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ANALYSIS

The global gas market, LNG exports and the shifting US geopolitical presence

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ABSTRACT

The upstream renaissance in the United States that has resulted from the successful application of new technologies in the exploration and development of shale gas has generated ripples through the global gas market. The US is soon to become a significant exporter of liquefied natural gas (LNG), which is remarkable given conventional wisdom just a decade ago was that the US would become a substantial importer of LNG. As this new market reality takes hold, the geopolitical position of the US is also evolving. But, the manner in which this emerging position of strength may be maximized is a subject of debate. In the paper, we argue that simply accelerating US LNG exports does not convey the same benefits as successfully promoting liberalization of global gas markets, particularly when considering the geopolitical priority of easing European dependency on Russian natural gas.

1. Introduction

The US shale gas revolution has raised the prospect that the United States can significantly expand its role as an exporter of natural gas and thereby reap economic and strategic benefits. Of particular debate is whether the United States government should undertake policies to promote exports of liquefied natural gas (LNG) from its shores in the wake of the Russian-Ukraine conflict of the spring of 2014. Recent political rhetoric has even suggested that the United States could replace Russia as the major supplier of natural gas to Europe or somehow use trade policy to favor allied nations, especially North Atlantic Treaty Organization (NATO) members, in the process of granting export licenses to natural gas companies seeking to export US LNG. The prospects that Russia could further use its natural gas exports as a geopolitical lever has elevated strategic elements of US natural gas policy and intensified interest in a push to increase US presence in the global gas market. While the level of US exports will ultimately rest on the commercial decisions of energy companies, US and European governments, through policy, can remove barriers to commercial opportunities and even promote trade flows otherwise not deemed to be commercial. In this paper, we address the possible outcomes of different approaches and their impact on US and European interests and global markets.

As a practical matter, the United States is already an exporter of domestic natural gas. The U.S. exported a total of 420 bcf of natural gas in the first quarter of 2014, almost all of which was by pipeline to Canada and Mexico. Under current law, companies must apply to the US Department of Energy (DOE) for a license to export LNG and attain permitting from the Federal Energy Regulatory Commission (FERC) for facility siting. DOE is charged with the responsibility to make a determination of "public interest" before granting a license to projects exporting to nations with which the US does not have a free trade agreement (so-called non-FTA countries). The commercial interest has been significant, which has resulted in filing over 40 license applications with most of them still awaiting disposition. Several US congressional hearings have been convened on the subject of US LNG exports, and debate has focused both on the implications for the US economy as a whole as well as on the consequences for US national interests and

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strategy energy policy. At the time of this writing, the US DOE had recently implemented changes to the procedures for reviewing LNG export applications,[1] and had granted final approval for three non-FTA licenses – Sabine Pass Liquefaction in Cameron Parish and Cameron LNG at Hackberry, both of which are in Louisiana – to export LNG.[2]

In this study, we investigate two alternative scenarios for US LNG exports. The methodology is grounded in the economic principles of international trade, resource extraction, and infrastructure investment and leverages geopolitical case studies in order to advance our understanding of the consequences of US LNG exports on global natural gas trade flows, pricing and geopolitics.[3] In particular, the analysis leverages the work done as part of the Geopolitics of Gas Research Project being conducted jointly by Harvard University and Rice University. Specifically for this paper, we compare two scenarios to a Status Quo case to investigate different ways in which US natural gas abundance could shape global gas markets – one in which the United States diplomatically promotes liberalization of natural gas markets – the Liberalization Case – and another in which policy is aimed at proactive support to augment the level of US LNG exports, perhaps via economic incentives, to achieve a level of LNG exports more than double the volume indicated under the Status Quo case – the North American Export Push case.

We find evidence that a strategic push towards liberalization provides greater supply diversity, more competitive pricing and improves energy security to US allies relative to a simpler scenario where a higher volume of US LNG exports is pushed into global markets. More specifically, if European and Asian gas markets were to become "liberalized" in the sense that spot pricing, active trading of volume and capacity rights, and greater market liquidity all become more significant features of global markets thereby displacing long-standing bilateral take-or-pay contract terms that currently dominate natural gas trade, there would be an increase in diversification of global natural gas supply sources and an overall improvement in energy security. Liberalized markets create greater fungibility of supply. This added liquidity brings with it more transparent pricing, which in turn facilitates greater investment in all parts of the natural gas value chain, enhancing resiliency and thereby energy security. In the liberalization case, Russia's supply dominance over the European markets is weakened; in contrast, Moscow is still generally able to maintain its traditional European market share, relatively speaking, under a scenario where bilateral contracts remain in place and larger volumes of US LNG exports are pushed into the market.

Under the North American Export Push case, we postulate a scenario where either government incentives – either on the part of the exporter or importer via tax or other fiscal programs – drive US LNG exports to over 12 bcfd by the early 2020s, which is roughly twice that in the Status Quo case. As a result, global natural gas prices fall to lower levels than those in either the Status Quo case or under the Liberalization case. In this instance, Australian LNG and long term prospects for shale gas in many international locations, such as Argentina and China, experience larger commercial setbacks than do Russian supplies. This is reflective of the relative costs of bringing each of these various resources to market. We discuss why we these results indicate that a high US LNG export strategy produces a less optimum outcome – when diminishing European dependence on Russian gas is a high priority – than a strategy that focuses on promoting a more liberalized global market structure. We conclude that high US LNG exports alone (and the resulting low prices) may not produce the same global supply diversity that might be desired.

2. Literature review

The early academic literature on the consequences of US LNG exports focused mainly on the implications for the United States. Much of the analysis in favor of US exports has centered on geopolitical and economic benefits. Estimates range to as high as $4 billion in increased overseas sales of US natural gas along with up to 60,000 jobs compared to about $500 million in lost energy-intensive industrial output [1]. A study commissioned by the US Department of Energy as part of its mandate to assess whether or not US LNG exports is in the national interest found that in the long run, the increase in US domestic natural gas prices would be limited under varying scenarios for US LNG exports, ranging from $0.22 to $1.11 per mcf in 2010 dollars [2].

More recent analysis considers the matter of US LNG exports in the context of international trade, thereby capturing the endogeneity of the export decision and thus the domestic price impacts. These analyses suggest that the relatively high costs of producing and liquefying natural gas then shipping it as LNG from the United States will ultimately constrain the volume of exports and thus limit the domestic price impact [3,4]. In addition, the more recent literature suggests the largest impacts of US LNG exports may not be in the US; rather they may occur in Asia which is expected to be the destination for new LNG exports from North America [5,6]. Indeed, the US LNG export contracts already signed are primarily committed to Asia [7,8], and other recent studies show that US LNG exports might contribute to greater supply and pricing competition in the region which is currently experiencing the highest LNG spot prices in the world [9,10].

Geopolitical analysis has centered on the idea that the United States can enhance a depoliticized, open global trade in energy by promoting, rather than curtailing, US LNG exports thereby enhancing US power and influence [11]. This includes the position that US LNG exports could be used to help US allies [12]. The US shale boom itself is also credited in the literature with the potential to lessen global dependence on major resource holding countries such as Iran, Russia, Qatar and Turkmenistan, thus bringing more competitive and stable natural gas markets [13,14].

The aforementioned studies make a substantial contribution to our understanding of the geopolitical and economic benefits the United States might derive from using policy to forward a concerted effort to expand US LNG exports. In our paper, we add to this literature by investigating a more global analysis of the economic and geopolitical implications from a change in US export policy and then consider what those global consequences demonstrate about implications for US strategy. Despite an apparent "rush to build" mentality, US LNG export projects face considerable competition for other global suppliers. With the price in Asia currently well above price in Europe and the United States, almost all new, international (greenfield) supply projects are being developed with an eye to supply the Asian market. In addition to LNG supplies from the United States and Canada, export projects have been announced to bring new LNG supplies from planned and potential developments in Australia, East Africa, the eastern Mediterranean, and Argentina as well as pipeline supplies from Russia to China. Thus, North American LNG will have to compete into this diverse supply curve. In turn, investment decisions for new LNG projects will also be influenced

[1] The US DOE recently altered its protocol for reviewing export applications. Prior to the announcement in late May, the DOE granted non-FTA *conditional* approval to applicants prior to FERC approval or even secured project financing. The DOE established an order reflecting the date of application filing in which applications would be reviewed without reconciliation of whether or not the applicant could move forward with the project. Going forward, the DOE has announced it will not review applications until the applicant has received FERC approval and the project can demonstrate necessary financing. This effectively removes any *conditional* approvals in the process.

