers to move gas between regions, and by building

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additional import capacity either as LNG terminals or pipelines, to give access to supplies from outside the EU. This form of strategic infrastructure often needs government support to coordinate the interests of players in the sector and to coordinate the interests of neighbouring countries. European policy has a role to play in many of these areas of action.

Domestic gas production may also have a role to play in mitigating seller market power. Domestic production of gas in Europe plays an important role in providing competition in the market for selling gas. The regulatory and fiscal framework covering gas production and the policies towards exploration and new production, including shale gas, can affect wholesale gas prices through their impact on competition as well as through the cost of the gas produced itself. While the cost of the gas is often discussed in the context of the development of shale gas production in the EU, the impact on market power of sellers more generally, and hence gas prices, is much less talked about, but it deserves to be considered.

The value of additional sellers has been estimated using Vivid's Buyer Power Model. To investigate the effect of additional sellers in the EU regional group, a scenario of additional sellers was tested for each market. DG ENER selected the scenarios for each region and they are listed in Table 7. The scenarios vary across regional groups to add realism. The Baltics scenario reflects a number of small sellers, each of 3 per cent market share, which could reflect new sellers importing LNG through the 'Independence' terminal or cross border pipeline supplies between EU regions. For Central Eastern Europe, a single new seller with 10 per cent market share is introduced in the model. This could be a new LNG supply, from the US, Central Asia or Middle East, for example. In South Eastern Europe was add a 10 per cent and a 5 per cent seller, which could both be new LNG suppliers. In North Western Europe and Southern Europe, two new sellers are introduced. In the North Western region, these would most likely be LNG imports from the US and the Middle East, diversifying the region's LNG base. In South Europe they could be a mixture of US or Middle East LNG and pipeline gas from North Africa.

Table 7.   **The assumptions for additional sellers under the additional seller channel of influence**

Market	Additional seller A	Additional seller B	Additional seller C
North Western Europe	5 per cent	5 per cent	
South Europe	7 per cent	10 per cent	
Baltics	3 per cent	3 per cent	3 per cent
Central Eastern Europe	10 per cent		
South Eastern Europe	10 per cent	5 per cent	

Source: *Vivid Economics*

The most pronounced impact of additional sellers is felt in the Baltics market. In the Baltics, where introducing three additional sellers with a total market share of 9 per cent might cause a 16 per cent fall in gas prices, as indicated in Figure 22. Correspondingly, the model predicts a 21 per cent increase in quantity

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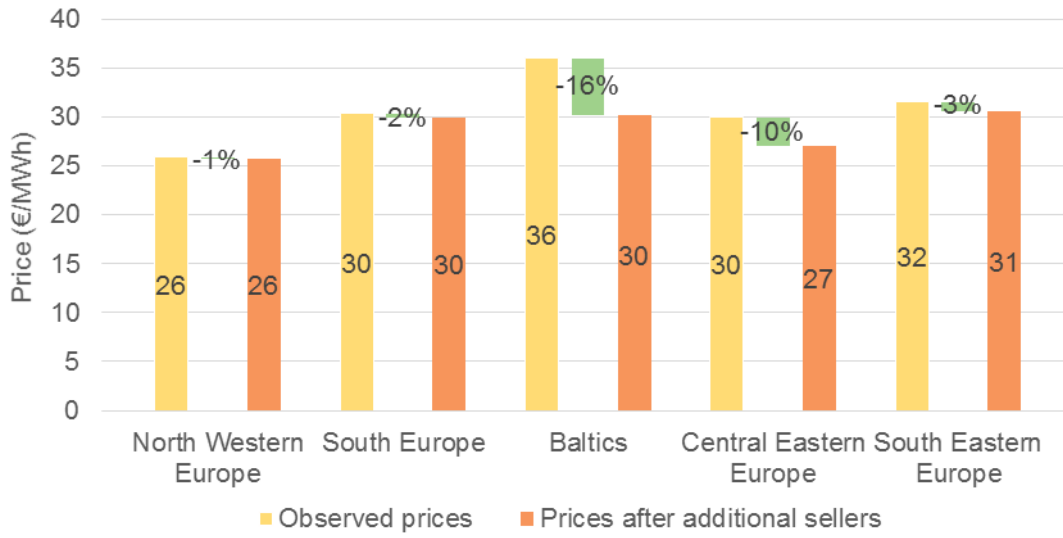
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consumed, while the seller side Herfindahl index decreases by 17 per cent, from 1 to 0.83. Introducing more competition to a near monopoly market has very strong impacts. Diversification also benefits the Central Eastern Europe market, where introducing one additional seller with a market share of 10 per cent could lead to a 10 per cent fall in prices and a 6 per cent increase in quantity consumed. Here, the Herfindahl index would fall by 17% per cent to 0.42. The effect of supplier diversification has only a minor impact on the remaining markets, these markets already having a diverse seller side market structure.

Seller diversification is a priority in the Baltics and Central Eastern Europe. Regional buyers' welfare increases by 78 €m/bcm in the Baltics and 75.6 €m/bcm in the Central Eastern Europe market, while total welfare increases by 37.2 €m/bcm and 18.9 €m/bcm respectively. The welfare gain in South Eastern Europe is relatively small at 11.4 €m/bcm for buyers and 4 €/bcm for European buyers and sellers. The reason that the welfare gain is relatively small is that region has already been active in promoting seller diversification, see Figure 8, so that bargaining power among sellers and buyers has become more balanced relative to the Baltics and Central Eastern Europe, see Figure 18. Note that these welfare estimates refer to each region *as a whole*, under the assumption of a single gas price in each region. The welfare changes for individual countries in each region will be different, depending on how strongly they diverge from the market average, as shown in Figure 9 above. In the case of South Eastern Europe, there is a wide diversion of prices across countries. This suggests that South Eastern Europe would benefit greatly from increased integration, but that once integrated it might have a sufficiently diversified seller base.

Additional seller policy has an insignificant effect on North Western Europe and South Europe. This comparison indicates the degree of inefficiency in the Baltics and Central Eastern Europe, where the traded gas quantities are far from their competitive market levels. The diversification of sellers in these concentrated seller markets could be an attractive policy option. This is reflected in Figure 23, which shows that the welfare gains of seller diversification are large for the Baltics and Central Eastern Europe, whereas they are minor or even marginally negative for the other regions.

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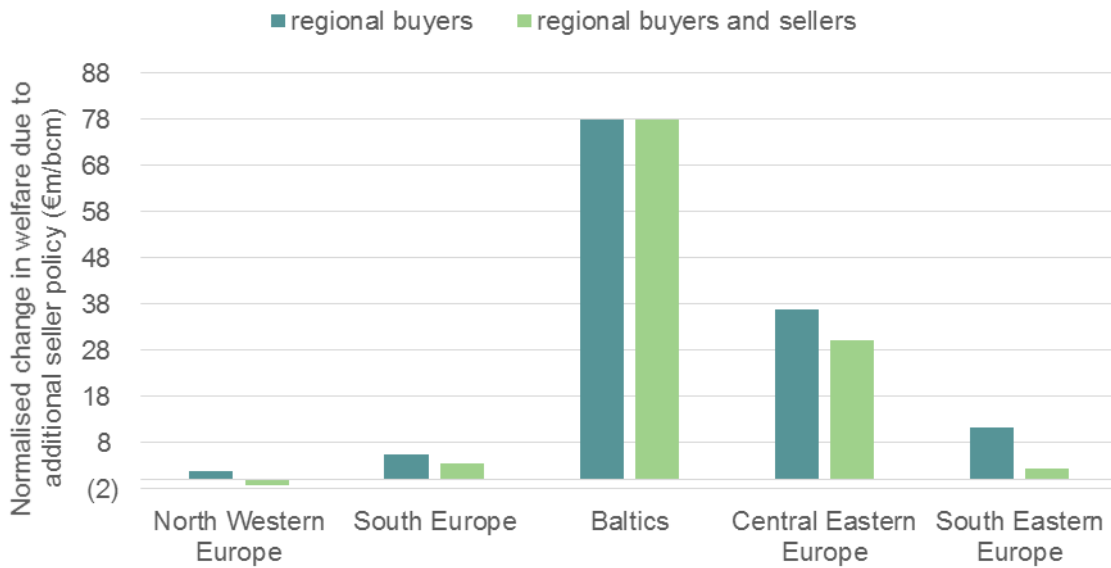
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Figure 22. **The effect of additional sellers**

Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

*Figure 23.* **Welfare gains due to seller diversification by region**

Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

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5.2 Market integration and negotiation

Average prices might fall between 3 and 11 percent across the five EU regions, and within about five years, gas consumption would increase by between 3 and 11 percent in response to market integration and/or improved negotiation. Let us suppose that improved market integration, in combination with actions such as improved within region interconnection, and/or negotiation intermediated by a single buyer, enables prices across the region to converge to the estimated fully competitive price in the market, or the lowest observed price, whichever is higher. If this price convergence occurs, countries that experience a fall in price also obtain higher gas volumes, so consumers enjoy the benefits of consuming more gas, while gas sellers' profit margins are reduced. These benefits are not unique to improved negotiation; for example, greater contestability or competition would have the same effect. The price reductions from improved negotiation would be smallest in South Europe and South Eastern Europe, where price dispersion is already narrow. But even in these regions, some countries, such as Italy whose prices are higher than the regional average, might significantly benefit. The price reductions would be largest in the Baltics and Central Eastern Europe, where the scope for improved negotiation appears to be the greatest. The true gains for Baltics and Central Eastern Europe could be larger than show because for these regions, the estimates are quite conservative. Greater market integration could offer further benefits to South Europe and South Eastern Europe, whose average prices lie well above the regression line in Figure 9, suggesting average price reductions are possible.

Figure 24. **Market integration and improved negotiation may result in substantial price reductions and quantity increases at the regional level within the EU**
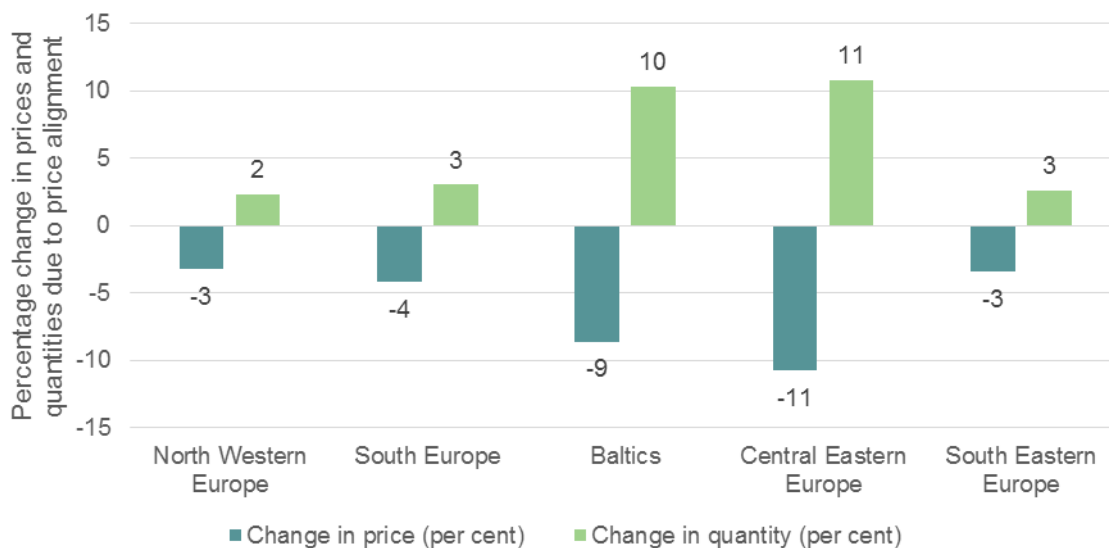
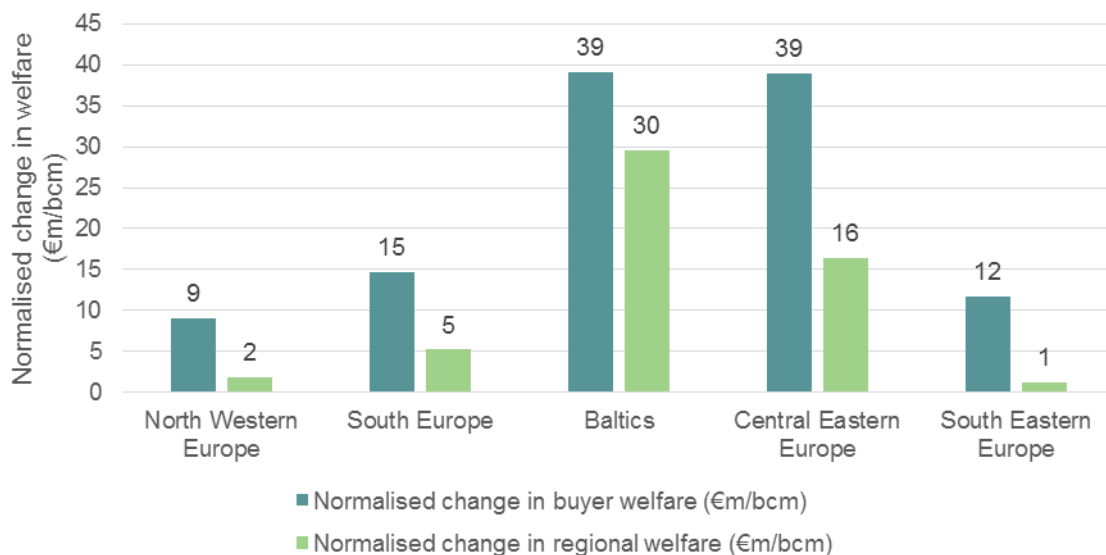*Source:* *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

The welfare implications of price harmonisation are considerable and positive for the Baltics and Central and Eastern Europe. End users enjoy welfare benefits from consuming gas directly or embedded within other products they consume. Lower prices for gas allow consumers to buy more as well as to save

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money on gas which they can spend on other goods and services. Market integration and improved negotiation could lead to increases in welfare of up to around €39m/bcm for consumers in the Baltics and Central Eastern Europe. The benefits to consumers are much lower in other parts of Europe, at between €9m/bcm and €15m/bcm. In some parts of Europe, the negative impacts on the welfare of sellers are significant, and this effect is greatest relative to buyer welfare in South Eastern Europe and North Western Europe. This means that the net welfare benefit in South Eastern, North Western Europe is only between €7m/bcm and €12m/bcm. These estimates indicate that improved negotiation could be highly beneficial in the Baltics and in Central and Eastern Europe, but would be less valuable in other parts of Europe.

Figure 25. **Welfare gains for EU buyers and EU Member States from market integration and improved negotiation are strongest for the Baltics and Central Eastern Europe**

Source: Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data

5.3 Seller optimisation

The above estimates of the impact of additional sellers can be generalised to any other changes in market structure which increase seller competition by reducing concentration. Similar benefits to the addition of sellers could be achieved through an increase in the market shares of smaller sellers, that is, optimising the mix of existing sellers. For example, increases in supply from non-EU sellers such as Algeria (DZA), Libya (LBY) and Norway (NOR) might all reduce market concentration if that gas reaches the Baltics and Central Eastern Europe. The following charts show first the current pattern of gas sales to the EU and then the effect of seller optimisation for each of the European regions. The benefit of optimisation is revealed by making the regional Herfindahl index successively smaller and reporting the welfare benefit for consumers. This pre-supposes that prices have converged to a single price in each region and so there are no remaining infrastructure, market or regulatory bottlenecks. The analysis does not report the benefit from moving from the current situation of sub-regional pricing to effective regional markets.