[2] The DOE has issued two final approvals to exporters that actually are building terminals. The third final approval to Carib is for a very small volume and is for uncommitted capacity. There are 6 additional *conditional* approvals that must receive FERC final approval before DOE gives final approval. The conditional approvals were granted under the previous application review process.

[3] Our analysis leverages the work done as part of the Geopolitics of Gas Research Project being conducted jointly by Harvard University and Rice University. See http://bakerinstitute.org/research/geopolitics-natural-gas/for more information.

by geopolitical factors, such as Russia's currently tense relations with the West following the invasion of the Crimean peninsula in Ukraine. Long-range demand in Asia and Europe could also shift dramatically depending on market developments related to geopolitical events, internal economic policies and economic growth.

3. Background: the US shale revolution and US LNG exports

Growing global natural gas demand is directing new political attention on the security of gas supplies, bringing an expanded geopolitical dimension to the natural gas market. By "geopolitical", we mean the influence of geographic, cultural, demographic, economic and technological factors on the international political discourse. Insofar as geographic and political choices influence natural gas trade along one route at the expense of another, investment and revenues are also diverted thereby bringing considerable political and economic implications.

We assess specific scenarios for global LNG markets in the wake of expanding US unconventional natural gas production and the possibility of large-scale US LNG exports. Alternative futures for world gas production and trade portend differing geopolitical realities prompted by emerging and dynamic energy trade relationships. Already, LNG supplies whose development was anchored on the belief that the United States would become a premium market are being diverted to European and Asian buyers due to increasing supplies of shale gas in the United States. The prospects for a continuing low cost supply of US natural gas from unconventional resources has brought with it increased interest — both among commercial investors and in policy circles — in US natural gas exports.

U.S. President Barack Obama, in his annual State of the Union address, specifically mentioned the positive impact of rising domestic natural gas production on the U.S. economy and energy security. Shale gas production in the United States increased from virtually nothing in 2000 to more than 30 bcfd by 2013. US shale gas production could exceed 50 bcfd and account for well over half of domestic natural gas production by the 2020s. The US Energy Information Administration (EIA) forecast in the Annual Energy Outlook 2014 that rising demand for natural gas in the United States will reach just over 80 bcfd compared to production of 94 bcfd by 2030, leaving significant room for exports. Given the pricing disparity that currently exists between the US, Europe and Asian markets, commercial incentive is more than sufficient to drive investments with a focus on expanding trade between the three markets, in particular from the US to Europe and/or to Asia.

Indeed, anticipating a growing supply of natural gas in the United States, over 40 applications for license to export LNG have been received by the US DOE. All applications have received approval to sell LNG to countries that have free trade agreements with the US (so-called "FTA countries"), but at the time of this writing only three applications have received *final* approval to sell LNG to non-FTA countries, and only two of those are tied to a physical terminal development project.[4]

The non-FTA license is considered critical for LNG export projects to achieve sufficient offtake since only one FTA country (South Korea) is a large importer of LNG in the global market. At the time of this writing, the total export capacity applied for non-FTA approval was approximately 37 bcfd, which significantly exceeds the current total global trade in LNG. It is unlikely that all of this capacity will ultimately be constructed,[5] but it does signal the significant commercial interest in exporting US natural gas as LNG.

The US LNG export approval process raises an important consideration. Namely, export licenses do not guarantee export volumes. A license is necessary for exports to commence, but it is not sufficient. Rather, market drivers are more likely to be the largest determinant of export volumes. Therefore, to understand the potential size of US LNG exports and the influence they will have on global gas markets, we use a dynamic, spatial equilibrium modeling framework (the Rice World Gas Trade Model (RWGTM)) to compare multiple scenarios. The model allows us to consider the fact that regional price differentials around the world will adjust to new supply and demand developments over time. Moreover, price changes will occur in every market, with the extent of the impact driven by the relative elasticities of supply and demand in the affected market. The resultant adjustments to market fundamentals, in turn, endogenously determine the volume of US natural gas trade that will occur over time. In our approach, US export volumes, therefore, are not treated as exogenous which is an important consideration when evaluating matters of international trade [3].

4. Methodology

We utilize the RWGTM to investigate how the emergence of LNG exports from the United States could influence the future development of global natural gas markets, change regional gas pricing and trade relationships, and alter geopolitical relationships over the coming decades.[6]

The RWGTM is a dynamic spatial partial equilibrium model in which all spatial and temporal arbitrage opportunities are captured. As such, each point of infrastructure in the gas delivery value chain — field development, pipelines, LNG regasification, LNG shipping and LNG liquefaction — is modeled as an independent profit maximizing entity, where profits are maximized intertemporally. Thus, the optimal investment path is dependent on the price received for wellhead production in the case of field development and on the tariff collected for transportation infrastructure, as well as a host of other parameters such as the upfront fixed cost, interest rate on debt, required return on equity, debt-equity ratio, income tax rate, sales tax rate and royalty. In this manner, the model is solving a classic intertemporal optimization problem for investment in fixed capital infrastructure.[7]

Put another way, the RWGTM proves and develops resources, constructs and utilizes transportation infrastructure, and calculates prices

[4] As noted above, until the recent rule change in reviewing applications and granting licenses to export, the DOE granted *conditional* non-FTA approval to applicants prior to any FERC approval or even secured project financing. In determining which applications for conditional approval to review first, the DOE established a queue in which applications would be reviewed without any reconciliation of whether or not the applicant could actually move forward with the project. This arbitrarily penalized some firms relative to others simply because they filed their paperwork chronologically later. At the end of May, the DOE proposed a procedural change to this process; namely, it will not review applications until the applicant has received FERC approval and the project can demonstrate it has attained the necessary financing. This proposed new approach will allow those applicants whom the market deems best suited to move forward to be considered first, which should bring clearer signals regarding project success going forward and allow the market to better gage the likely scale of export volume.

[5] To wit, in the early 2000s there were over 45 approved applications to *import* LNG to the US, which was a signal of commercial interest at that time, but only a few facilities actually ever were built and made operational.

[6] The Baker Institute's RWGTM was developed by Kenneth B Medlock III and Peter Hartley at Rice University using the Marketbuilder software platform provided through a research license with Deloitte Marketpoint, Inc. The architecture of the RWGTM, the data inputs, and modeled political dimensions are distinct to Rice and its researchers. The RWGTM is used to evaluate how different geopolitical pressures, domestic policy frameworks, and fundamental market developments can influence the long run evolution of regional and global gas markets and how those developments in turn influence geopolitics. A brief description of the RWGTM is contained herein, but more detail is available upon request.

[7] The initial conditions are calibrated to recent historical data. The terminal value condition must also be specified in order to find an optimal investment path in natural gas production and delivery infrastructure. As such, the transversality condition is modeled by assuming a competing technology, such as solar, becomes available at a specified delivered price to consumers in unlimited quantities. The RWGTM Status Quo case assumes the competing price is $14 per mcf equivalent in 2020, declining to $9 per mcf equivalent by 2070. We have run scenarios where the backstop is accelerated through cost reductions, but that is not germane to this study.

to equate demands and supplies while maximizing the present value of profits within a competitive framework. So, new capital investments in production and delivery infrastructure must earn a minimum return for development to occur. The debt-equity ratio is allowed to differ across different categories of investment, such as proving resources, developing wellhead delivery capability, constructing pipelines, and developing LNG infrastructure. By developing supplies, pipelines and LNG delivery infrastructure, the RWGTM provides a framework for examining the effects of different economic and political influences on the global natural gas market within a framework grounded in geologic data and economic theory. In fact, the RWGTM has been used to this end in multiple studies and published works.[8]

Since geopolitical influences can alter market outcomes in many different ways, the non-stochastic nature of the RWGTM facilitates scenario analysis thus allowing a characterization of how geopolitical events alter previous, current, and future investment decisions. In this way, the intertemporal nature of the RWGTM allows a complete analysis of the impact on investment decision pathways of specific scenarios.

Supplies are characterized for both conventional and unconventional resources across 144 regions into three primary categories: (1) proved reserves; (2) growth in existing fields; and (3) undiscovered resources. The resource data derives from sources such as the Oil and Gas Journal, U.S. Geological Survey, National Petroleum Council, Australian Bureau of Agriculture and Resource Economics, and Baker Institute research on unconventional resources in North America and globally. North America finding and development (F&D) costs for non-shale resources are based on estimates developed by the National Petroleum Council (NPC) in its 2003 report, and have been adjusted using data from the Bureau of Economic Analysis (BEA) KLEMS database to account for changes in upstream costs since the early 2000s. The associated F&D cost curves are developed by linking data on well development costs to the geologic characteristics of each play in areas where such information is known, then using that information to assign costs in regions where costs are unknown. In summary, costs have been econometrically related to play-level geologic characteristics and applied globally to generate finding and development costs for all regions of the world. The methodology employed for non-shale gas resources is outlined in detail in Hartley and Medlock (2006).[9] In general, long-run F&D costs increase with depletion, although technological change can counter the effect.

While rapid growth in shale gas production is a relative new reality of the natural gas market, the fact that geologists have been writing about shale for decades is indicative of the fact that the resource was known, but it was not believed to be technically, much less commercially, feasible. Indeed, the phenomenon of shale gas's rise as a prolific technically and commercially exploitable resource was largely an issue of technological innovation, rather than one of geologic discovery. Even today, innovations are occurring at a pace that is, on average, continuing to raise the productivity of shale gas wells. This, in turn, drives down per unit costs of development (in $ per mcf), thereby making a greater amount of resources economically viable at a given price.

The RWGTM contains estimates of recoverable shale gas and associated development costs for shale resources around the world. The assessments of technically recoverable resources are informed by the work of Advanced Resources International, which was commissioned by the US Energy Information Administration. The geophysical data in that report are used to generate finding and development cost curves by econometrically estimating the relationship between geophysical data and average expected ultimate recovery (EUR) data for wells drilled in the US in areas where such information is available. This, along with drilling costs, where cost is primarily a function of average drilling depth, is used to construct a cost (in $ per mcf) for development. The resource costs are then "tiered" using the standard deviation of EURs around the mean.[10] Many factors influence development cost. For example, shale that is clay-rich is generally not prone to yield high production rates, which in turn tends to reduce its attractiveness commercially, even if there is a large assessment of technically recoverable resource. This is but one determining factor, as thermal maturity, total organic carbon, natural fracturation, isopach, permeability, porosity, and other features are also critical. To be sure, the degree of complexity involved in developing cost curves for undeveloped shale resources is high and involves a significant degree of uncertainty.

It is very possible that estimates of commercially accessible shale gas resources will change over time as development continues. Moreover, resource assessments for shale gas in all parts of the world could change, particularly as technologies and processes are developed — largely through experience — to increase productivity, lower costs and identify shale properties more accurately. It is also important to note that in regions where water resources are scarce, the assessment included in the RWGTM is reduced, and in some cases where water constraints are extremely severe, no resources from that region are permitted into production. We also honor "above ground" constraints on development, such as moratoria (or *de facto* moratoria) in places like France and the state of New York.

We utilize the RWGTM to determine the optimal level of investment in infrastructure and resource development according to a project-specific intertemporal maximization of the discounted present value of profit. The model weighs various factors influence the lifting cost and breakeven price of the resource to determine the level of investment and the regional patterns of investment, thereby changes the patterns of trade under different scenarios.

International natural gas trade, in the model, is able to progress either by LNG or pipeline. In modeling natural gas trade we consider the costs associated with movement via *existing* infrastructure (i.e. — tariffs) and the costs associated with *greenfield* infrastructure (i.e. — tariffs plus the fixed cost of capital). This allows the identification of points of arbitrage amongst pipeline flows and LNG into market, which is an important when evaluating the costs and benefits of proposed infrastructure as well as understanding what geopolitics can mean for infrastructure developments and trade relationships.

Pipelines are fixed infrastructures that facilitate point-to-point delivery of natural gas. Accordingly, pipeline capacities and rate

[8] For example, see Medlock, Kenneth B., "Modeling the implications of expanded US shale gas production," *Energy Strategies Review*, No. 1, (Jan 2012); Hartley, Peter and Kenneth B Medlock III, "Potential Futures for Russian Natural Gas", *Energy Journal*, Special Issue, "World Natural Gas Markets and Trade: A Multi Modeling Perspective" (2009); Hartley, Peter and Kenneth B Medlock III, "The Baker Institute World Gas Trade Model" and "Political and Economic Influences on the Future World Market for Natural Gas", in *Natural Gas and Geopolitics: 1970–2040*, ed. David Victor, Amy Jaffe, and Mark Hayes, Cambridge University Press (2006).

[9] "The Baker Institute World Gas Trade Model" in *Natural Gas and Geopolitics: 1970–2040*, ed. David Victor, Amy Jaffe, and Mark Hayes, Cambridge University Press (2006).

[10] The methodology so described begins with an analysis of well performance in shale basins where active development has already commenced. This data, taken from DrillingInfo.com, allows a detailed panel analysis of the EUR in all shale gas wells drilled since 2003, totaling over 25,000. This facilitates the construction of average EUR by shale basin and the standard deviation of EUR by shale basin. This information is then used to construct "tiers" by sampling from the distribution of EURs at different point. As EUR falls, for a given drilling and completion cost, the cost per mcf rises. For shale resources where there has been no active production but there is an assessment and some knowledge of geophysical properties, the EURs and their distributions are then constructed using the fitted parameters from estimation of the known basins, and the cost per mcf is then constructed. More detail on this is outlined in the RWGTM model documentation and is available upon request.

structures have been collected and are modeled as they exist. New pipeline capacity will be developed as long as the variable cost (tariff plus fuel) is covered and a return to capital is earned on the upfront fixed cost. LNG shipments are modeled using a point-to-point approach where shipping costs are related to voyage distance. Port-to-port distances data were collected for every possible LNG trade and a non-linear econometric relationship was estimated. This estimated relationship was then used to construct the cost of shipments for every possible port-to-port route in the world. The initial flows on existing trade route were matched to flows reported for 2010 in the *BP Statistical Review*. For countries to expand along new or existing trade routes, investments in new LNG tanker capacity must occur.

Existing contracts for both pipeline and LNG deliveries are modeled for exporters (importers) as a push onto (pull from) the market to ensure volumetric flow. Contract and capacity data is obtained from a variety of sources, such as *Petroleum Economist* and *Platts* databases. On the one hand, with regard to LNG flows, contracts *do not* necessarily dictate the direction of flow, meaning swaps are allowed to occur as long as the alternative trade arrangement bears a higher commercial return. This assumption becomes more relevant in later years in the modeling time horizon as the depth of the LNG market does not facilitate significant swaps until the 2020s. Notably, the LNG market has been tending in this direction as the proportion of short term and spot sales of LNG has increased from less than 5 percent in the early 2000s to over 20 percent in the past couple of years, signaling an increasing propensity for volume diversion.[11] Moreover, as argued in Hartley (2014), this trend is likely to continue as the LNG market deepens with the entry of new suppliers and demanders. On the other hand, with regard to pipeline flows, contracts *do* dictate flow between parties because pipelines are fixed infrastructures, meaning the concept of destination flexibility is not entirely relevant. For both pipeline contracts and LNG contracts the contract volumes are assumed to roll forward in the Status Quo Case. In other cases, where specified, contract volumes are allowed to roll off, which necessitates that continued flow be commercially desirable relative to alternative arrangements.