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Figure 26.   **The EU could encourage some of its pipeline importers to increase production**
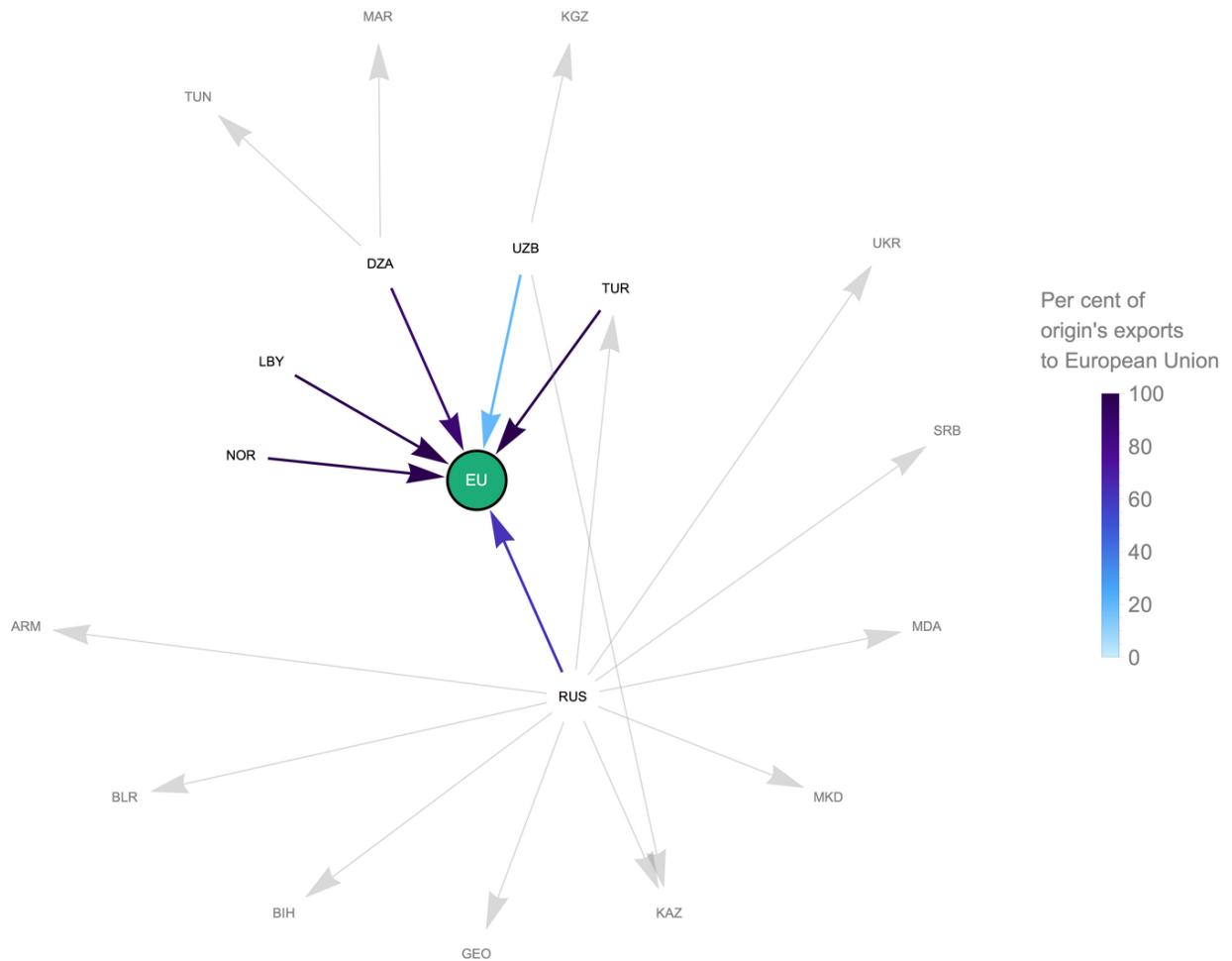
Source: *Vivid Economics based on IEA data*

Seller optimisation would have the greatest benefit in the Baltics and Central and Eastern Europe. In these two regions, a reduction in concentration, measured by a fall in the HHI of 0.1, reduces prices by around 10 and 15 per cent respectively, see Figure 27 and Figure 28. This is much greater than the scale of benefits seen in other regions for the same change in the HHI. Further reductions in the HHI in these two regions generate similar but diminishing benefits. The reduction in prices is accompanied by a similar proportion of increase in EU welfare from gas consumption and production.

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Figure 27. **The impact of changes in seller concentration in Central and Eastern Europe: it is sensitive to changes in seller concentration**
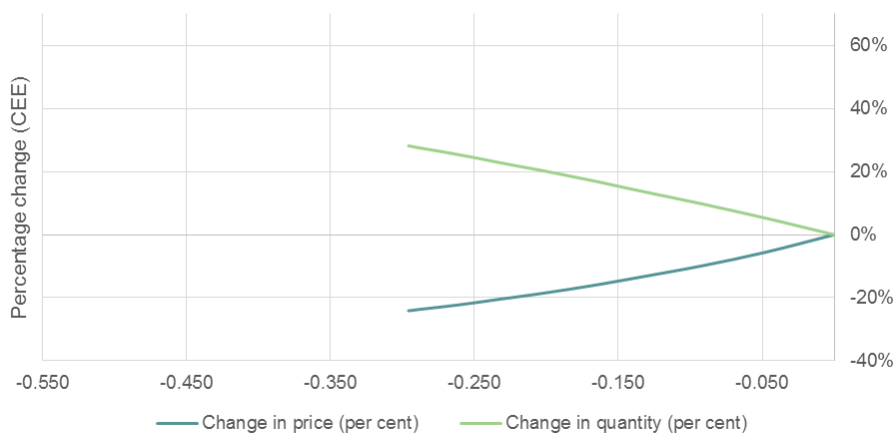
Note: *Note: 1. Current seller HHI is .0.66 (0.508).The CEE market model is calibrated by adding an additional seller with a 10% share, because this more faithfully produces the prices observed in the market. The modelled HHI in the CEE market is 0.508 instead of 0.66.*

2. Model is run for different scenarios where increasing numbers of sellers with increasing market shares are added to the regional market. The lengths of the plots differ across figures due to higher HHI sensitivity to seller addition when the initial HHI is high.

Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

Figure 28. **The impact of changes in seller concentration in the Baltics: it is sensitive to changes in seller concentration**
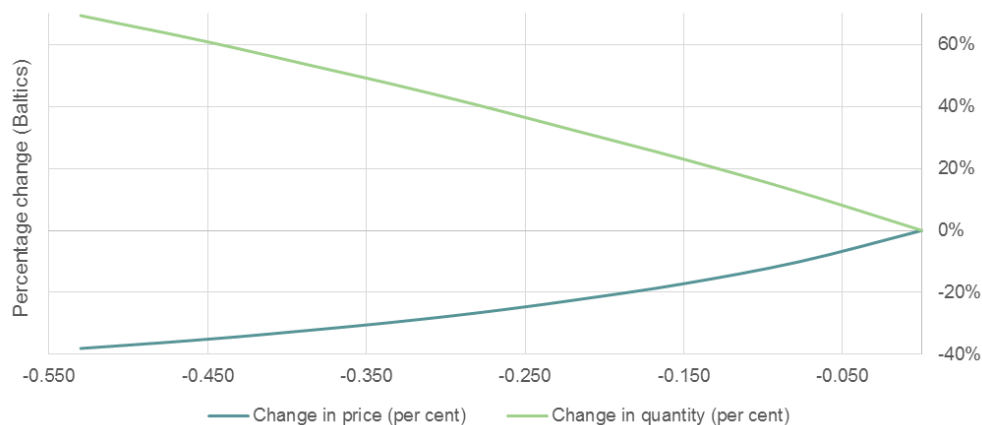
Note: *Note: 1. Current seller HHI is 1 (0.82). In the Baltics market model the monopoly of Russia is initially adjusted to make it behave as if there is another seller with a 10 per cent share, because this more faithfully produces the prices observed in the market. It is consistent with the market being contestable and means that the initial modelled HHI in the Baltics market is 0.82 instead of 1.*

2. Model is run for different scenarios where increasing numbers of sellers with increasing market shares are added to the regional market. The lengths of the plots differ across figures due to higher HHI sensitivity to seller addition when the initial HHI is high.

Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

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South East Europe, North West Europe and Southern Europe all show much less sensitivity to seller optimisation. In these three regions, a reduction in the HHI of 0.1 would cause a price drop of less than 10 per cent, but only smaller HHI reductions are feasible because the regions as a whole already have low levels of seller concentration, see Figure 29 to Figure 31. Seller optimisation in these markets would generate little benefit.

Figure 29. **The impact of changes in seller concentration in South East Europe: it is *in*sensitive to changes in seller concentration**
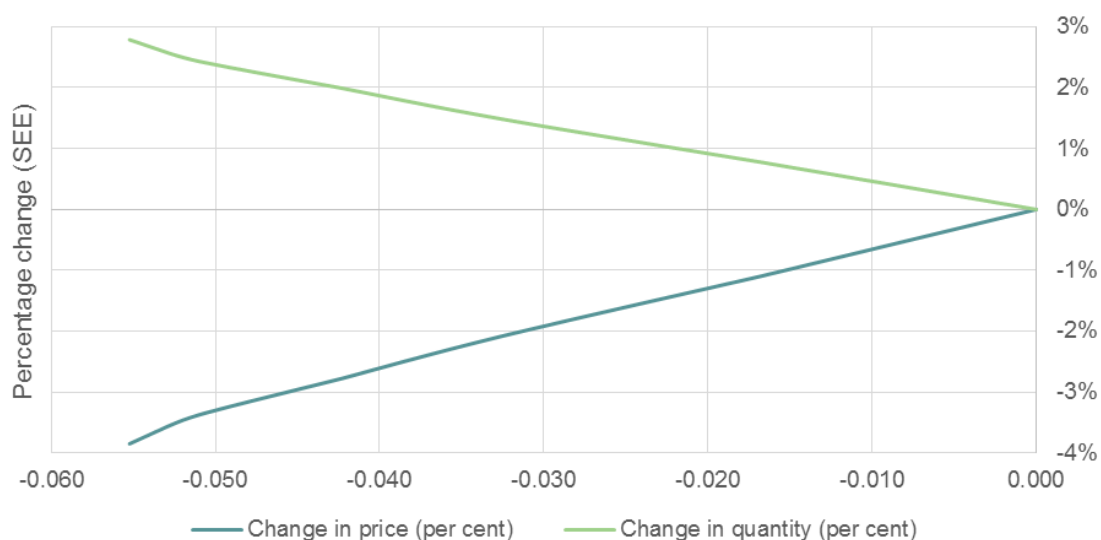
Note: 1. Current seller HHI is 0.209

2. Model is run for different scenarios where increasing numbers of sellers with increasing market shares are added to the regional market. The lengths of the plots differ across figures due to higher HHI sensitivity to seller addition when the initial HHI is high.

Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

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Figure 30. **The impact of changes in seller concentration in North West Europe: it is *in*sensitive to changes in seller concentration**

Note:	Note: 1. Current seller HHI is 0.11
	2. Model is run for different scenarios where increasing numbers of sellers with increasing market shares are added to the regional market. The lengths of the plots differ across figures due to higher HHI sensitivity to seller addition when the initial HHI is high.
Source:	Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data

Figure 31. **Southern Europe market is *in*sensitive to changes in seller concentration**

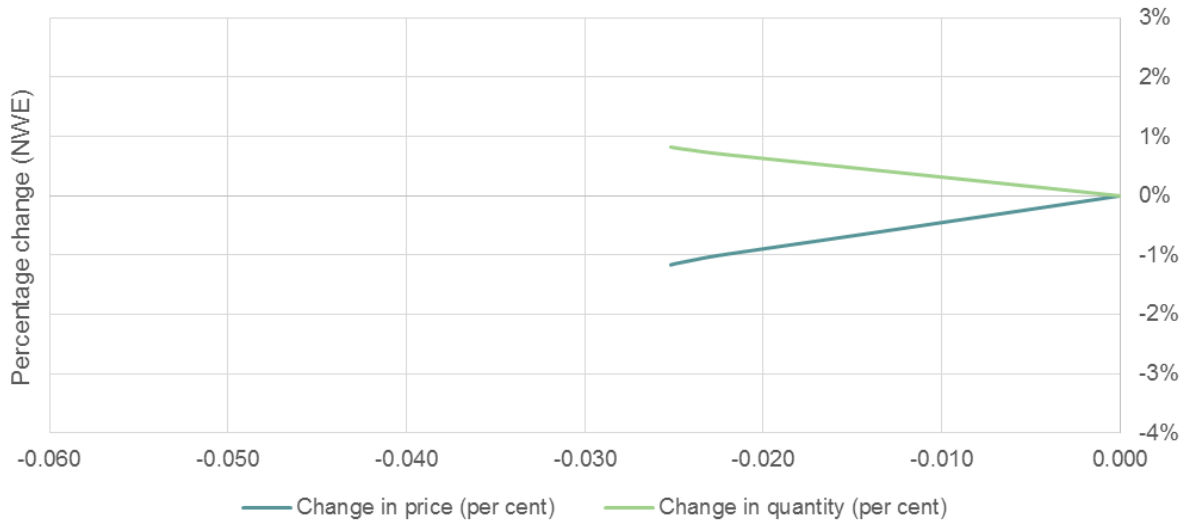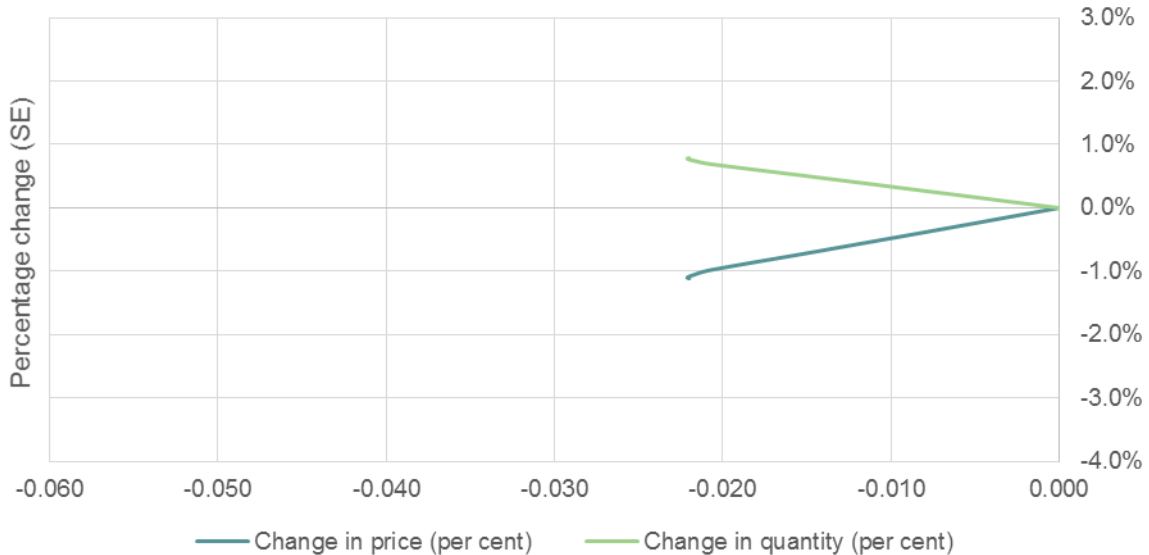| Note:	Note: 1. Current seller HHI is 0.10
	2. Model is run for different scenarios where increasing numbers of sellers with increasing market shares are added to the regional market. The lengths of the plots differ across figures due to higher HHI sensitivity to seller addition when the initial HHI is high.
Source:	Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data

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The Baltics and Central Eastern Europe benefit far more than any other region from seller optimisation. The change in buyer welfare from seller optimisation is between 5 and 10 times greater per unit volume of gas consumed in the Baltics and Central Eastern Europe than for the other regions, and the Baltics stands to gain the most, see Figure 32. When the impact of seller welfare is included, the difference between these two regions and the other regions is even greater, see Figure 33. For the other regions, seller optimisation generates no net benefit and may not be an attractive policy option.

Figure 32. **Change in buyer welfare due to seller optimisation (normalised by current quantity)**
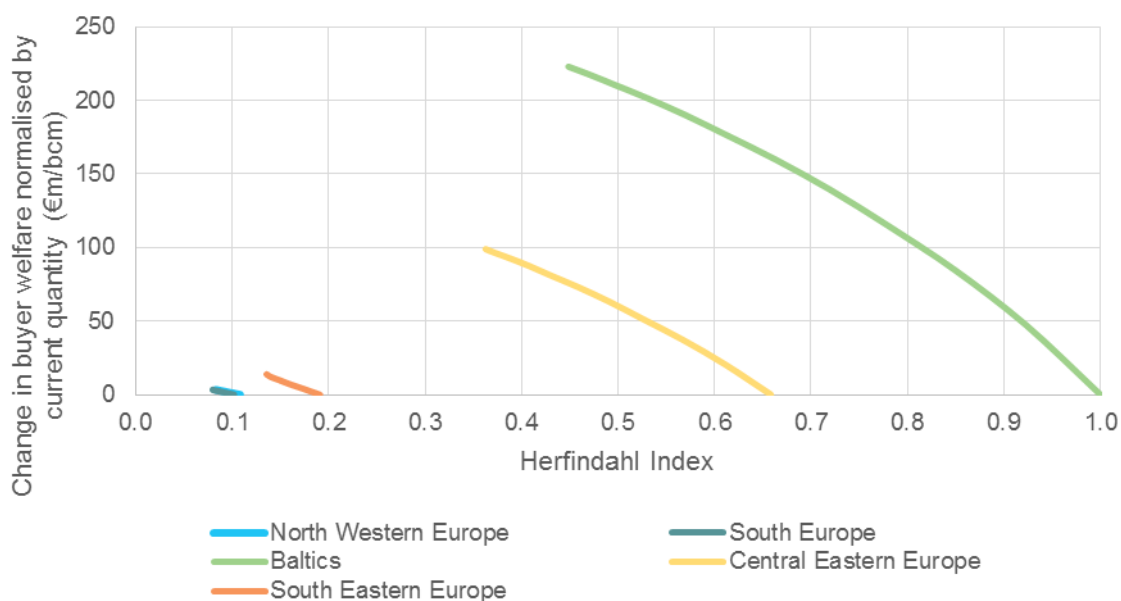
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Figure 33. **Change in EU welfare due to seller optimisation (normalised by current quantity)**
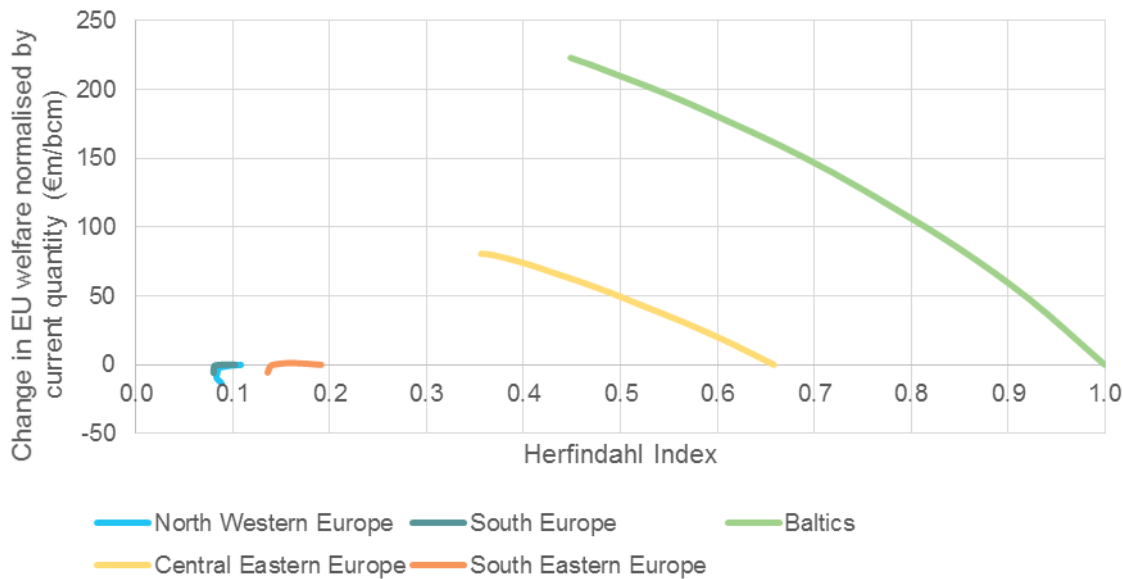
Note: Buyer and seller welfare deteriorates at some level of HHI, this is due to sellers losing welfare given low market prices

Source: Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data

In conclusion, optimisation of the seller portfolio would be beneficial in the Baltics and CEE regions where the HHI is high and the welfare gains are likely to be high. The NWE and SE have low HHI and the HII of the SEE is also assumed to be low. The gains from reducing the HHI further would yield only modest improvements in welfare.

5.4 Restriction of consumption

The net welfare benefits of a single buyer restricting gas consumption to obtain a better price would vary considerably across EU regions. If a single buyer can restrict consumption, then sellers' prices may fall and although consumers would suffer a welfare loss from forgone consumption, they would enjoy the benefit of lower prices for the balance of their consumption. Putting aside the considerable practical difficulties of engineering a restriction in consumption, which are addressed in Section 7, in theory there may be net welfare benefits from even quite small restrictions in consumption in the Baltics and to a much lesser extent South Europe, making it worthwhile considering the practicalities of the option for these regions. For example, considering the market benefits for energy efficiency schemes in these regions. However, for other regions, especially North West Europe and South Eastern Europe, the benefits are small and given the practical barriers, unlikely to be worth considering further.

The first step in the calculation of welfare impact is to find the price cut achieved for each percentage reduction in consumption, which is expressed as a ratio: the sacrifice ratio. This sacrifice ratio is the percentage change in price divided by the change in quantity, and its value depends on the elasticity of supply, as shown in Figure 34. The relationship between the quantity cutback and the resulting price

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reduction is approximately constant; this linearity is likely related to the modelling assumption of iso-elastic demand and supply. The second step in the welfare calculation is to calculate the change in welfare for consumers due to quantity reduction, which depends on the elasticity of demand. The final step is to add in the impacts on the welfare of sellers. The net impact on welfare is an inverted U-shaped curve, where welfare is maximised by restrictions of approximately 12 to 20 per cent of consumption, but practically feasible consumption restrictions are more likely to lie between zero and a few per cent.

Figure 34.   **Sacrifice ratio: price reductions achieved for gas consumption cutbacks**
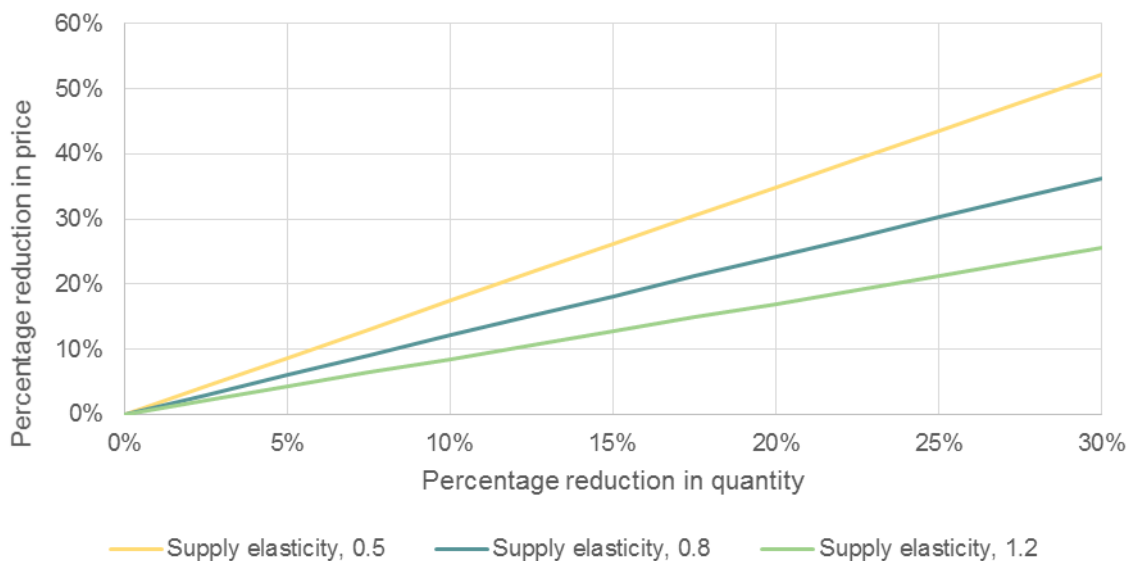
Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

The Baltics might benefit from a welfare increase of up to €30m/bcm in their gas consumption, through the price reductions they might obtain from sellers. As the consumption restriction increases from zero to around 30 per cent, welfare increases. Beyond around 30 per cent, it starts to decrease with further restriction. The Baltic buyers are constrained in their commercial freedom to restrict consumption by the terms of their current contracts, which require them to take or pay for 75 or 80 per cent of their current consumption. This changes the welfare payoff, so that the welfare increase declines after a 20 or 25 per cent restriction in consumption. Although these welfare gains are theoretically possible, as shown in Figure 35, they carry practical barriers to delivery which are likely to become very challenging beyond restrictions of a few per cent. It may seem surprising that a single supplier would react to a strategic reduction in demand by lowering prices, but in fact the optimal profit maximising strategy is to sacrifice some margin to avoid an even larger demand reduction. If the supplier is more aggressive and chases volume of sales, then it would choose to cut prices even further. Only if it is unaware or motivated by other, perhaps political, considerations would it cut prices by less.

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Figure 35. **Baltics welfare changes in response to a restriction of consumption**
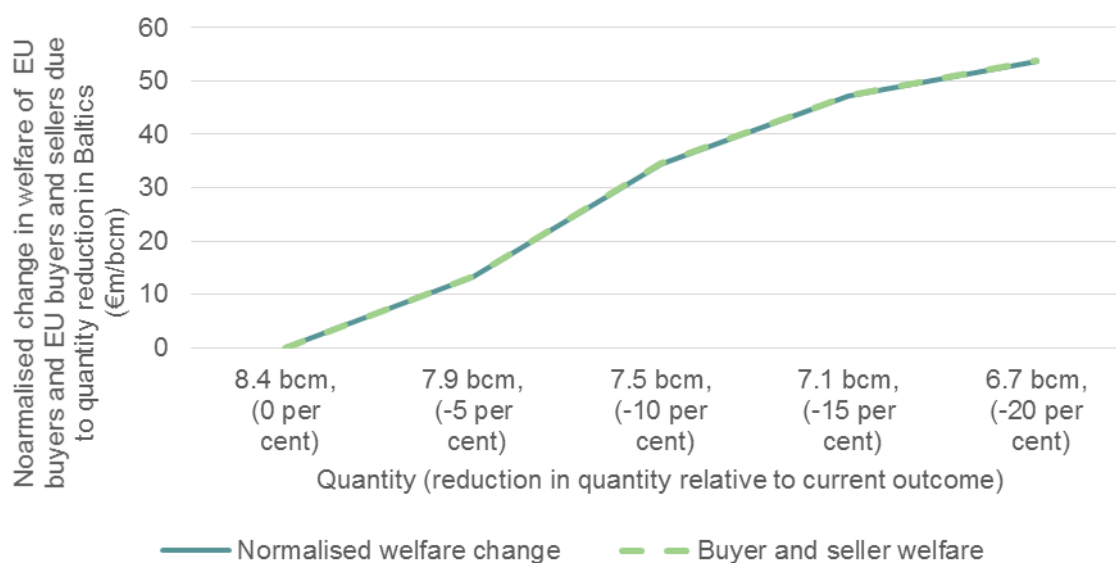
Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

In contrast, North Western Europe's consumers have much less to gain and its sellers have a lot to lose by cutting consumption, so that welfare increases by around only 1 per cent following a similar 2 per cent cut in consumption. This demonstrates that a policy of consumption restriction, like the policy of tighter negotiation, would only make sense in some parts of Europe. Neither could be introduced as a pan-European policy.

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Figure 36. **North Western Europe welfare changes in response to a restriction of consumption**

The other regions all have properties lying between those of the Baltics and North Western Europe, but none offers such a strong positive response as the Baltics. The results for other regions are shown in Figure 37 to Figure 39.

Figure 37. **Southern Europe market welfare changes in response to a restriction of consumption**

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Figure 38. **Central Eastern Europe welfare changes in response to a restriction of consumption**
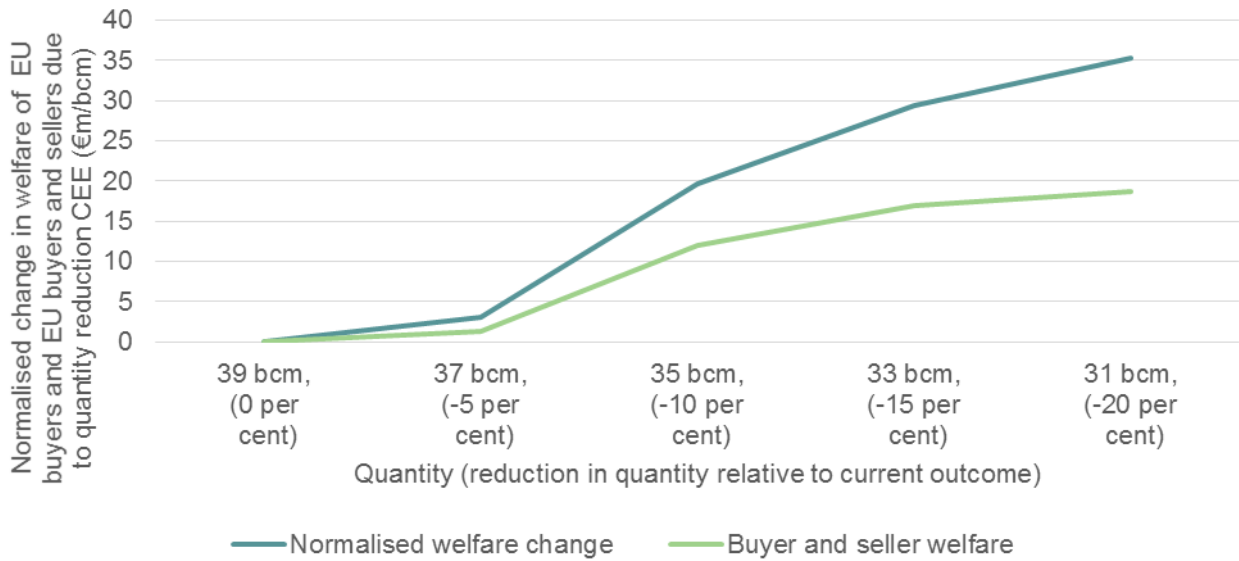
Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*
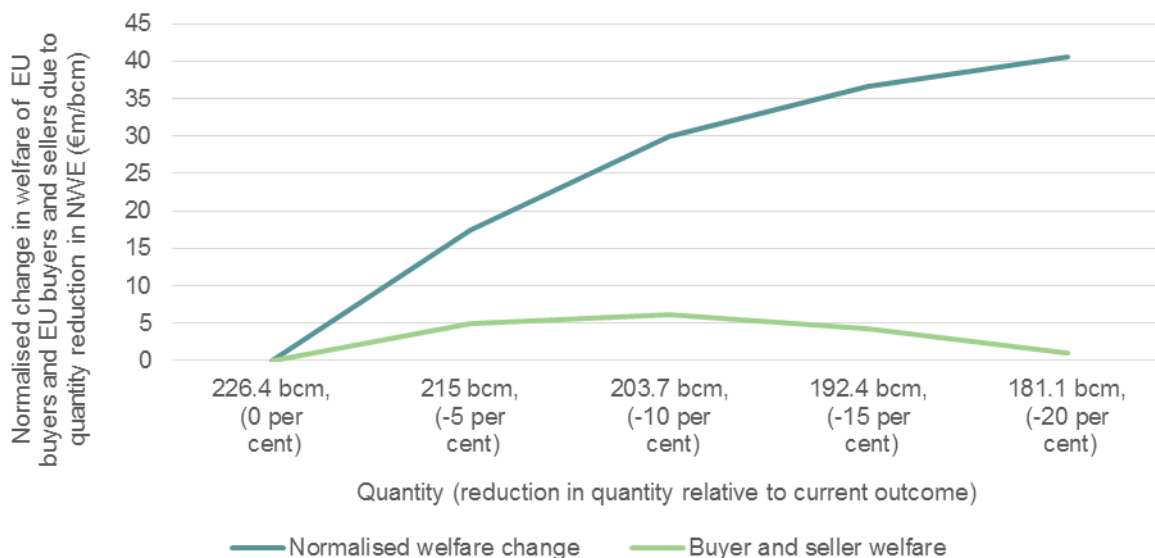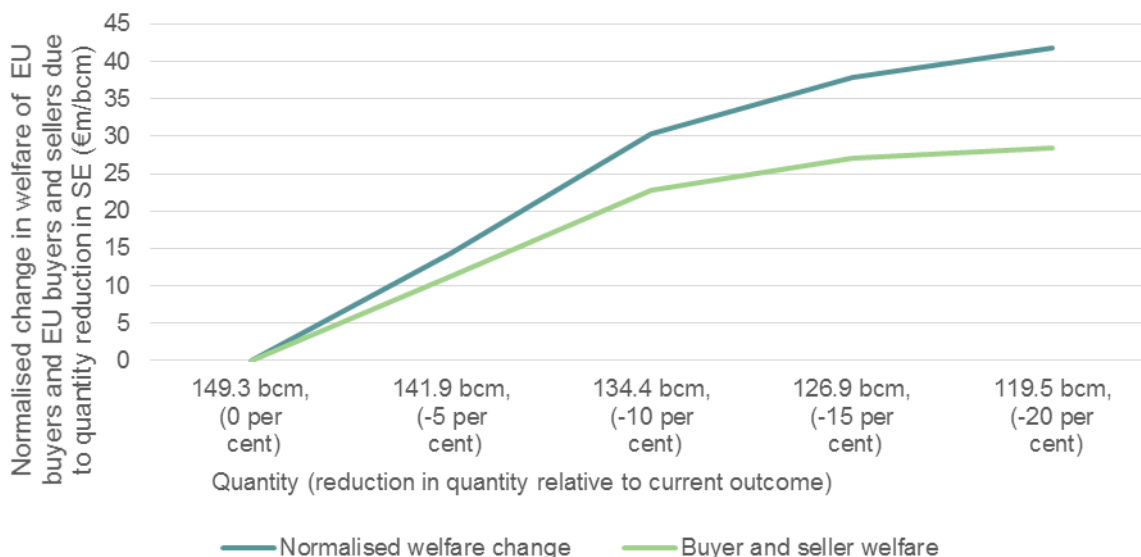
Figure 39. **South Eastern Europe welfare changes in response to a restriction of consumption**
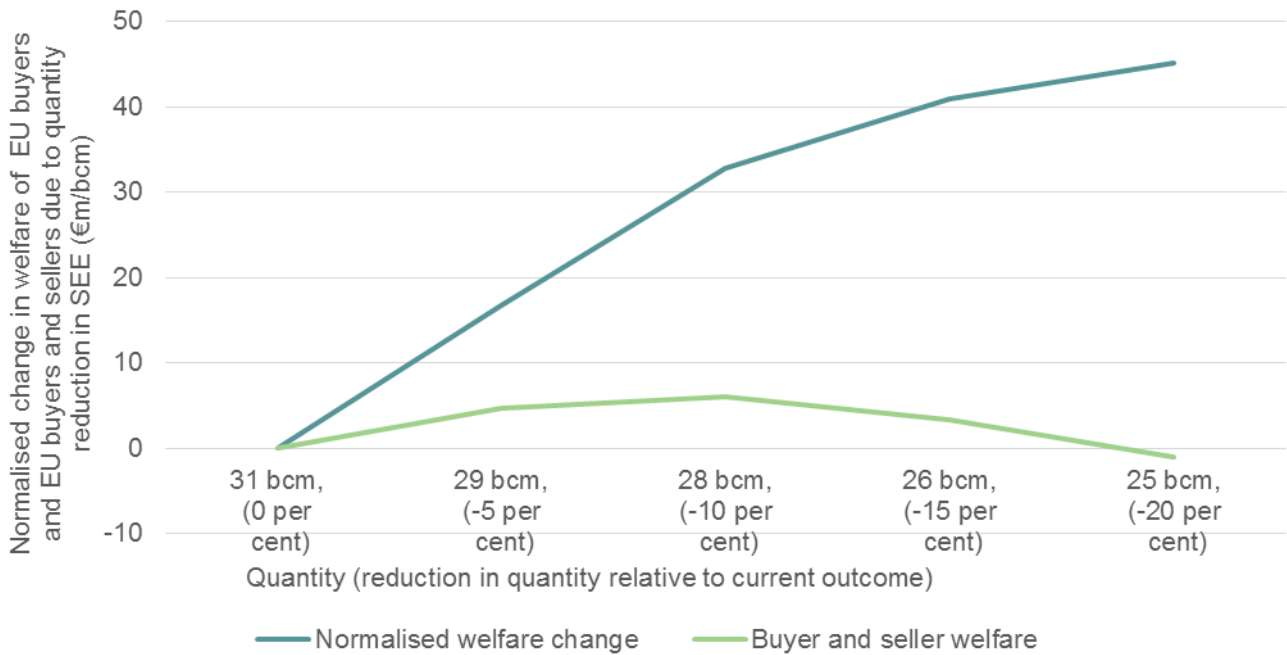
Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