5. Modeling results

The commercial case for US LNG exports is based on the current wide disparity between US natural gas prices and the relatively high premium found in spot European and Asian LNG markets in the aftermath of the Japanese crisis at Fukushima. This price disparity has raised the prospects that companies can profit from the sale of relatively inexpensive natural gas in the United States — accounting for the cost of liquefaction and transport — to higher priced Asian or European LNG markets. Indeed, spot prices for natural gas in both Europe and Asia are well above the current spot price in the US (see Fig. 1). Thus, any trade from the United States when evaluated at current market prices looks very profitable. Initially, the impetus to export LNG from the United States was borne out of this commercial motivation. The geopolitical implications then emerged to drive policy discussion of possible incentives to facilitate a faster realization of the commercial opportunity.

However, for US LNG exports to be sustainable in the long run, the long-term price relationships across regional markets would have to continue to drive LNG trade. In other words, US natural gas prices will have to remain at a sharp discount to Asian and European prices. To answer the question regarding whether this market equilibrium will be sustained over the long term, however, we must study how the current arbitrage window encouraging trade might change over time, were US or global trade policies to change. In the immediate aftermath of the nuclear disaster at Fukushima in Japan (see Fig. 1), monopoly pricing by natural gas suppliers such as Gazprom, and greater technical and political barriers to the development of natural gas resources abroad contributed to a sudden rise prices in Europe and especially Asia where demand for LNG shifted upwards overnight without a comparable increase in available supplies. Thus, a constraint on the ability to deliver LNG to meet the unexpected demand surge was realized.

Both the spread and the *volatility* of the spread between JKM and Henry Hub are indicators of the existence of a constraint. Indeed, since the disaster at Fukushima, the JKM premium has increased dramatically during peak demand periods (winter months) and subsided during periods of softer demand (summer and shoulder months). Moreover, the standard deviation of the spread of daily prices between JKM and Henry Hub has increased by 25 percent since Fukushima, which represents a significant shift. This is exactly what one should expect when a constraint on deliverability exists to a particular market. Importantly, as argued in Medlock (2014), the disaster at Fukushima triggered the current market tightness that characterizes the Asian market. With regard to the analysis performed herein, we assume portions of the Japanese nuclear fleet become reactivated beginning in 2015, with online nuclear capacity ramping up to 70 percent of its pre-Fukushima capacity by 2018.

Relatively high prices in Europe and Asia (a commercial motivation) as well as broader European concerns about security of supply created by the recent Russia–Ukraine conflict (a geopolitical motivation) is heightening interest and encouraging investment in new supplies in many regions around the world — all indications of pending growth in diversification of global supplies. This includes recently announced upstream progress in shale in Argentina, strong commercial interest in developing offshore resources in Mozambique and Israel, and the entry of new LNG supplies from Papua New Guinea. The emerging changes to supply and trade flows helped push spot LNG prices to pre-Fukushima lows in Asia and Europe in August 2014. However, the approach of winter and the associated expected demand increases have contributed to a reversal of this trend since, with JKM prices for prompt month deliveries steadily climbing.

We utilize the Rice World Gas Trade Model to answer the question whether continued investment in new supplies globally will effectively close the arbitrage window for US LNG to remain price competitive in the Asian and European natural gas markets over time. To do this, we compare a business as usual scenario (Status Quo Case) to circumstances where gas market liberalization accelerates around the globe (Liberalization Case) and a scenario where US LNG exports are increased to a higher level would be commercially feasible absent some sort of security premium attached to US sourced supplies (North American Export Push Case).

The current global natural gas market is characterized by a high preponderance of long-term contracts at prices linked to crude oil and petroleum products, but a growing segment of the market is developing for spot and short term sales.[12] Russian gas exports to European Union member nations totaled 125 bcm in 2013 or roughly 27% of supply, with nine eastern European countries, such as Bulgaria, Poland and the Czech Republic, relying on Russia for over 70% of their gas supplies. The European Union also receives significant deliveries of natural gas by pipeline from North Africa and the North Sea. Russia and China recently announced a new gas pipeline deal in May 2014 that would include shipments of 1.3 trillion cubic feet of gas to China over 30 years. Qatar is the largest supplier of global LNG, with an export capacity of just over 77 million tons per year to a diverse slate of countries including Japan, South Korea and the UK. Australia currently ranks second, but exports of LNG are expected to grow substantially in the next three to five years. The majority of all of these supplies are delivered via

[11] According to data from the International Group of Liquefied Natural Gas Importers (GIIGNL).

[12] See Hartley, Peter, "The Future of Long-Term LNG Contracts," CES Working Paper, October 2013.

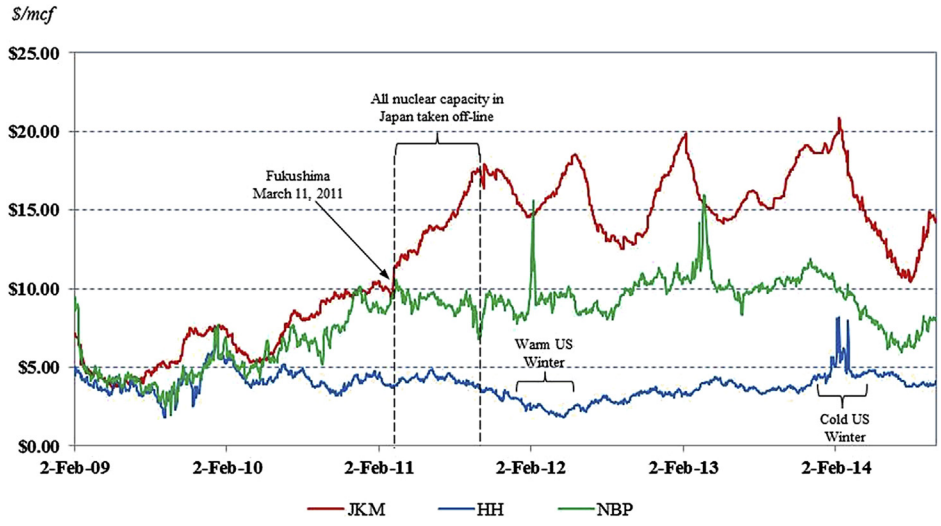

Fig. 1. Global Spot Prices (Daily, Feb 2, 2009–Sept 30, 2014). Source: Platts.

bilateral contract with price indexed to oil and oil products. However, the terms of contracts have been evolving and the entry of US supplies into this market is introducing a further element of spot price indexation and portends a shift in the nature of trade in global gas markets.

We begin by presenting the RWGTM Status Quo Case which assumes that the geopolitical conditions in today's global natural gas market will generally persist into the future. For instance, the status quo case assumes that economic sanctions will continue to block the development of natural gas exports from Iran and that political instability will thwart exports from Iraq until 2020. The Status Quo Case also takes into account that Qatar has placed a moratorium on new export projects from its main North Field, thus capping Qatari LNG exports capacity at its current level. The Status Quo Case also delays the production impact of Mexico's announced sector reforms based on existing internal barriers to shale development in the country owing to internal politics and issues related to the new laws that are still being worked out, although this assessment may prove overly pessimistic in the coming years.[13]

Under the Status Quo Case, which assumes that Europe takes no specific policies to replace imports from Russia, US LNG exports have difficulty competing in the European market. Russian pipeline gas presents a major competitive challenge to the export of US LNG to Europe, and even Asia longer term. Indeed, in the flow of Russian gas exports to Europe remains in a strong position, and Russia gains additional market share in Asia after 2020 (see Fig. 2). This finding confirms the strength of Russia's incumbent position in the European market due to its legacy infrastructure.

Under the Status Quo Case, US LNG exports face a wide range of competing LNG export projects around the globe and therefore grow to about 5.5 bcfd (see Fig. 3). Nevertheless, the US emerges as the third largest LNG supplier globally, behind Qatar and Australia. As indicated in Fig. 4, as new supplies come online from LNG projects already under construction, natural gas prices in Asia and Europe fall, reducing the opportunities for US LNG.