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Normalising for gas consumption, welfare gains are widespread and high among Southern European and Baltic states. The Netherlands, Romania, Denmark and Croatia are the only countries that lose out from consumption restriction, driven in part by producer losses accruing to domestic gas production. The UK, Germany and Poland have a low welfare change per unit consumption. All other countries would see their welfare improve at a significant rate. The welfare gains are modelled for a more realistic consumption cut of 5 per cent, which might be delivered through energy efficiency programmes, for example. This yields welfare improvements of more than €10m/bcm for Southern European and Baltic countries, but significantly less for all other countries, see Figure 40.

Figure 40. **Welfare change due to a 5% restriction of consumption, per unit gas consumed, by region**
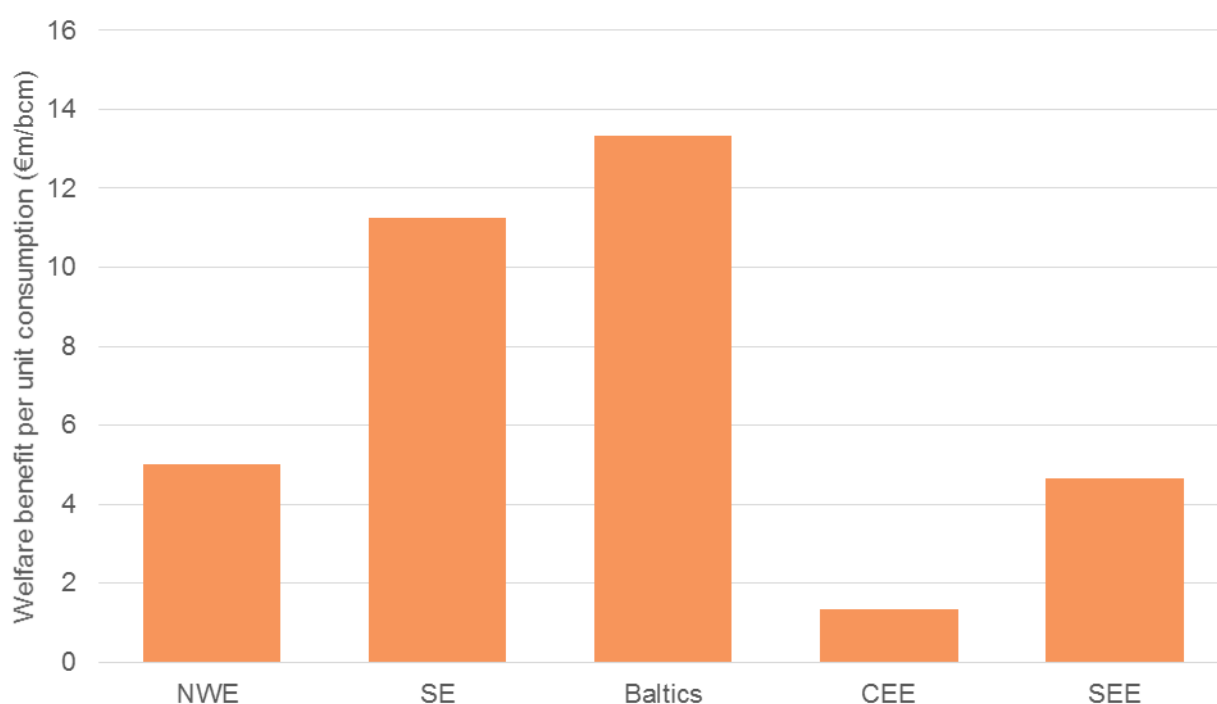
Source: *Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data*

5.5 Security of supply events

5.5.1   Impact of 50 per cent outage of imports from Russia

This section presents results on the impact of buyer-power policies on security of supply in the EU. The objective is to assess how robust the EU gas market would be in the face of significant supply shocks, and to understand how this robustness is affected by policy options.

A greater security of supply is indicated by a smaller loss of consumer welfare in the event of a supply shock. This link makes it possible to quantify changes in security of supply. To begin with, there are many different possible definitions of security of supply. A reasonably general definition, which also captures the

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spirit of many others, is 'the availability of sufficient supplies at affordable prices'(Yergin, 2006). This captures the objective that, all else being equal, greater consumption and lower prices are desirable; in this way, it is similar to standard definitions of consumer surplus in economics. This provides a link between the results from the economic modelling and the notion of supply security: a greater security of supply is indicated by a smaller loss of consumer welfare in the event of a supply shock. Security of supply becomes measurable in terms of welfare.

The economic modelling considers two scenarios of supply shock. Both shocks involve the loss of individual current sellers. The first is a 50 per cent reduction in supply from Russia, affecting supplies to the East. The hypothetical scenario is a *force majeure* or political conflict. The second is a complete outage of supplies from Qatar, the biggest seller of LNG to the EU, which would affect supplies to the North West. The hypothetical scenario here is a *force majeure*, such as a blockade of the Strait of Hormuz. For both scenarios, gas deliveries are impossible for a period of time sufficient to exhaust current reserves, of several months' duration. Given that the model is calibrated to annual data, the results directly correspond to the annualized impact of these supply shocks on market outcomes.

The shocks in question temporarily affect the capacity of sellers to provide the same quantity at a given price. In the short run, unaffected sellers have limited scope to increase output to make up for the outage and consumers are very price inelastic in their demand. This leads to a rapid and large upward swing in prices. The economic modelling estimates the impact of the shock under the current gas market arrangements, that is, without any policy options. It estimates their impact again, first in the presence of improved negotiation in the form of a range of long-term contracts, which provide some protection against price spikes, insofar as they offer some volume flexibility at prices tied to oil rather than gas market fundamentals; second, in the presence of additional sellers.

In the short run, seller outage can cause large price spikes. The definition of the short run has been discussed in Section 4.8.1. In the short run, both the elasticity of supply and demand are low, resulting in a large price response following a supply outage. For example, the model estimates that the short run effect of a 50 per cent Russian outage is to boost prices in North Western Europe by 37 per cent, despite the relatively low importance of Russian supply. South Europe is less exposed to Russian supply and experiences a lower price increase and quantity decrease. However, the Baltics would be more severely affected with prices rising steeply.

In the long run, there will be a more flexible response from sellers and buyers to the outage, if the outage persists. The impact on spot prices will be lower in the long run than in the short run, as additional supply is brought on line and as consumers trim their use of gas. The predicted price changes are large, which means the model results will be illustrative. This is because models which are calibrated, as this one is, on current and recent market conditions, become less reliable in the face of large shocks that explore market conditions well outside the span of the market history from which the model data is drawn. In particular, it is because the estimates of elasticities for the current market may be less valid in market conditions which involve much higher price levels. Nevertheless, the results of the model described below are indicative of the scale of changes in prices and welfare.

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The price increases from a long run supply shock can be estimated and vary significantly across regional EU markets. The Buyer Power Model is used to estimate long run price increases as a result of outage. It is not currently possible to model short run impacts reliably, but the price impact will be much larger in the short run than in the long run, perhaps around twice as large, based on the ratio of short and long-run supply and demand elasticities, see Section 2.5, but could be much greater than twice as large taking into account buyer power effects. The long run price increases are estimated at between 4 per cent and 21 per cent. The highest increases, 21, 20 and 16 per cent, are seen in the Baltics, Central Eastern Europe and South Eastern Europe, due to the high share of supply which comes from Russia in those regions. It is lowest, at around 4 and 7 percent, for the other two regions, see Figure 41.

Additional sellers confer a benefit in a seller outage situation. The effects of price increases experienced in an outage are mitigated when the seller base is more diversified. The effect of additional sellers can be seen in the lower percentage increases in estimated prices shown in Figure 41. The effect of additional sellers is quite small in the regions where Russia is a minority supplier, namely North Western Europe, South Europe and South Eastern Europe: in the long run, price rises are one or two percentage points less pronounced than they would otherwise have been. The effects of additional suppliers are stronger for the Baltics, where they attenuate the price increase from 21 per cent to 19 per cent. In South Eastern Europe, it appears as though the addition of sellers leads to a larger price increase. In fact, what is happening is that there is a large market structure effect associated with Russia's loss of seller power: this forces a stronger downward pressure on prices in the baseline outage scenario than it does in the additional seller outage scenario. The modelling results here do not show sequential events where an outage occurs and additional sellers are subsequently introduced. Instead, they show how the regional outcomes would differ if the outage occurs with the current market structure (light green bars) and with a market structure in which there are additional sellers (orange bars). Those additional sellers could be present before the outage occurs, as illustrated by the yellow bars.

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Figure 41. **Effect of 50 per cent Russian outage on prices**
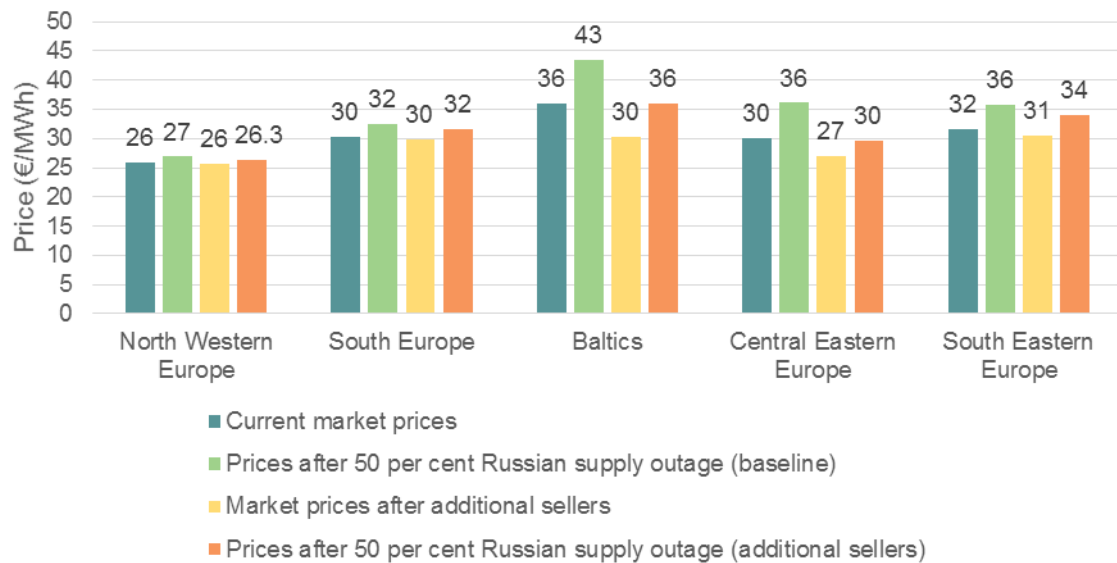
The increase in prices and retrenchment in consumption which accompany a security of supply event may result in large welfare losses to EU buyers. In the largest regional group, the loss could potentially be as large as €-4.3 bn/year in the long run. It could be much higher in the short run. **An indication of the total loss to all EU Member States is €11 bn/year in the long run; again it could be much higher in the short run**. In addition to the partial equilibrium losses, a large supply shock may have macroeconomic effects similar to a large oil shock. The magnitude of the price increase can simultaneously drive the price level up and constrain EU consumer spending on other goods and services, leading to downward pressure on aggregate demand. This stagflation effect could be very costly to the economy, leading to a reduction in output far larger than the initial welfare loss. When additional sellers are introduced, the loss to all EU Member States falls by €1 bn/year to €9.9 bn/year, see Table 8.

Table 8. **The effect of a 50 per cent Russian outage on welfare**

Variable	Region				
	Baltics	Central Eastern Europe	North Western Europe	South Eastern Europe	South Europe
Change in welfare (baseline, €/yr/pp)	-60	-14	-22	-33	-19
Change in welfare (after additional sellers, €/yr/pp)	-34	-25	-19	-29	-15

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The Baltics have the most to gain, relatively speaking, from the security of supply enhancement offered by additional sellers. The negative welfare impact is cut by the largest relative amount in the Baltics, see Figure 42. The Baltics and South Eastern Europe are most exposed to a Russian outage, but of all the regions, only the Baltics could substantially mitigate the effects of an outage: it is the only region which could very substantially increase its security of supply by introducing additional sellers.

Figure 42.   **The effect of a 50 per cent Russian outage on welfare**
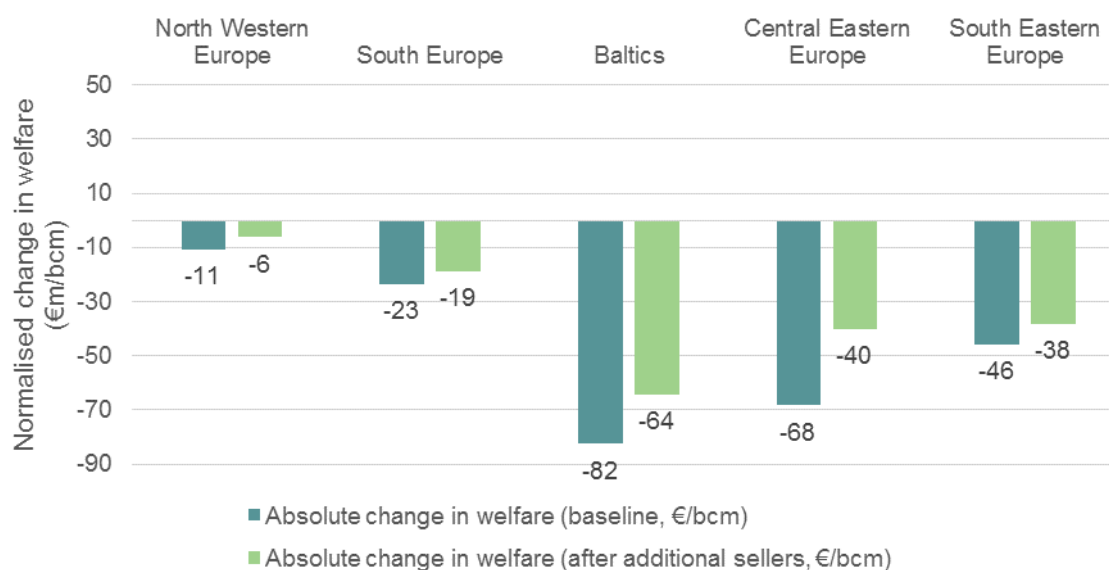
On the other hand, the case for strategic reserves or other safeguarding options[2] to reduce the impact of outage scenarios is strong, especially in the Baltics, South Eastern Europe and Central Eastern Europe, where Russia currently has a large share of supply. The size of the reserves would have to be a large proportion of the potential short run loss of supply in order to be effective, providing cover until investment to replace lost supply kicks in or the lost supply is restored. If there is a significant likelihood of a large outage, it may become economically viable to incur the cost of maintaining reserves or to maintaining additional import capacity so that additional sellers can be brought into action swiftly. This seems most likely to be the case in the Baltics and Central Eastern Europe markets where the potential welfare loss is highest, but not in other regions. The reserve has two beneficial effects: first, it replaces lost supply, curing the cause of the price shock; and second, it temporarily increases seller competition, depressing prices, see discussion of strategic reserves in Section 6.3. It is because strategic reserves act on both these channels, they may be able to counteract most or even all of the effect of a temporary outage on prices. Furthermore, seller diversity confers the benefit of reducing the optimal volume held in the strategic reserve.

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[2] Measures such as: long term commercial storage; cross-border swap agreements; options on purchasing of LNG cargoes or flexible demand contracts with interruptibility clauses, etc. are all part of the set of valuable safeguarding options to mitigate the impact of a security of supply event. The analysis of these measures is beyond the scope of this study.

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5.5.2   Impact of complete cessation of Qatari LNG supplies to the EU

The impact of a complete cessation of Qatari supply is more moderate than a Russian outage. Whereas a 50 per cent drop in Russian exports implies a drop of 57.9 bcm, a complete Qatari outage only implies a drop of 23.8 bcm of exports to the EU. Qatar does not currently have large market shares in Western Europe, supplying 6 per cent of gas to North Western Europe and 7 per cent to South Europe. None of the other regions would be affected. This is assuming that only Qatari supplies to Europe are affected. If Qatar ceased exporting completely, there would be second order effects on global gas prices which are not included in this assessment. Nevertheless, a sudden total loss of Qatari supply to the EU could produce a substantial price response because the consumption response will be limited. In North Western Europe and South Europe, prices might increase by around 5 per cent in the long run and perhaps double that figure in the short run. As with the Russian outage scenario, the long run figure is calculated using the Buyer Power Model and takes into account changes in seller power that might arise as a consequence of the outage. The short run figure will be much higher, the relative short and long run elasticities suggesting that it could be twice as large.

Figure 43.   **The effect of loss of supplies from Qatar on prices, long run**
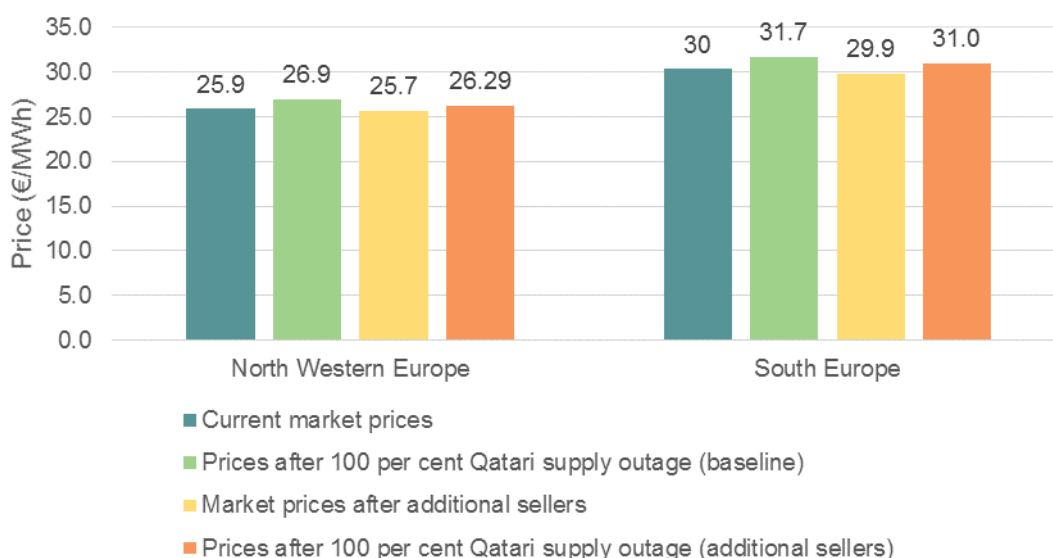
Current market prices
Prices after 100 per cent Qatari supply outage (baseline)
Market prices after additional sellers
Prices after 100 per cent Qatari supply outage (additional sellers)

Source: Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data

The welfare impacts of a Qatari outage are somewhat smaller in South Europe and slightly larger in North Western Europe compared to the partial Russian outage. This reflects the relative dependence of South Europe on Russian supply. In South Europe, the welfare cost is estimated at €16m/bcm and in North Western Europe it is €11m/bcm. The figures for the 50 per cent Russian outage in these regions were €23m/bcm and €11m/bcm respectively. Additional sellers confer a modest security of supply advantage, reducing the welfare impact of an outage by between €0.6m/bcm and €0.4m/bcm.

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Figure 44.   **The effect of loss of supplies from Qatar on welfare, long run**
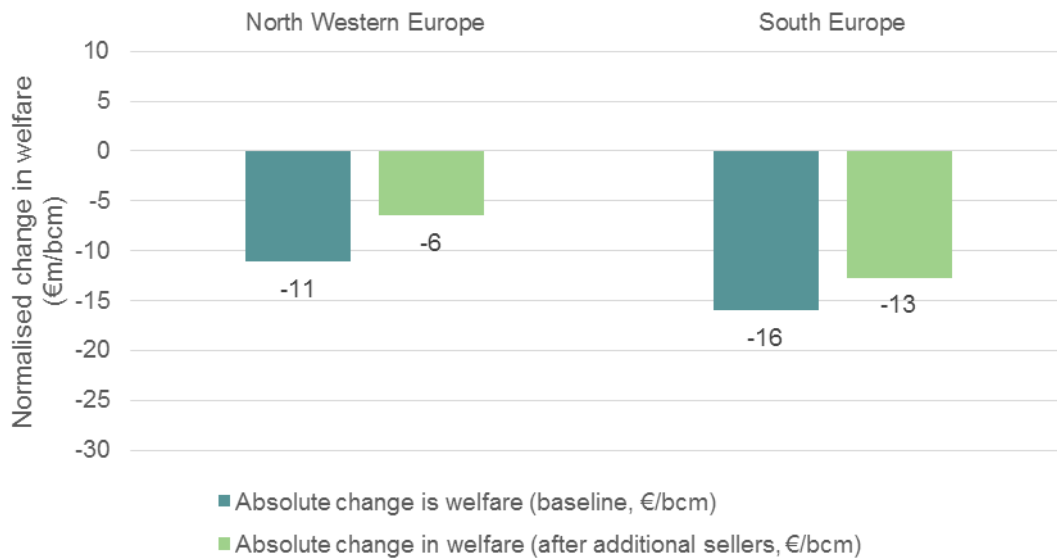
5.6 Retail market outcomes

5.6.1   Introduction

The above impacts on wholesale gas market buyers would also be transmitted to final consumers. This part of the analysis concerns the impacts in the retail market, that is, the sale of gas to residential and commercial gas end consumers.

Retailers and gas buyers are separate entities. Retailers purchase gas wholesale from gas buyers and/or from gas sellers and distribute it to final, retail, consumers.

A single buyer policy where all gas purchasing is carried out collectively might adversely affect competition in the retail sector. A single wholesale buyer might diminish effective competition between retailers. First, it would change the proportion of retailers' total costs which are within their own control. Retailers compete based on their input costs, that is, the cost of natural gas, and the cost and value of their services. A collective purchasing arrangement creates a single wholesale price for all retailers, thus reducing the proportion of an individual retailer's input costs which is under its own control, for example through its negotiating skill and its contracting strategy with wholesale market buyers. This consequence of collective wholesale gas purchasing might reduce the scope of competition between retailers. Second, a reduction in scope for competition on cost might lead to a reduction in innovation and might also lead to consolidation in the market. This effect is in contrast with policies to introduce additional sellers or to optimise the seller portfolio which would create more or more capable counterparties for buyers to contract with. Greater seller competition is unlikely to have much impact on the relationship between buyers and retailers, but if some buyers and retailers are vertically integrated, then it might encourage competition among retailers.

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In some markets, retail prices may be regulated. Where retail prices are subject to retail price controls, the rate of cost pass through is influenced by policy. The regulation may state the way in which a reduction in wholesale natural gas prices is shared between retailers and consumers.

5.6.2   Competitiveness and cost pass-through

The potential impact of the policy options depends on the degree of competition in the retail sector, which determines how wholesale gas price changes are passed through to final consumers. In a competitive market, changes in costs of gas purchased by the retailer are fully or almost fully passed on to final consumers, whereas the retailer may absorb a proportion of cost changes in less-than-competitive markets, such as those characterised by oligopoly or monopoly. Across all 28 EU Member States, the average number of large retailers is three, where a large retailer is defined as having at least a five per cent share of final consumption, as shown in Figure 45. The UK has the most competitive retail market with seven large retailers, whereas Finland, Poland, Latvia, Lithuania and Estonia have only one main gas retailer. In addition, the large retailers have a cumulative market share of more than 50 per cent for all countries except Germany and Italy, which possess hundreds of small retailers. All other Member States combined have fewer than 75 retailers in total (Eurostat, 2015b).

Figure 45.   **The main retailers have around 80 per cent combined market share in most regions**
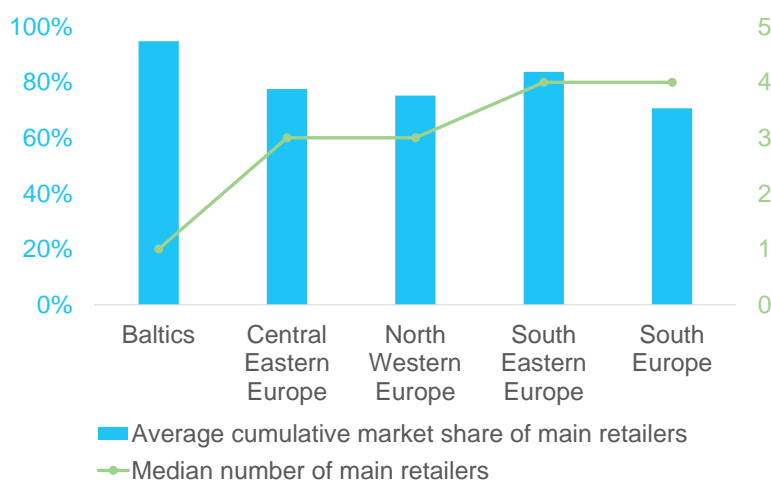
Note: *Main retailers are defined as having at least a 5 per cent market share of final retail consumption.*

Source: *Vivid Economics based on Eurostat (2015)*

Cost pass-through rates for individual European gas retail markets can be estimated using economic theory and mostly fall into the range of 50 to 85 per cent (Vivid Economics, 2013)**, based on the number of large retailers in each region.** Economic theory predicts that among other factors, such as strategies and market shares, the number of competitors in a market determines the degree of cost pass-through. This ranges from 50 per cent for one main competitor to over 80 per cent for four or more competitors, as shown in Figure 46. Smaller retailers add further competitive pressure and drive the cost pass-through rate up above these estimates. The number of retailers operating at the national level may, in some cases, be smaller than regional modelling indicates, which would tend to lower pass-through.

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Furthermore, in some countries, especially those with very few retailers, retail prices may be regulated and there may be a statutory requirement to pass on all or most of changes in wholesale costs. The speed of pass-through under market-based pricing and regulated pricing may be different.

Almost all wholesale gas price changes will be passed through to the retail market. Based on the structure of the large retailers alone, the cost pass through rate from wholesale to retail markets is at least 75 per cent except for the Baltics, see Figure 46. In most of Europe, the presence of smaller retailers or regulation will push the cost pass-through figure closer to 100 per cent. These cost pass through estimates are in equilibrium, which might take two to three years to be realised, but could occur faster.

Figure 46. **Cost pass-through to final consumers is 60 per cent or more even with few retailers**
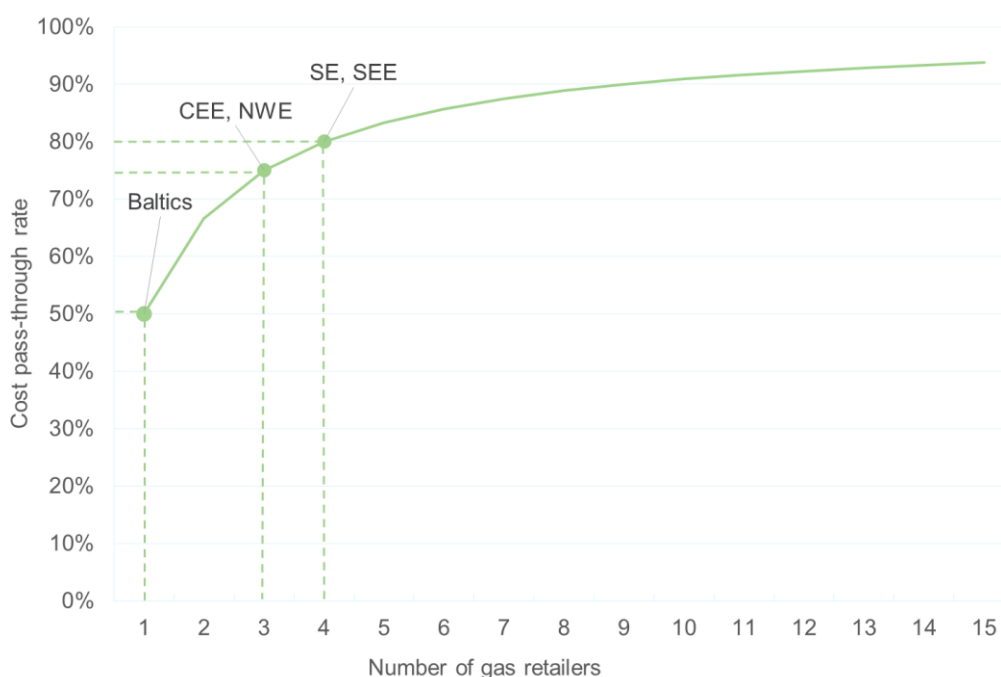
Note: 1. The cost pass-through estimates are based on the same economic theory underlying the Buyer Power Model.

2. The cost pass-through rate applies to markets in which gas is the main energy source used and cost pass-through rates might be lower in the power sector where gas competes with other sources of power generation.

3. The cost pass through rate is likely lower (higher) than indicated in countries with less (more) retailers than the regional median.

3. Main retailers are defined as having at least 5 per cent market share of retail gas consumption

Source: *Vivid Economics*

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6 Qualitative impact assessment

On asymmetric information, liquidity, hubs and strategic reserves

6.1 Asymmetric information

6.1.1 The role of asymmetric information in competition economics

The term 'asymmetric information' refers to a situation in which parties have unequal amounts of information. For example, a buyer or seller might have more or less or different information from another seller or buyer. Asymmetric information is common and it reduces the strength of competition. Its effects are explained below.

There are three key insights from economic theory that appear to be robust across a range of modelling approaches.

First, asymmetric information leads to welfare losses because it prevents beneficial trade from occurring; this may create a role for government policy. A key lesson from a large economics literature on the impact of asymmetric information is that it can act as a barrier to trade, preventing trade between two or more parties, which would be economically efficient, from occurring (Mas-Colell, Whinston and Green, 1995). In most cases, the presence of asymmetric information is likely to reduce social welfare relative to an otherwise identical setting with perfect information; in other words, information asymmetries create deadweight losses on top of those driven by the number of players being small.

For example, in Akerlof's famous 'Market for Lemons', buyers do not know the quality of different goods (while sellers do), and this can lead to the market unravelling with no trade in high-quality items taking place (Akerlof, 1970). The reason is that buyers cannot tell apart high from low quality, which creates an incentive for sellers of low quality products to pretend to be high quality. This makes it difficult for sellers of high-quality product to be adequately compensated, inducing them to leave the market: a phenomenon known as adverse selection where only the low-quality products remain in the market. Alternatively, sellers of high-quality product may choose invest in certification schemes, product warranties or other methods of quality verification to overcome the asymmetric information problem; the government or regulation may also play a productive role in such efforts. Although the quality of natural gas can easily be measured, the quality of the counterparty and its commitment to supply or to make payment may not always be so easy to measure, even though contracts are protected by contract law. In any case, quality is not the only type of information that is relevant. Companies use information to form expectations of future market prices and to make strategic decisions, such as the proportion of gas to buy or sell under long-term contract or whether to invest in an LNG terminal. They use information such as the volume of upstream investment, the level of production costs the quantity of downstream demand and the critical point is that they have unequal access to this information.