Underlying the limitation on US LNG export volumes in the Status Quo Case is the lack of sustained profitability for arbitrage to other markets. The annual price differential, past and projected, between the liquid market trading hubs of Henry Hub and JKM and Henry Hub and NBP is indicated in Fig. 5. Also indicated is the cost of the trade between a generic US Gulf Coast terminal and a terminal with price indexed by the indicated receiving market. In the case of both markets, the price differential falls below the fixed plus variable cost of the trade, meaning some contracts might be "out of the money" for a period of time. However, continued demand growth in developing Asian economies ultimately results in profitable sales of LNG from US terminals. By contrast, barring a major disruption of supplies, the economics of US LNG exports to Europe is starkly different. Under such circumstances, the long run price differential between Henry Hub and NBP is not sufficient to support base load flows from the United States to Europe. While these findings do not mean that US-sourced LNG never flows to Europe, as there may be seasonal trade opportunities, it does indicate that US LNG would have to be priced at a premium of about one dollar per mcf to incentivize the trade — a level that might emerge for example temporarily in the case of unusual seasonal weather conditions or of course if there was a period of prolonged geopolitical distress such as a cutoff of supplies from Russia or a disruption from North Africa.

Under the Status Quo Case, the growth of supplies from Australia and the United States alters the destination for low cost Qatari gas, which is increasingly pushed to India and Pakistan instead of Northeast Asia. While not considered in this analysis, geopolitical factors could alter this outcome, in particular if Qatar was willing to accept lower returns to maintain its exports to a specific location to buttress its geopolitical importance [15].

6. Scenario analysis: liberalization case

In order to stress test the results of the Status Quo Case, two alternative scenarios were executed using the RWGTM. Recognizing that a large number of different scenarios could possibly be analyzed, the two reported herein were selected to highlight specific economic and geopolitical effects. In the first scenario, the Liberalization Case, all long term contracts are assumed to fully unwind between 2020 and 2025. Of course, existing capacity remains in place and the RWGTM takes into account that the cost of operating incumbent infrastructure can be discounted in the face of underutilization since it need not bear a fixed cost of capital to operate. We consider this evolutionary feature based on the history of the US natural gas market where the unwinding of contracts that took place in the US gas market in the 1980s as take-or-pay arrangements were legally abrogated and pipeline capacity was unbundled from pipeline ownership.

[13] See Morales, Isidro, "The Twilight of Mexico's State Oil Monopolism: Policy, Economic, and Political Trends in Mexico's Natural Gas Industry," available at http://bakerinstitute.org/research/geopolitics-natural-gas/.

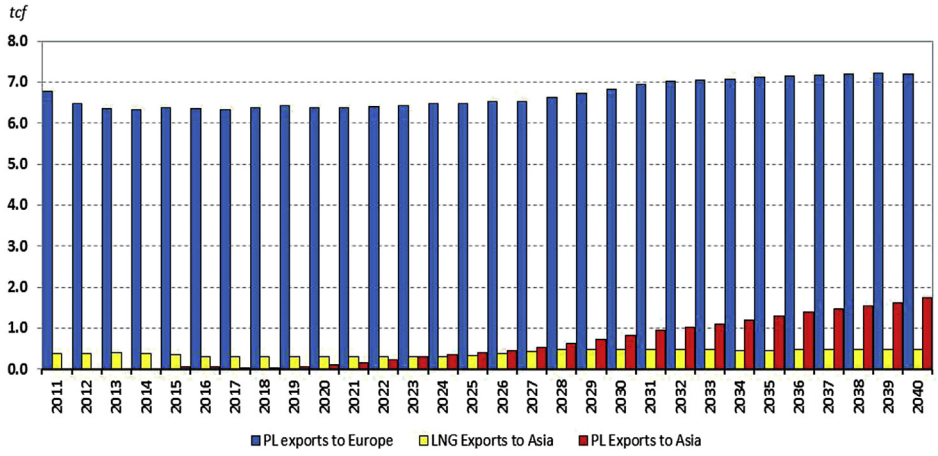

Fig. 2. Russian Natural Gas Exports in the Status Quo Case.

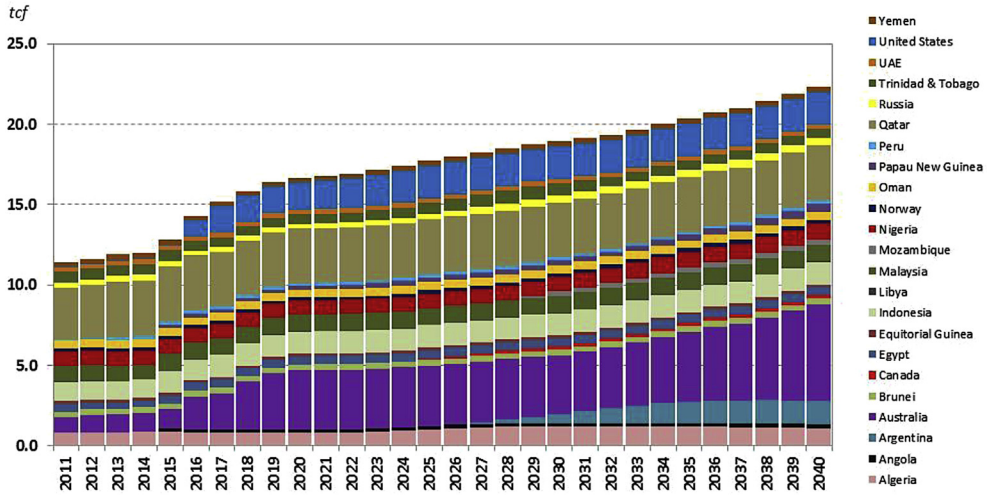

Fig. 3. Global LNG Exports by Country in the Status Quo Case.

Importantly, in the Liberalization Case it is also assumed international capital flows are generally more fluid, allowing drilling and completion costs to fall with long term service sector development. This occurs because the assumed shift in market structure aids the emergence of independent producers because barriers to entry for smaller capital players are reduced. The emergence of liquid "hubs" promotes price discovery and provide the signal required to incentivize market entry and capital investment. In turn, over time, the existence of a deeper capital market and a larger number of investors promotes the development of a larger indigenous upstream service industry. More

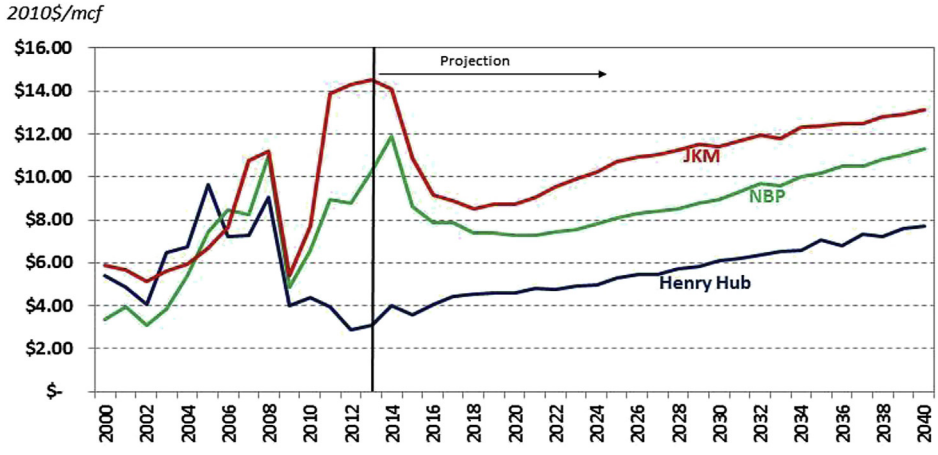

Fig. 4. Select Global Prices.