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Second, having access to better information on market conditions can be an important source of competitive advantage for an individual buyer or seller. Private information by an individual party often allows it to earn an informational rent in the marketplace, which is essentially a reward that induces this private information to be revealed to the market via the player's actions. In particular, this information has value since to a firm since it can tailor its product-market strategy to it. In wholesale gas markets, for example, large sellers which supply gas to several different countries and regions may have a superior understanding of how demand conditions vary across buyers. Individual sellers are also likely to have varying degrees of information on the production costs of their own gas supplies and those of rivals.

Third, asymmetric information probably has a negligible impact on market outcomes if there are both many small buyers and many sellers, all of which are small relative to the overall market. An important theoretical literature examines the impact of asymmetric information in 'large' markets, that is, markets with many buyers and sellers (Vives, 2000). The key question is whether, as the number of sellers grows large, market outcomes become fully efficient even in the presence of private information. Put another way, do large markets aggregate information efficiently? In some cases, large markets are indeed efficient and converge to the perfectly-competitive outcome; specifically, this holds when the unit cost of each seller is constant with respect to its production volume. Then the diverse information held by different sellers is still consistent with the classical predictions of perfect competition, as long as the number of sellers is large. In practical terms, large probably means at least 50 different sellers (and buyers) for an approximate result. The extent to which these conditions apply to EU natural gas markets has not been explored in the literature. For example, there are no estimates of how individual gas sellers' marginal costs vary with production. On balance, applied to gas markets, this literature suggests that countries with a larger number of sellers should also experience fewer market distortions due to asymmetric information.

6.1.2   Effects on asymmetric information arising from the buyer-power policy options

A consideration is how each policy option, especially the single buyer policy, could affect the quality of information held by different players in the market, and the impact of this on market outcomes.

Some policy options may improve buyers' information on market conditions and their relative bargaining power versus sellers. As a side-benefit, some policy options may lead to buyers obtaining better information about gas market conditions in Europe. **The single-buyer** option has clear potential to do this, by institutionalizing the exchange of information about demand conditions in each participating country, or about contract terms with non-EU suppliers. The precise extent of such information effects will depend on the organizational structure and operation, for example, of the single buyer. Such information aggregations among buyers could improve their bargaining power versus sellers, essentially by making their decision-making more responsive to prices. Another downside is that it may reduce competition downstream: if wholesalers pay the same for the gas, they lose the incentive to compete downstream and can pass on all the costs. A policy of **information exchange between existing buyers** may be able to generate both lower prices and higher consumption, by reducing barriers to trade, which is an attractive combination. For example, there might be an information policy which is transcribed into a regulatory requirement to publish contract prices and volumes, or to report them to a statistical agency for anonymous republication. The question is how strong this effect might be, of which there appears to be no means of estimation, and how feasible it would be.

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6.2 Liquidity

6.2.1 Introduction

This section covers the impact of the single buyer and the policy options of increasing the number of sellers and seller optimisation, on contract structure and gas hubs. The single buyer is an example of collective purchasing. The policy option of additional sellers has the opposite impact to buyer aggregation in the sense that it increases the number of market participants, so it is always discussed separately. The final option of seller portfolio optimisation would not affect the number of players.

6.2.2 Contract structure

Gas buyers with a sufficient choice of sellers may be able to choose contract length, indexation, seller and market. A collective buyer will wish to build a portfolio of contracts. It can rely on bilateral contracts, with short or long time frames, and can use both spot markets through gas hubs, where these exist, and over-the-counter (OTC) bilateral negotiation to obtain the contracts. However, as discussed in more detail below, collective purchasing may itself reduce the number of counterparties trading on gas hubs. There are two effects. On one hand, collective purchasing would directly reduce the number of individual buyers who were already using hubs; on the other hand, it could aggregate buyers who previously did not trade on hubs.

The current market is a mix of legacy bilateral long-term contracts and hub-based short-term and spot contracts, together with some more recent long-term contracts. Long-term contracts have been largely oil-indexed and have declined in market share as they expire and have been replaced in part by hub-based spot contracts, as shown in Figure 47. The mix of indexation has also changed, with an increasing proportion of new long-term contracts based on gas benchmark prices rather than oil indexation. The economic driver behind these changes has been the high price of crude oil over the period from 2006 to 2014 and the declining price of hub-traded natural gas since 2008, which created a significant price differential over the past seven years, making it more economical for gas buyers to push for competitively-priced natural gas instead of oil-indexed natural gas. Other parts of the world have also moved towards competitive pricing, but the EU has moved further and faster over the last decade, and started with market-determined long-term contracts rather than the regulated prices common in some other regions.

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Figure 47. **Europe's gas markets have moved away from long-term contracts towards hub-based pricing**
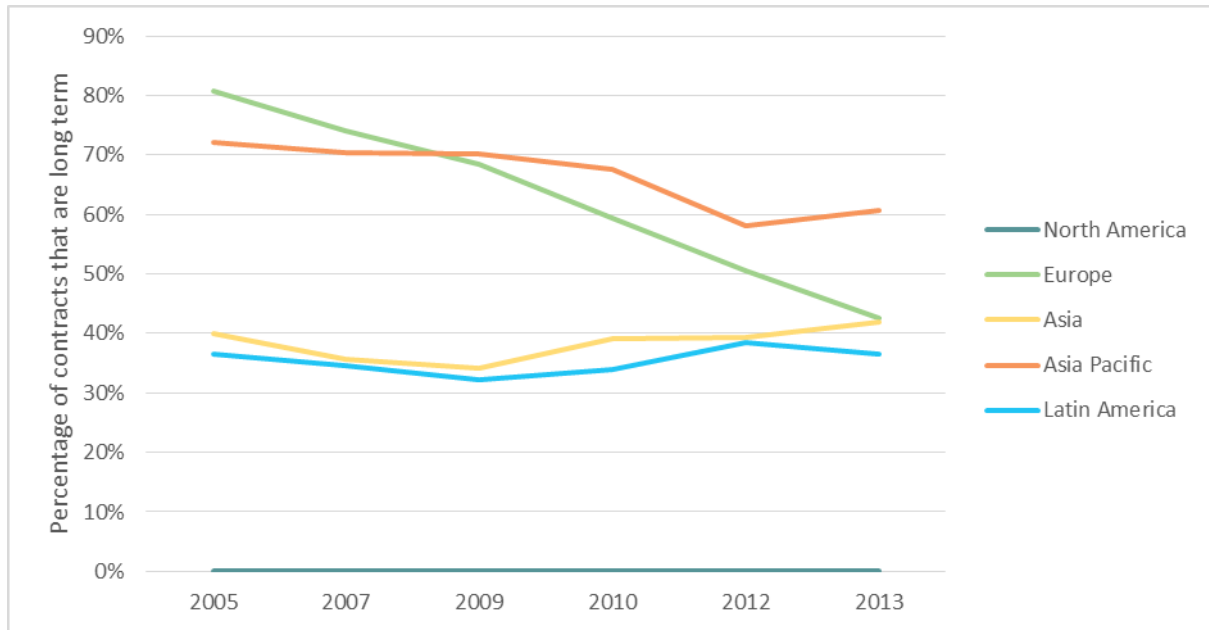
Source: *Vivid Economics based on International Gas Union data (2013)*

Long and short term contracts provide different benefits. Long term contracts provide certainty to sellers and buyers about the quantity of gas and its price. For sellers, the benefits include certainty to recover initial investments in production and infrastructure. For buyers the benefits are cost stability which feeds through into stable prices for customers, and secure capacity, which allows them to develop their market share and pricing strategies. Short term spot contracts, on the other hand, offer flexibility to adjust to volatile prices and changing market conditions. They allow sellers to respond to changes in demand or availability of supply gluts, keeping the market in balance. A recent example is the LNG price spike in Japan after Fukushima, which drew in additional supply, and the steep decline in gas prices in the US due to the abundance of unconventional natural gas, which triggered greater uptake of gas in US power generation and investment in export capacity. LNG spot cargos provide flexibility across continents, arbitraging price differentials and reallocating supply towards markets with higher prices.

The transition in contract portfolios caused by the policy options occurs gradually as existing contracts are replaced. Regional volumes of long term contracts differ, with particularly large volumes in long term contracts in Southern and North Western Europe, as shown in Figure 48, and this determines the rate of change that a new policy might effect. A movement towards spot markets requires the further development of gas hubs and exchanges, which might take more time to develop, since it involves building institutions. In comparison, a movement towards bilateral contracts might take place quite rapidly since it requires no institution-building, while it may also increase the risks faced by the contracting parties in some cases.

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Figure 48. **Southern and North Western Europe have a significant volume of gas contracted out to 2030**
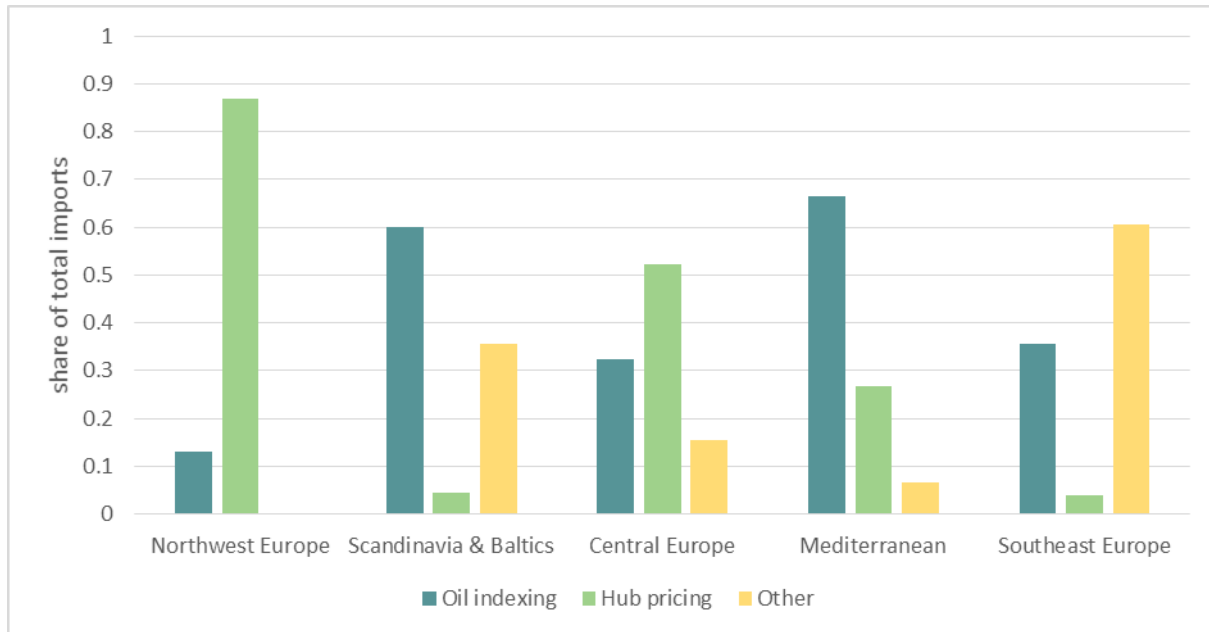
Note: *Import shares are calculated by normalizing with total imports. IGU region definitions differ slightly from those used in this report.*

Source: *Vivid Economics based on European Commission DG Energy (2013)*

6.2.3 Hubs

Gas can be traded bilaterally and through hubs. Bilateral trades require seller and buyer to negotiate directly and arrange for the transport of gas. The level of information on prices in bilateral negotiations varies but is lower than the information on gas hubs where gas prices are publicly available. Bilateral trades, which may rely on a hub marker or other benchmark, can have varying contract lengths and might provide the advantage of adding to security of supply by providing sufficient certainty to sellers to fund infrastructure, such as additional transmission and extraction capacity. Gas traded on hubs is generally limited to shorter-term contracts, but it is the most transparent method of trading as prices and volumes are published. Hubs bring together multiple buyers and sellers in the same market place at the same time making it easier for buyers to find willing sellers and for sellers to find willing buyers.

European gas markets started with almost exclusively long-term bilateral contracts. Gas prices were and still are to some extent indexed to oil prices. With the development of the National Balancing Point in the UK, a separate reference price independent of oil prices could be set and market-pricing of gas has spread since then throughout Europe to cover approximately 50 per cent of current consumption.

Gas hubs provide economic value by connecting several market participants and competitively determining gas prices by market forces. Gas hubs can coordinate storage, LNG terminals, pipelines, traders and consumers and retails at one central point. The advantage of this coordination is the resulting depth and volume of the market, meaning that all participants can buy and sell sufficient volumes of gas. The interaction of these market participants and their desire to buy and sell certain volumes determines the price

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of natural gas. The determination of prices by several trades, especially trade of volumes exceeding the exchange of physical volumes, defined as the churn ratio, provides a strong, reliable price signal that reflects the current value of gas and might be different than gas prices set by regulation and/or oil-indexation.

The policy options might change contract portfolios, contract structures and market liquidity by changing buyer behaviour and/or the number of market participants. The impacts on contract portfolios and contract structures arise from the effects policies have on hub liquidity. High liquidity can lead to greater supply diversity by attracting additional gas volumes, particularly spot LNG cargoes, due to the certainty over what price can be achieved. This is because liquid hubs assure sellers they can sell a parcel of gas without significantly moving the market price. Prices at liquid hubs can also be used as the reference price for long-term contracts, lessening the dependence on oil-indexation. The impact can differ by region and over time, reflecting the number of market participants and the existing contract structure.

The impact of buyer policy options on hubs are most felt in the region with well-developed hubs: North Western Europe. The NBP in the UK and TTF in the Netherlands are Europe's deepest and most liquid hubs. Other hubs in North Western Europe, such as the Zeebrugge hub in Belgium and Gaspool in Germany, are comparatively smaller but still larger than hubs in Southern Europe. No gas hubs existed in Eastern Europe, the Baltics and South Eastern Europe in 2012 and 2013, the period of focus in this study. Policies which lead to additional sellers may lead to a greater volume of trading and will enhance the value added by hubs. Policies which lead to a reduction in the effective number of buyers, namely a single buyer, will reduce the volume of trades on hubs and will undermine their role.

The diversification of supply can benefit hub development throughout Europe. Adding additional suppliers and volumes to the market benefits not only already existing hubs, but also could provide the impetus to expand developing hubs in South Europe and North Western Europe. The creation of hubs in Eastern Europe, the Baltics and South Eastern Europe would require a large diversification of supply and possibly increased interconnectivity. The diversification of supply can provide the first step towards hub formation. The development of hubs serving the Baltics and Central Eastern Europe would make pricing in these regions more transparent and might help to break down some of the price differentials within them. It could help buyers in these regions negotiate more favourable prices. Hub development takes time whereas improved negotiation might be possible immediately.

6.2.4   Liquidity impacts

Liquidity is a key characteristic of a well-functioning gas market. Liquidity provides two main benefits:
–   a price signal based on market fundamentals; and
–   a deep market, assuring sellers that they can sell desired volumes without moving the market.

Liquidity can be determined by three measures: First, churn ratio: volume of gas traded divided by gas consumption. A higher value indicates it is easier to trade gas multiple times. Second, bid-ask spread: the difference between the sell and buy price of natural gas. A small spread means lower costs for sellers and buyers and indicates a strong price signal. Third, depth: trading volume along the forward curve, such as spot, 3 months, 1 year, more than a year. A deep market can absorb additional quantities at various contract lengths without the sale affecting price (Miriello and Polo, 2015).

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Four factors influence liquidity: number of buyers and sellers, interconnection, demand-side participation and vertical integration. A high number of buyers and sellers correlates with higher volumes and additional trading, providing the necessary transactions and depth to the market. The additional seller and seller optimisation act on this channel. The capacity to physically exchange gas between buyers and sellers, and to potentially balance it between unconnected buyers, increases market participation and depth of the market. Reduced vertical integration increases liquidity because vertically integrated gas consumers have less need to trade gas along the forward curve. Structural separation of gas selling and buying functions supports both liquidity and created demand for hubs, improving transparency and reducing asymmetric information.

European gas hubs are developing further, with the National Balancing Point in the UK, the Title Transfer Facility in the Netherlands and the Gaspool in Germany leading the way. These three hubs have a high degree of liquidity, providing a strong price signal for gas buyers and sellers in these markets. The large number of buyers and sellers, the high degree of interconnection between them and sufficient demand side participation contribute to their liquidity. Miriello and Polo (2015) show how various liquidity measures have changed since 2011, in particular, churn ratios rising from around 17 in 2011 to around 18.5 in 2013 for TTF, and similarly rising from 2.5 to 3.0 for NetConnect Germany and Gaspool. Volumes in these hubs have also increased over the same period. The volumes and churn ratio for the UK NBP fell over the same period.

LNG markets, particularly spot markets, require a strong price signal and market depth to find Europe attractive compared to other regions. Lower liquidity and depth reduces the incentive for LNG suppliers to send spot cargo to Europe. Developed gas hubs provide this liquidity and depth and create the incentive to enter long-term contracts as well as direct spot cargos towards Europe. The strength of a gas hub price signal is illustrated by the indexing of some LNG short- and long-term contracts to the price of Henry Hub in the US, the world's currently most liquid hub.

Under the Single Buyer policy, the number of buyers declines drastically, and with it liquidity. Under the Single Buyer policy, only one buyer remains. This implies that the number of gas trades declines. The churn ratio, the volume of sales divided by the physical exchange of gas, would fall closer to one. The opposite impacts are true for increasing the number of sellers in the market. In this case, liquidity in the markets increases and with it a lower bid-ask spread, a higher churn ratio and a deeper market, increasing the current benefits generated by gas hubs.

The negative impacts on liquidity of the Single Buyer policy might be mitigated to some extent by appropriate behaviour, but a residual significant detriment to liquidity would be expected. The main benefits of a strong price signal and a deep market might only be emulated in part with appropriate behaviour by the Single Buyer, for example, through a requirement to purchase a minimum proportion of its gas through hubs. It might also be required to purchase at a minimum frequency and maximum parcel size, but a Single Buyer will not exhibit the same variety of purchases and pricing as a collection of independent buyers, so there will be a significant residual detriment to liquidity. In the same spirit, a Single Buyer might credibly commit to absorb certain volumes of spot market gas, such as LNG. There would be difficulties in operating rules such as this, for example, a requirement to purchase a proportion from a particular source

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may conflict with objectives to purchase efficiently, if LNG prices are high, and either it will become a complex legal set of rules which anticipates every eventuality, or it will be opaque as to how judgements are reached from day to day. In this respect, the Single Buyer Policy might only in a limited way replicate the benefits provided by a well-developed gas hub and reduce any negative impacts for other sellers and buyers. Then there are additional functions they would have to reproduce as they replace the gas hub's coordination and balancing activities. The buyer policies may possess much of the same information about demand and supply than is revealed through gas hubs, but there would be less information revealed to other market players. Even if suitable arrangements are put in place, in order to be effective in mimicking the properties of a hub, the collective purchaser has to be run well. It will carry a risk of failure and it is not easy to monitor and enforce behavioural commitments. The details of these mitigation actions are not developed further here given the overwhelming practical challenges in operating a Single Buyer.

6.3 Strategic reserves

The discussion here focuses on how a strategic reserve might be designed and its potential drawbacks, in part based on lessons from reserves in oil markets. The option of a strategic reserve for natural gas forms part of an additional sellers' channel of influence. It could come in several forms, including; storage, LNG options and swap agreements. The role of strategic reserves has already been discussed in conjunction with the modelling results on the impact of security of supply events in Section 6.5.1.

The operation of strategic storage is similar to that of additional capacity for existing sellers for a limited period. The gas storage sellers operate in normal market conditions, but they only sell gas booked in a strategic reserve under stress conditions, not under business-as-usual conditions. Gas storage could be run as a collective enterprise or privately. A collective enterprise differs from a privately-operated storage operator in that its objective is not to maximize profits by performing regular intertemporal, for example, seasonal, price arbitrage. Instead, it aims to minimise price changes in the event of a strategic outage. If and when volume from a strategic reserve comes onto a market, the impact is likely to be comparable to that of supply from other sources. In the collective model, the strategic reserve would behave like an additional seller. In the private model, the sellers who book gas in storage are likely to be many of the same sellers who sell during normal market conditions, so rather than acting as an additional seller, the elasticity of supply and the sellers' market shares will change.

The primary rationale for a strategic reserve is to facilitate and smooth the response to an unexpected supply disruption. A strategic reserve does not address more general concerns about the price level in a market being 'too high' or deal with market conditions that are tight for other reasons. In public discussion, however, the objective of a strategic reserve can be confused; high prices can lead to widespread calls for a strategic reserve to be tapped – even when they are not due to a disruption of supply.

While there is no prior international experience with strategic reserves in natural gas markets, policy lessons can be drawn from oil markets. The International Energy Agency (IEA) and the US Strategic Petroleum Reserve (SPR) were created, following the 1970s oil crises, to deal with supply disruptions. The oil crisis of 1973/4 fostered the creation of the IEA, whose signatories were the major Western oil-importing countries. These are committed to maintaining emergency oil reserves equivalent to 90 days of net imports,

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and to allocating reserves in a way that balances shortages in individual countries. In parallel, the US established its SPR, managed by the Department Of Energy, which today also includes some refined products in addition to stocks of crude oil. Similarly, the EU introduced stockholding obligations on all Member States, set out in Article 3 of the Oil Stocks Directive 2009/119/EC.

The original rationale behind the US SPR was to buy time for responding to supply disruptions originating outside the US. The idea behind the SPR was to buy time: on one hand to deal with the supply disruption itself, and on the other for international diplomacy to help address any political conflict. Since the 1990s, the SPR's objective has been somewhat loosened. The core of the ongoing debate lies in different interpretations of a 'severe energy supply interruption': whether this refers solely to an actual supply disruption with physical shortage, or whether it includes an *anticipated* tightening of supply leading to an 'early drawdown' of reserves to prevent price spikes (Bamberger, 2009).

The US SPR has purchased oil via a combination of outright purchases and 'royalty-in-kind' volume transfers from oil producers. On the operational side, the SPR has since 1990s largely been filled with royalty-in-kind (RIK) additions from local US oil production rather than outright purchases. These involve oil companies directly transferring physical oil volumes from their US production sites to the underground storage facilities of the SPR in lieu of making contractual royalty payments to the US Government. Its earlier purchases were conducted directly in the crude oil market. A similar arrangement could be used to fill strategic gas reserves in the EU.

Drawdowns from oil strategic reserves have occurred in practice on a discretionary basis. In principle, drawdowns from a strategic reserve can arise in two ways: at the discretion of a government, regulator, or other policymaker, or following a formal rule-based mechanism. For example, the rule could be to draw down a certain quantity if the price of a commodity rises above a trigger price. The design of the US SPR relies on government discretion, and has rejected such rule-based drawdowns. This confers greater ability to flexibly respond to market events, and may mitigate any distortionary market impacts.

Crude oil from the US SPR has been sold at competitive prices using an auction mechanism. Given the decision to release volumes from the strategic reserve, a notice of sale is issued, which specifies the volume, characteristics, and location of the petroleum for sale. Bids from qualified entities are reviewed by the US Department of Energy and awards made. It is estimated that oil can enter the market around two weeks following the notice of sale (Bamberger, 2009). A similar mechanism could be used for EU strategic gas reserves.

The history of the IEA's strategic reserves features only three actual drawdowns over the space of 40 years. Emergency drawdowns of IEA signatories' strategic stockpiles have occurred on three occasions. First, during the Gulf crisis in January 1991, shortly before hostilities began, the IEA coordinated a global strategic release. Second, in the aftermath of Hurricanes Katrina and Rita in the US during the summer of 2005. Third, in 2011, in response to supply losses from Libya and concerns over high oil prices (Yergin, 2011).

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The fact that strategic reserves have been in operation for 40 years suggests that they can bring significant benefits to importing countries. Strategic reserves in the key oil-importing countries were introduced over 40 years ago and survive to this today. Although the operation of individual reserve programmes has evolved over time, for example the US SPR, the basic objectives remain unchanged (Emerson, 2006). This fact suggests that strategic reserves have conferred significant benefits on oil importers – probably mainly to consumers – and that these benefits have the potential to be long-lasting. Although there appears to be no detailed economic analysis of any of the three IEA drawdown episodes, policy discussions suggest that these releases were successful.

Despite its advantages, a strategic reserve comes with a number of potential drawbacks. First, the establishment and operation of a strategic reserve can crowd out private investment in storage facilities. This concern is particularly salient if private storage operators already have low profitability, for example, due to low seasonal price fluctuations. Second, there is scope for conflicts of interest between the owner or operator of a storage facility and those relying on it. For example, how a strategic reserve prioritizes between the national interest of the country in which it is located, and those of a neighbouring country. Third, a large strategic reserve of any commodity comes with a significant economic opportunity cost. For example, Ejarque (2011) estimates that the cost of a strategic, permanent, gas reserve in Denmark and Italy would equal 16 to 20 per cent of the value of their respective storage markets. Fourth, if the reserve has not been deployed for some time, this can lead to calls for its liquidation in order to free up the financial commitment for other purposes.

There are number of differences between oil and gas markets, with implications for the desirability and feasibility of a strategic reserve.

The international markets for crude oil and natural gas differ, so the cost benefit analysis for strategic reserves in oil might not be mirrored in gas. First, while oil is at least to a first approximation a global market with a uniform price, global gas is still fragmented into regional groups (mainly North America, Europe, and Asia) with distinct pricing mechanisms. Second, gas is more difficult and more expensive to store than oil, and many European countries currently only have limited storage facilities available. Third, despite recent events in the Ukraine, gas markets have not experienced crises of similar magnitudes and international scope to those that hit oil markets in the 1970s and 1980s. This lesser degree of urgency may, in part, explain why no strategic gas reserve has been developed in Europe to date. Fourth, oil consuming countries have long relied on long-distance shipping while this has only recently become important in some gas consuming countries.

Some of the design issues around a single European gas buyer – regional scope and participation – also apply to a strategic reserve. First, should the strategic reserve be a single EU-wide mechanism, or split up by some or all regions within Europe? Second, should participation by individual countries be voluntary or mandatory? Who should act as the central coordinating body? How does a strategic reserve fit into the completion of the internal energy market in Europe, notably the design of policy around gas transportation? These questions are beyond the scope of this report but would have to be addressed if the option were to be taken forward for further analysis.

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A strategic European reserve offers significant benefits of a public-good character and so the funding of its formation and operation may have to be enabled by government. The economic benefits of strategic reserves would likely be dispersed amongst a large number of wholesale and retail gas buyers and final consumers across Europe, while its economic costs would be more concentrated, accruing to existing private gas storage operators whose profits decline, as well as being covered by some form of contribution from either sellers or retail buyers. Further questions are how the reserve is designed and how the upfront investment costs are shared across countries. Again, similar to the potential benefits from a single buyer, it is likely that the benefits from a strategic reserve will be relatively greater for Eastern European markets than in Western Europe, because of the greater source diversity in Western Europe. Strategic, publicly-supported reserves such as this can be made compatible with liberalised markets if their objectives are clearly set and tied to policy objectives, if their operating mandates are strictly limited in line with their objectives, and if their size is appropriately matched to their purpose.

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7 Challenges in the operation of collective purchasing

The practical difficulties of operating a collective purchasing scheme

The establishment of a new institution in the form of a single buyer, which here is used as shorthand for any collective purchasing authority, requires a range of practical arrangements to be put in place. Many of these arrangements will be necessary no matter what precise legal form it takes. Two types of arrangements must be considered; functional and legal arrangements. The functional arrangements have to be considered first, before the pros and cons of different legal forms can be considered. The discussion below articulates the functional arrangements which may be needed and shines a light on some of the practical challenges that would have to be overcome to deliver them. This prepares the ground for a consideration of the legal forms at some later date, beyond the scope of this study, if the single buyer receives political support.

A single buyer would have to be able to credibly write contracts, some of which may be long term, up to 20 years in length. In order to do so, it must have a strong, long-term political commitment behind it. The most robust basis would be a statutory foundation, in primary legislation. To achieve such support it may be necessary to demonstrate success of similar institutions operating elsewhere. This includes the feasibility of adopting some similar institutional arrangements such as enforcement sanctions on members, preventing those members from purchasing elsewhere, or similar patterns of payoff for participation, where participation is on a voluntary basis. Credible longevity of this form also demands a clear set of benefits which is widely recognised as accruing. There ought also to be a low level of disbenefits, so that no politically represented group feel so disadvantaged that it is motivated to launch an effective programme of political lobbying, causing the authority to be dismantled.

The conditions for widespread political support may not exist. First, not all regions would benefit to the same extent, with some Member States having much less reason to support it strongly than others. Second, the single buyer generates disbenefits for sellers, who might lobby against it. Third, there is no analogue in gas markets in other jurisdictions upon which to model it. These three reasons make it unlikely that the single buyer would enjoy broad political support.

The restraint of consumption appears to be quite impractical as an option. The single buyer will have to enforce contracts not only with sellers but also with its own members. This might be straightforward for its facilitation and enabling outputs, through which it would improve price negotiation, encourage sellers and promote seller diversification, but could be very difficult for the restriction of consumption. In the case of the restriction of consumption, sanctions which are legally enforceable and incentive compatible would have to be devised. That is, the single buyer authority and its members would wish to enforce those sanctions when they are needed. It seems unlikely that Member States would be willing to sign up to the threat of strong

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sanctions against their gas buyers and the restraint of consumption appears to be quite impractical as an option.

A key issue to be decided is whether individual members would be allowed to side-contract. Side-contracting means buying gas on their own without going through the Single Buyer, as is observed in some collective purchasing schemes, such as US hospitals. If side-contracting is allowed, it would undermine the credibility of the Single Buyer, since sellers would have the option of selling to the Single Buyer or of dealing with individual members on a discretionary basis behind its back. If side-contracting is prohibited, then buyers and individual Member States will no longer have sovereignty over their gas purchasing.

A single buyer has to be able to assemble information for its negotiations and to have access to its members' anticipated demand and the reaction of their demand to changes in price. This is not especially technically difficult nor demanding in terms of the private information that would be revealed. It simply needs members to be cooperative and to deliver information in a timely manner. Some members are likely to find it easier than others to meet the demands of the single buyer in a timely fashion, but it should not present a practical barrier.

The single buyer will have to develop an arrangement agreeable to all members, for determining the prices paid by all members. It is likely to be able to set a uniform price with adjustments for transport costs, since costs will reflect differences in geography. Some members will then benefit more than others from collective purchasing, but there will be a common base price. Transparency and independence would be virtues and the single buyer would have to find ways to demonstrate transparency and might, through its constitution, governance and processes, be able to show independence.

The single buyer will need to have a clear commercial negotiating mandate from its members so that it can enter into contract negotiation with sellers and close deals in a timely manner. This mandate will have to be broad, so that it can react to changing circumstances without having to seek new mandates, but also sufficiently narrow that it is not going outside the remit which its members are comfortable with. It will have to deal explicitly with complex topics such as risk and will have to represent members' preferences, which will not be uniform and may not be aligned. It could be a complex mandate to negotiate. To simplify the process, it might be possible for a few founder or core members to work out a mandate, allowing others to join the club on the same terms if they wish. Under an alternative, mandatory model, significant policy and political effort might be needed to devise a mandate which attracts sufficient support.

The single buyer would have to be robust to unexpected events and future disagreements between members. When legal commercial arrangements are put in place of the sort anticipated for a single buyer, they will have to anticipate a wide range of market events such as seller outage, and the pursuit and receipt of damages and the ways in which these are distributed between members. On the one hand, the legal arrangements could become quite precise and restrictive. On the other hand, they might be left quite broad and principals-based, relying on dispute resolution mechanisms to resolve disputes if and when they arise. These arrangements do not mean that a single buyer cannot be set up, but they do mean that unless there are models which can be copied, there is a considerable amount of work to be done to devise the arrangements underpinning the institution.

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The single buyer will need access to capital. As well as initial working capital with contributions from each member, it might also need recourse to Sovereigns or other strong financial players to allow it to write high value long-term contracts. It will have to consider in what form this financial collateral is supplied and whether the tariff applied to some members is different to others, to reflect their financial strength. Although this need not be an overly demanding problem to solve, it is another aspect in which distributional questions will arise and it will take effort to devise the arrangements.

The single buyer will need governance arrangements which reflect the political and commercial interests in its activities, coupled with arrangements for the monitoring and evaluation of its performance. It is likely to need not only an executive but also particular forms of member and possibly also government representation. It is likely also to wish to set out codes of conduct for itself and for its members in order to affirm expectations and to reduce the risk of disputes. In addition to the functional arrangements above and the legal form, it will need appropriate resources to carry out commercial negotiations, trade, carry out market analysis, write legal contracts and manage relationships with its members, with governments and with sellers. These aspects of staffing and resources are likely to be relatively straight forward to work out once its mandate and legal form are clear.

Collective purchasing faces major practical difficulties and is in competition with alternative policy options. It is unlikely that a mandatory single buyer would attract sufficiently broad political support at European level, given the likely opposition of sellers to the scheme, but it might receive some political support within the regions standing to benefit most from it. The institution would at least struggle and may well find it impossible to implement restraints on consumption, but it could have success in other ways, enabling more effective negotiation, seller entry and seller diversification. On the other hand, the same outcomes that a single buyer might enable could also be achieved through other means, by expanding the interconnection of infrastructure, by supporting trading of gas via hubs by encouraging market players to use gas hub pricing as relevant price benchmarks for long-term gas contracts and by enabling information sharing on buyer negotiation, all of which need not involve collective purchasing. The information exchange involved in the last two options may however restrict or eliminate competition, in particular on downstream markets. The only mechanism which could not be achieved outside collective purchasing is restraint on consumption, but the practical barriers to a single buyer delivering this appear insurmountable. Overall, the conclusion is that collective purchasing at best is not more effective in raising European welfare than alternative policies and at worst is much less desirable than those other policies.