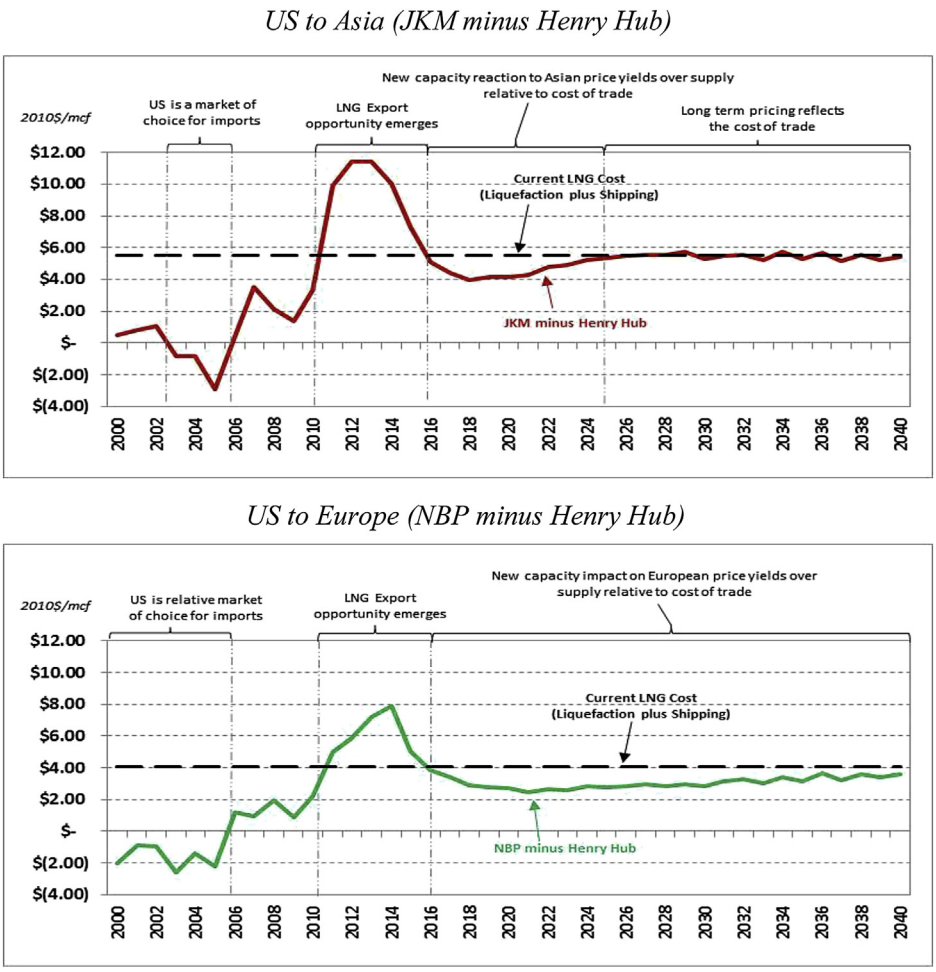

Fig. 5. Global Price Differentials.

generally, the shift in market structure facilitates greater investment in greenfield infrastructure opportunities throughout the energy value chain. Finally, in this case, we do not assume bans or moratoria that are currently in place are lifted.

Under the Liberalization scenario, we see a reduction in natural gas prices in all markets and security of supply in Europe and Asia is enhanced due to greater supply diversification and enhanced fungibility. As European market reforms take hold and costs fall, Europe is also able to achieve higher indigenous natural gas production, with considerably higher shale gas production relative to the Status Quo — up from 4.5 bcfd in the Status Quo Case to 8.2 bcfd in the Liberalization Case in 2030 (or 45 bcm per year to 85 bcm per year) and 7.4 bcfd in the Status Quo Case to 11.1 bcfd in the Liberalization Case in 2040 (or 76 bcm per year to 115 bcm per year). This indigenous production response allows Europe to dramatically reduce its imports from Russia (see Fig. 6), with the Russian market share falling to just over 16% by 2030. Europe is generally more energy secure in this case due to the diversification of supply, which in turn, reduces the leverage that Russia has in using natural gas exports as a tool to achieve foreign policy objectives. Indeed, this case is the most damaging for Russia's dominant position in Europe, as it remains under pressure throughout the coming decades as a result of this change in European policy.

Ironically, the liberalization of European markets shrinks the opportunities for US LNG exports relative to the Status Quo Case. The US exports slightly less LNG in this case, about 5.0 bcfd compared to just over 5.5 bcfd in the status quo case, largely due to higher production from shale formations in Europe and Asia. Production growth in Mexico is higher due to the liberalization of its upstream sector and the consequent growth in shale gas production just south of the Texas border.[14] Thus, higher Mexican output also displaces pipeline exports from the United States, lowering US prices but not sufficiently enough to counterbalance reductions in European and Asian prices that reduce the arbitrage window for US LNG exports.

With regard to Asia, the benefit of promoting more open and transparent markets also produces energy security gains. Liberalization encourages greater indigenous supply development in Asia and therefore promotes greater diversification of supply. It also results in lower prices in Asia (see Fig. 7), which promotes greater use of natural gas in power generation, thereby providing environmental benefits through the displacement of coal at the margin. However, these lower Asian prices would restrain the ability of US companies investing in LNG export terminal capacity to garner the needed returns and are thus likely to cap opportunities for US LNG exports compared the status quo case where long term contracts and entrenched monopolies continue to dominate the market. This competitive global marketplace also reduces Russia's ability to sell more natural gas to China. The increase in Russian gas exports to China is less than 0.2% compared to the Status Quo Case, leaving Russia with losses in Europe and very little gain in Asia to compensate. Overall, Russian gas export revenues would likely

[14] Note the Status Quo Case does not assume liberalization of the Mexican upstream oil and gas sectors. So, in many respects, the results in the Liberalization Case, with respect to Mexico, may be indicative of the new path that Mexico is now forging.

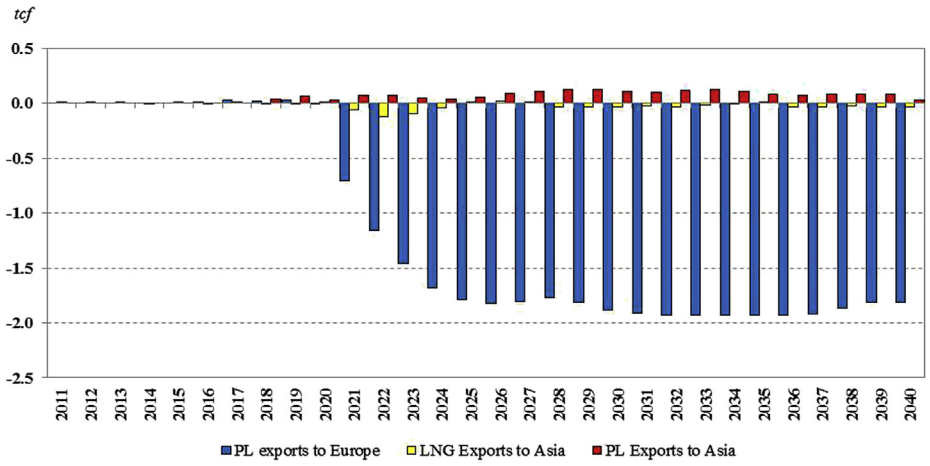

Fig. 6. Change in Russian Exports in the Liberalization Case relative to the Status Quo.

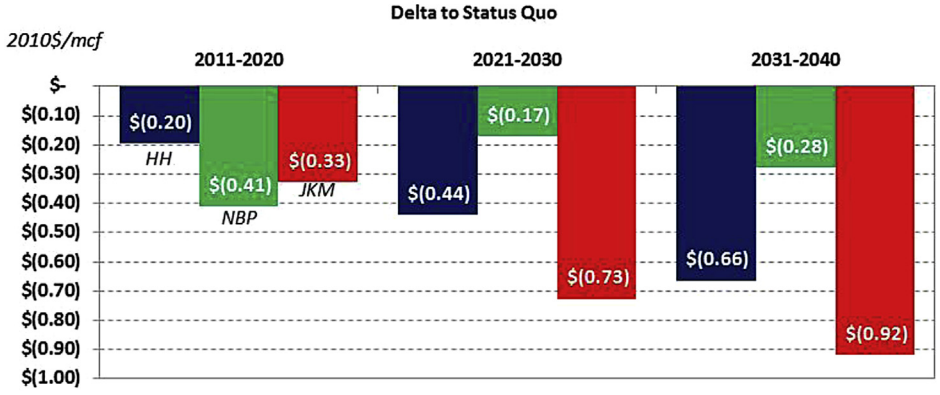

Fig. 7. Regional Price Changes (Liberalization minus Status Quo: Decadal Averages).

suffer from lower global natural gas prices worldwide and lower export volumes as compared to the Status Quo Case.