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8 Conclusions

The EU is a diverse continent. In order to explore this diversity, the EU Member States have been presented as five regional groups. These groups exhibit significant price differences; at the extremes, Lithuania, as part of the Baltic market, had a 2013 average price of €38/MWh while that in Denmark (in North Western Europe) was 42 per cent lower. This price dispersion is linked to substantial differences in circumstances, including market concentration amongst gas sellers and buyers, interconnection, information and possible differences in buyers' negotiating skills and strategies. The European gas markets have changed greatly over the last two decades and most regional groups, but not all of them, now experience much more competition than they did before. That has brought real benefits to consumers. The competition has come in two forms, first as an increase in the number of sellers such that the EU has become much more diversified in its gas sources, and second through improved information available to participants through the development of gas hubs.

The distribution of observed market prices and characteristics combined with economic theory of markets suggest several possible channels for lowering prices in the currently high-priced regions. The channels with the greatest potential for enhancing buyer welfare through lowering prices and increasing consumption are additional sellers and market integration. Further channels: the diversification of sellers by means of shifting market share from large to small sellers, improved negotiation and the restriction of consumption, offer smaller welfare benefits and may be less feasible. A single buyer could play a role in delivering lower prices through any of these channels, but in all except the case of restriction of consumption, the single buyer is not uniquely placed to do so. For example, pricing based no gas hubs could address the information and negotiation channel. Meanwhile, additional sellers could be encouraged by expanding the international connectivity of the gas network.

In combination, this evidence suggests that there is no significant net benefit from introducing a mandatory single buyer in wholesale gas markets. First, there are relatively few examples of collective purchasing in gas or other sectors other than on a voluntary basis. In these examples, the collective buyer appears to act as an intermediary and there is no firm published evidence that the collective purchaser wields buyer power to counteract the bargaining strength of sellers with large market shares. Second, the theory based modelling of the effects of collective purchasing across the various EU regions indicates that, in those regions where seller power is high, the political costs of driving prices down would be high, and a single buyer would not have the political capital to exercise its market power. Whereas a dominant seller may easily choose to restrict supply, a collection of buyers cannot restrict consumption among their customers. The modelling shows that there are much more effective and politically more feasible means to reduce prices and erode seller power, and it does not take a single buyer to deliver them.

In the scenarios of a supply outage, price rises could be large and threaten economic growth. While it is more difficult to model a short term supply shock in exploring changes in relative bargaining power, the long run effects of a supply shock shed light on the short term. It is clear that a partial Russian outage would lead to strong price rises in the Baltics and Eastern Europe. By contrast, its impact on Western European markets would be muted because they are not so heavily dependent on Russian sources. A full outage of

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Qatari LNG would have no direct impact on Eastern European markets as these have not relied on LNG to date (excepting Lithuania recently). The effect on prices in Western European markets is also limited and in fact similar to the effect of a 50 per cent Russian outage. The modelling graphically shows the security of supply benefits of seller diversity in the Baltics and Central Eastern Europe regions because of the twin benefits of reducing the volumetric magnitude of the outage and the mitigation of the market power of the dominant seller. A similar twin benefit would be generated by the operation of a strategic reserve in these regions. In fact, a strategic reserve is even more effective because it immediately offsets a significant part of the outage while also temporarily increasing seller competition. Neither of these options requires a single buyer, but the strategic reserve is likely to be funded by placing an obligation on either sellers or buyers, typically the former.

Despite the diversification of sellers across the continent in recent years, eastern European markets remain much more concentrated on the side of sellers. This concentration has a deep effect on the character of the markets in Eastern Europe. In contrast, in Western Europe and in the south, the concentration of sellers is much lower. As a result, market power between buyers and sellers is more balanced in the latter locations. This difference in market structure drives a fundamental difference in bargaining power between sellers and buyers across the regions, visible as a strong regression relationship between prices and seller market concentration across the continent. However, it is not the only factor and physical access to sellers and interconnection, together with the availability of information, for example through regional hubs, contribute to price differentials across the continent.

International evidence from several markets outside the gas sector reveals a small number of enduring single buyer institutions operating on a voluntary basis. These institutions, including one for medical supplies in the US, appear to generate benefits for their members by reducing administrative costs through larger scale, increasing the negotiating skill at the point of purchase, and they may also enable access to a larger number of sellers. It is unclear whether or not they achieve lower prices by restricting consumption and whether or not they skew the market shares of sellers to increase seller diversity: neither of these strategies has been reported so they are probably not employed. It is possible they are doing little more than playing a classic intermediation role, lowering costs and improving quality though specialisation and scale. The collective purchasers in the literature are not single buyers in the sense they are considered in the economic literature, which is the same sense that a cartel is a single seller: the real world examples are more like intermediaries.

Evidence from previous modelling studies offers little insight into single buyers in gas markets. There is a range of gas modelling approaches and there is a body of evidence from those models on the effects of seller market power. The buyer side of the market is much less well explored and there appears to be no published work on the price and welfare impacts of collective purchasing in wholesale gas markets, with very little theoretical work on buyer power and the channels by which single buyers might benefit consumers. The principal effect that is widely discussed in the general economics literature is that single buyers can achieve consumer welfare gains by restricting consumption. The practical arrangements for delivering this appear not to have been a topic of research before. The literature shows that competition is very effective in reducing seller power and that asymmetric information can reduce welfare in markets, pushing prices up and reducing trade.

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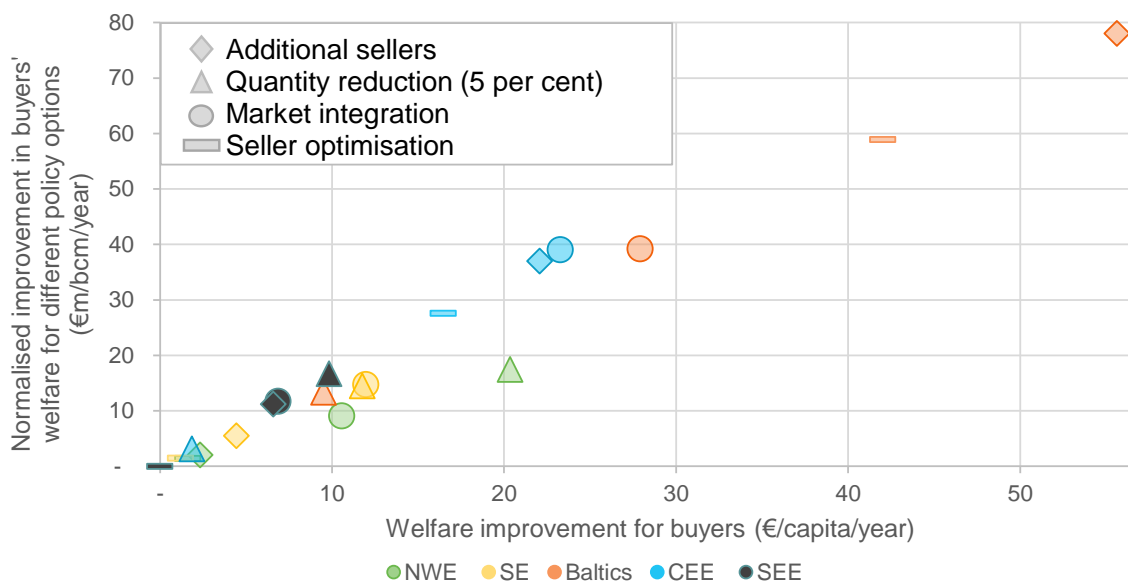
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The evidence from economic modelling in this study suggests that increasing competition between sellers and improving information are the best ways to improve consumer welfare in the EU wholesale markets of natural gas. It has been possible to extend previously available modelling techniques to explore the potential impacts of a single buyer and to compare them with alternative options, such as increasing the number of sellers and market integration, on a consistent basis. The modelling robustly demonstrates the effectiveness of competition between sellers in lowering prices and raising consumer welfare. It also suggests that improvements in negotiation offers welfare gains similar in magnitude to greater competition between sellers, without specifying whether it is achieved through greater negotiating skill, or through better information that arises through cooperation between buyers, or through the operation of a hub. The modelling suggests that these are the most effective channels for improving welfare and neither of them depends on collective purchasing to deliver it. Furthermore, it suggests that the one channel which could only be delivered by a single buyer, restraint of consumption, is ineffective in significantly enhancing welfare over the range of scenarios which might be politically feasible.

The descriptive quantitative evidence and the economic modelling suggest that effective remedies may be available to the current high-price markets in the Baltics and in Central and Eastern Europe. In these two regions, the evidence suggests that prices are significantly above competitive levels and that sellers are making supernormal profits at the expense of consumers in the region. The investigation suggests three remedies may be effective: integration of the region through re-selling of gas and greater interconnection; the fostering of additional sellers through greater import infrastructure and development of improved commercial arrangements or hub-based contracts; and improved negotiation. Further work would be needed to explore the feasibility and, in the case of improved negotiation, the relevance of these remedies.

Additional sellers and market integration are far more valuable in the welfare they create for buyers than other channels. The quantitative estimates of the impact of these channels of influence show that, in two regions, the Baltics and Central Eastern Europe, these two channels are relatively much more valuable than other channels (the vertical axis). This is shown by the small blue and orange markers in the top half of the chart in Figure 49. The additional sellers channel creates around twice as beneficial an impact as market integration, and market integration is between twice and four times as beneficial as quantity reduction (consumption restriction). The other regions experience quite small relative impacts from any the channels. This leads to the conclusion that additional sellers and market integration would be worthwhile pursuing in the Baltics and in Central Eastern Europe but are a lower priority elsewhere.

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Figure 49. **Summary of impacts by region and channel of influence**

| Note: | The size of the markers reflects volume of gas consumption in the region |
| Source: | Vivid Economics based on SPD Frontier, IEA, Eurostat, Reuters and Platts data |

The single buyer carries with it some serious risks. The centralisation of purchasing across a whole region carries risks because it will reduce wholesale market liquidity and depth and this will reduce the availability of information to sellers and to the single buyer. For the same reason, it would not be compatible with the development of new gas hubs or continuing effective operation of existing hubs. There is a choice to be made between taking a market route where buyers and sellers engage in price discovery through market transactions, and infrastructure providers respond to differentials in market prices, or a single buyer route where all transactions occur through hidden bilateral trades and there is the risk of institutional failure.

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Appendix 1 Asymmetric information

8.1.1   Asymmetric information in standard competition economics

Standard competition economics, in theory and in practice, relies on the assumption of symmetric information between buyers and sellers. Standard models of competition have a small number of sellers who can act strategically to influence market outcomes while there is a large number of buyers who have no influence (Tirole, 1988). Examples include a textbook monopoly model as well as models of oligopoly competition between two or more sellers such as Cournot, Bertrand, and Hotelling competition. The assumption of symmetric information is commonly also made in practical analyses conducted on competition and antitrust policy (Motta, 2004). These models assume that information on demand conditions and sellers' cost is perfect and symmetric, that is, all sellers and buyers are fully and identically informed about market conditions.

Market power can lead to significant market distortions and distributional effects, even with symmetric information. In a wide range of settings, the socially desirable welfare-maximizing outcome (first-best) has price equal to marginal cost, leading to an economically efficient amount of consumption. In a simple monopoly model with symmetric information, the firm maximizes its profits by raising price above the perfectly competitive level, leading to lower-than-optimal consumption. This has two key implications. First, there is a market distortion in form of a deadweight loss: some trade between seller(s) and buyer(s), which would be economically efficient, does not take place. Second, the surplus arising from the trade that does take place accrues disproportionately to seller(s), while buyer(s) achieve less surplus than in a competitive setting. These features were presented above in the discussion of the economic framework in Section 5.1,

Economic theory shows that market power effects can be large even with symmetric information. For example, the first-best outcome, which maximizes overall welfare, has all surplus going to buyers. By contrast, with a linear monopoly, 25 per cent of this maximum surplus becomes a deadweight loss, while 50 per cent is captured by the monopolist, implying that buyers in aggregate receive only 25 per cent. Similar conclusions apply in richer oligopoly models that feature competition between two or more firms on the sell side, although the magnitudes of the two effects will usually be smaller (Anderson & Renault, 2003; Corchon, 2008).

Under Cournot competition with homogenous products, if some firms acquire better information on demand conditions, this not only raises their own profits, it also reduces the profits of other firms that do not gain access (Cason, 1994). At least in some cases, consumer welfare and overall social welfare will rise as the amount of information held by sellers rises, though in general this also depends on how costly it is for firms to acquire the information in the first place. By contrast, under Bertrand competition with differentiated products, less-informed firms may gain; this is because higher prices are strategic complements (Vives, 1990).

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8.1.2 The role of asymmetric information in the literature on competition in natural gas markets

The existing academic literature on EU gas markets assumes that buyers and sellers have the same information about market conditions; it does not address the impacts of asymmetric information. There are a number of well-established models of European and global natural gas markets in the academic literature, all of which assume that information is perfect and symmetrically held by all players. These papers typically employ Cournot-style models with the assumption of a relative small number of sellers with market power on one side of the market and a large number of atomistic buyers on the other side; that is, buyers have no influence on market prices. Moreover, they assume perfect and complete information on the state of demand conditions across markets, sellers' production costs and transport costs, and the capacity levels of different parts of the natural gas infrastructure such as pipeline capacity.

This literature focuses on obtaining and discussing numerical results from model simulations; they spend little time on the potential impacts that asymmetric information may have on the results. For example, the widely-cited papers that deal with market power in the European gas markets by Egging, Gabriel, Holz, & Zhuang (2008), Egging & Gabriel (2006) and Holz & von Hirschhausen, Christian Kemfert (2008) do not contain *any* analysis or discussion of the role of asymmetric information. Very little is known about the potential impact of asymmetric information in the existing gas markets literature.

8.1.3 Insights from economic theory on the impact of asymmetric information on competition

The economic theory on the impact of asymmetric information on imperfect competition focuses on models in which only sellers have market power. In general, asymmetric information could take several forms:
– information on individual buyers' willingness-to-pay for a good, that is, the demand conditions;
– information on individual sellers' production costs, that is, the supply conditions;
– information on the quality of the good provided by a seller;
– information and beliefs held by buyers on sellers' competitive strategy, and *vice versa*.
Economic theory generally does not explore all of these aspects.

Most models of imperfect competition with asymmetric information assume a particular market setting. In particular, they assume that only sellers have market power while buyers are atomistic with zero influence on market prices. Moreover, only individual sellers are assumed to have degrees of information, typically on demand conditions or on each other's marginal production costs. By contrast, buyers have equal information and only decide how much to purchase at the market price.

These assumptions limit the direct applicability of previously-published results to the present study of natural gas markets. Here, the bargaining power of buyers plays a critical role and asymmetries also pertain to differences in information held by the buy- and sell-side of the EU gas markets. These information asymmetries are probably most about demand and cost conditions; the quality of the good traded is commonly known.

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Appendix 2 Buyer power model

The Buyer Power Model (BPM) is a quantitative model of industrial markets, grounded in the economic theory of imperfect competition. Its key feature is that both buyers and sellers can have market power; that is, they can influence the prices at which they trade, rather than acting as price takers. The model allows for a flexible representation of all market structures, ranging from perfect competition to pure monopoly and pure monopsony. This includes the case of bilateral oligopoly in which individual buyers and sellers have different degrees of market power. Such a structure is needed for a meaningful analysis of policies aimed at raising buyer power.

In line with economic theory, the BPM assumes that individual market participants optimize their respective payoffs, and derives the resulting Nash equilibrium. A seller chooses a sales strategy that maximizes its profits, and a buyer chooses to purchase a quantity that maximizes its utility from consumption net of purchasing costs. Sellers with lower production costs will tend to supply more while buyers with higher willingness-to-pay will tend to purchase greater quantities. In this sense, the approach can be seen as a generalization of the standard Cournot model of competition, in which only sellers have market power while buyers are assumed to be price takers. The BPM's further assumptions are also in line with standard practice, and are discussed in detail in Section 5.4 of the main text.

The theoretical model is then calibrated to market data with relatively parsimonious data requirements. Given a particular geographic market definition, the key inputs are the market price and volumes sold, together with the market shares of individual buyers and sellers. These data are combined with estimates of market level demand and supply elasticities, sourced from the existing academic and policy literature. These data allow for all of the underlying model parameters to be identified. While the frequency of the data can be varied, it is generally preferable to work with annual data, in part because this avoids issues of seasonality.

The model can then be used to estimate how different buyer power policies affect the market outcome. This includes price and quantity impacts as well as welfare metrics in form of consumer and producer surplus. This allows for different policies to be compared to one another in an internally consistent fashion. By calibrating to different geographic regions, the model can also analyse how the impacts a particular policy differ across regions.

Compared to the existing literature on modelling natural gas markets, the main distinguishing features of the BPM are the incorporation of buyers' market power and the low data requirement.

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