7. Scenario analysis: North American export push

In the second scenario, it is assumed that buyers (or their governments) recognize a "security of supply premium" for North American-sourced LNG, thereby creating conditions that drive firms to lock up 12 bcfd of contracted flows from North America, roughly twice the level in the Status Quo Case. In this case, North American natural gas production is higher in 2040 by 10% relative to the Status Quo Case. This increase in production is necessary to support a much larger presence in the international natural gas market, where the United States represents 21% of the global LNG export market compared to 9% in the Status Quo Case by 2040. Even with high US output, the additional level of US-sourced LNG exports contributes to only slightly higher prices in North America than under the Status Quo Case while having a dramatic downward impact on long term Asian prices. Under this scenario, US prices rise by about $0.40 per mcf from 2031 to 2040 (see Fig. 8), while the Asian spot price is almost $0.70 per mcf lower than in the Status Quo Case. Therefore, the price impact in Asia is roughly twice as large as in the US as US LNG exports are ramped up.[15] Thus, it is not surprising that US domestic natural gas producers and Asian buyers have been lobbying the US Congress and the US Administration to actively promote US LNG exports. Note, however, that such price changes do not support uncontracted flows, meaning the contract holders must indeed place a premium on US LNG volumes relative to the spot market.

However, further analysis of the scenario shows that a major push for US LNG exports alone does not yield the energy security benefits that many proponents of exports are seeking, namely broader diversification of supplies to Europe and Asia and the reduction in Russia's geopolitical leverage to utilize its natural gas exports as a geopolitical lever. Under a scenario where long term contracts are honored and market structures remain the same, higher levels of available US LNG is not sufficient to drive Russian gas out of the European market. Russia's pipeline supplies are sufficiently low cost to allow Moscow to defend almost its full European market share against US LNG export supplies which cost roughly $4.00 per mcf (including the fixed cost of capital) to be delivered across the Atlantic. Instead, US LNG exports knock out higher cost European indigenous production from the North Sea as well as local European shale production. This would be a counterproductive result from a geopolitical point of view, but it could be an outcome that environmentally motivated Europeans would welcome.

Moreover, not only would a push to incentivize higher volumes of US LNG to Europe fail to produce the geopolitical goal of diversifying the continent away from over reliance on Russian supply, it would be costly to whatever party was "subsidizing" the US marginal sales — either as unprofitable transactions by US companies or by a large security premium paid for European or Asian deliveries, were the US or European governments to subsidize such exports to ensure they came to fruition.

[15] The economic rationale for this is discussed at length in Ken Medlock, "Natural Gas Price in Asia: What to Expect and What it Means" (2014).

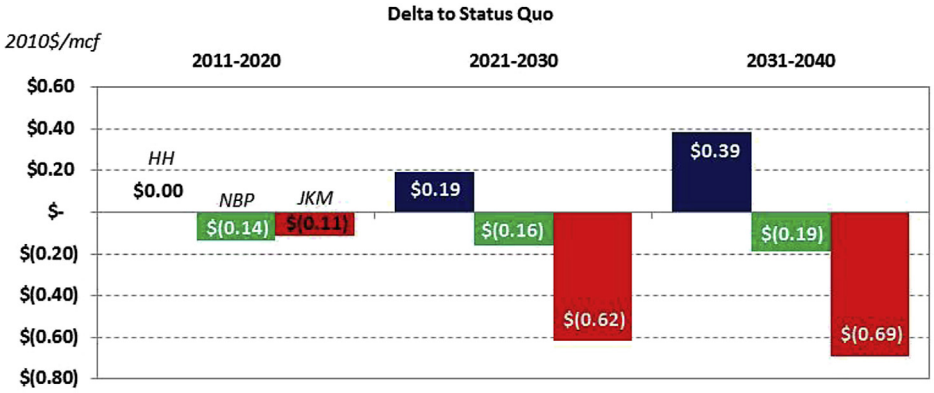

Fig. 8. Price Delta Relative to the Status Quo.

As can be gleaned from Figs. 5 and 8, to motivate 12 bcfd in US LNG exports would require a long run price premium of just over $1 per mcf to Europe and Asia. In other words, for such a scenario to come to pass, it is evident that buyers in Asia and Europe would have to value being tied to a highly liquid North American market sufficiently enough that they would be willing to maintain supply contracts that are "out-of-the-money" on a long term basis. If not, some other party would have to pay this cost to prevent US LNG contracts from being abrogated.

As indicated in Fig. 8, under the export push scenario, we see a reduction in natural gas prices in European and Asian markets. Russia's position in Europe and Asia, however, is largely unchanged relative to the Status Quo. As seen in Fig. 9, although Russian exports to Europe and Asia are lower, the volumetric change relative to the status quo is very small — totaling only about 320 mmcfd (or 0.12 tcf) to either Europe or Asia at the maximum. Perhaps surprisingly, this case does very little to damage Russia's dominant supply position in Europe. However, the resulting lower natural gas prices could conceivably have a negative impact on Russian export revenues, contingent on the contract terms of supply to European buyers.

Overall, higher US LNG exports adversely impacts other key shale gas developments that might be considered geopolitically desirable. If global LNG was in ample supply, investors would be dis-incentivized to push domestic sources for gas, favoring instead less expensive imports. Thus, under the high US export scenario, China's shale production is about 3 bcfd lower than in the Status Quo Case where investors have less commercial incentive to develop Chinese shale. Similarly, shale production in Argentina, Australia and Europe is lower. Higher US LNG closes opportunities for Australian and Argentinian producers to enter the global LNG export market with shale gas supplies because US gas saturates the buyers which might have been captured by Australian and Argentinian sellers in the Status Quo Case. This illustrates the importance of a "first mover" advantage in the global gas market, which raises the stakes for current export policies from all three countries.

Under the high US LNG export scenario, the largest commercial and geopolitical impacts come from the competition for Asian markets. US flows displace Qatari LNG out of Northeast Asia and Europe toward South Asia—India, Pakistan and Thailand, potentially diminishing the importance of Qatar to both the US and its allies such as Japan, South Korea and Europe. Notably, US LNG also reduces China's interest in Russian supply. Under this scenario, Russia's LNG and pipeline exports to Asia are about 13% lower relative to the Status Quo Case in 2030.[16] However, by 2040 the competition from LNG is not as strong, and Russia's LNG and pipeline exports are only about 5% lower relative to the Status Quo.

The negative impact of a high US LNG export push on Australia, which is an important US regional ally, is yet another reason why the US might want to favor a strategy that focuses more directly on market liberalization rather than one that simply provides assistance to push more LNG into the market. The United States might do better to promote open markets and let the chips fall where they may commercially, rather than be perceived as promoting sales of natural gas from its own borders to the detriment of the Australian economy.

8. Conclusion: implications for policy

The scenario analysis presented herein gives some guidance to policy aims regarding US involvement in global gas markets. To begin, we note some clear strategic implications for US and European policymakers. These implications are particularly pertinent at a time when recent Russian actions in Ukraine have focused attention on reducing Russian leverage over Europe. Russia's share of Europe's gas imports was 125 bcm representing roughly 27% of European Union supply in 2013, and 9 European countries rely on Moscow for all or a large proportion of their gas supplies,[17] with a large fraction of this transiting Ukraine. Not only is this alarming in the face of a newly revisionist Russia, but other sources of European supply — such as gas imports from North Africa, specifically Egypt and Libya — may face challenges owing to domestic instability in the months and years ahead. For example, Egypt was forced to cut LNG exports to Europe in early 2014 in response to domestic fuel shortages while Libya's pipeline exports to Italy were down 11% to 5.7 bcm in 2013 due to ongoing security problems.[18] In sum, given the challenges facing supplies to Europe the current situation highlights the importance of a deeper, more diversified supply base.

For European policymakers, our analysis cautions strongly against the growing tendency to view imports of US LNG as a panacea. For some, the prospect of US LNG exports not only holds out the prospect of reducing dependence on Russia, but offers Europe greater energy security without undertaking politically difficult policy change. However, the analysis herein suggests that such goals might be better achieved through the liberalization of European gas markets, which would facilitate price transparency, open access and allow an unimpeded capital flows in to the natural gas sector throughout the value chain.

To begin, absent unanticipated developments in supply or demand, such as a prolonged disruption in Russian supply, the strategy of cultivating high levels of US LNG imports to Europe would be costly and

[16] Note the recent gas deal between Russia and Asia that slates volumes for delivery beginning in 2018 is slightly larger than the status quo case outcome. Therefore, the US LNG case renders the volumes to be slightly less, although still large.

[17] Energy Intelligence Group.

[18] Energy Intelligence Group.

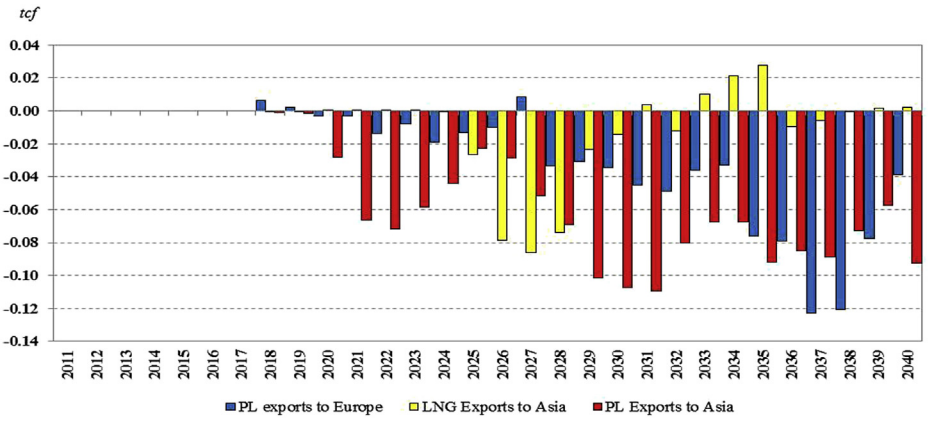

Fig. 9. Change in Russian Exports under High US Exports relative to the Status Quo.

would likely require European governments to take measures to incentivize such imports in the absence of sufficient market forces. While recent events with Russia may have changed European calculations, European buyers have not previously demonstrated a willingness to pay a significant premium for gas supplies perceived to be more geopolitically secure. Moreover, the gas supply arrangements between Gazprom and large utility and industrial buyers in Europe have long legacies in many cases, and unseating those commercial ties could prove difficult. Nevertheless, if governments are willing to take such measures, they will likely find them costly, at a time when European competitiveness is still seen as great a concern as energy security; some anticipate that the already high price of electricity in Europe risks the "deindustrialization" of Europe.[19]

Perhaps more importantly, our analysis demonstrates that — absent additional measures — high US LNG exports will not have the most tangible and visible energy security dividend — namely, reducing Russian market share in Europe. A situation where US LNG exports reach 12 bcfd under today's market framework where buyer–seller relationships are dominated by long term contracts will still allow Russia to maintain its share of the European gas market. Under this policy strategy, high US LNG exports are more likely to knock expensive domestic European shale production and Norwegian gas out of the market rather than cheaper Russian gas. Under such circumstances, Russia's continued dominance in the European market would permit Russia to maintain its geopolitical leverage. Importantly, as discussed above and widely in the international relations literature, such dependence can dampen European reaction to Russia's apparent agenda to reassert itself in the post-Soviet sphere.

This is not to say that high US LNG exports reaps no energy security benefits globally or even specifically to Europe. On the contrary, greater US LNG exports will increase liquidity in the global LNG market and contribute to the easing of the current tightness of the market, making it more resilient to unexpected disruptions. In turn, a more liquid global market means that Europe — if faced with a partial or full cutoff of Russian gas — would be able to replace that gas more easily and perhaps at less of a price premium than might otherwise be possible. In a world where LNG markets are deeper, investment in new LNG import capacity could hinge less heavily on long term contracts as capacity investment becomes less risky to equity investors in a more liquid market.[20] If so, the development of new capacity in eastern Europe—Poland, the Baltics, Croatia, etc. — when coupled with the current spare capacity in existing European LNG import terminals — such as in France, the UK, Italy and Spain — *would* provide ample opportunity for alternative suppliers to deliver LNG to Europe in the event of a disruption of pipeline supplies.[21] In fact, rising Pacific LNG production from Papua New Guinea and elsewhere allowed Qatar to divert LNG to Europe in the spring of 2014, which helped moderate European prices and contributed to a giant inventory build ahead of winter. Importantly, however, achieving these outcomes need not hinge on adopting policies that promote US LNG exports; rather, if such outcomes are encouraged through market restructuring in Europe in particular, then US LNG exports will be a market determined outcome, whatever the volume. In this case, the cost of subsidies would not be borne, yet the desired goals of a more diversified market would be reaped.

Nevertheless, some US policymakers may see the critical takeaways of this analysis very differently than their European counterparts. At first glance, US policymakers may assess that a large push of US LNG exports could discourage the burgeoning Sino-Russia energy relationship, thereby dissuading a greater geostrategic cooperation between these two powers and thus conveying geopolitical benefit to the US. In addition, large quantities of US LNG exports may also be viewed as important support to US allies, particularly in Asia, where Japan in particular is struggling to meet post-Fukushima domestic economic and political challenges as well as energy security concerns.

Some US policymakers may also support policies that promote aggressive US LNG exports based on the view it could lower global natural gas prices, alter trade relationships and erode Russia's geopolitical influence in both Europe and Asia. In addition, support for high US LNG exports could be motivated by the realization that promoting first-mover advantage in global markets for US producers will reduce any potential window for Iran to capture a part of the global gas market, particularly in LNG, for some time. In turn, this could dampen that country's ability to use its resource wealth as leverage for other aspirations. Of course, if US LNG exports are very high as a result of policy support rather than market forces, they will carry serious implications for the profitability of new and existing export ventures all over the world and affect future investment and trade pathways everywhere, not just in Russia and Iran.

[19] See the comments of Germany's Economy and Energy Minister Sigmar Gabriel at a January 2014 energy conference in Berlin (http://www.nytimes.com/2014/01/22/business/energy-environment/german-energy-official-sounds-a-warning.html?_r=0)

[20] See Hartley, Peter, "The Future of Long-Term LNG Contracts," forthcoming *The Energy Journal*.

[21] Europe currently has nearly the same amount of spare LNG import capacity idle as it imports Russian gas today. The tightness of today's market, however, makes it very unlikely that in a crisis, Europe would be able to lure adequate imports of LNG to them at a time when Asian buyers see LNG as critical to their energy security.

Despite the potential perceived benefits, in the realm of policy options, our analysis does not argue for a policy that subsidizes, or even promotes, US LNG exports. First, as explored earlier, this approach does not significantly advance what is probably regarded, in the current context, as the top geopolitical priority when it comes to gas: lessening Russia's grip on Europe's market. If the top US goal is to diversify market supply and reduce Russia's leverage to use energy as a geopolitical lever, then our analysis indicates the best course of action for the US would be to push its European allies to move forward with proposed reforms towards more liberalized markets that promote greater price transparency and open access on transportation systems in order to encourage greater continental trade and investment in natural gas in Europe. More generally, the analysis herein supports the notion that the US should be pushing globally for more open and competitive markets. Indeed, reforms that allow for the free flow of investment capital into European and Asian gas markets would result in a significant diversification of supply globally and lower prices overall. More liberal markets would cut into long term revenues for Russian gas exports and possibly erode Russia's regional influence in Europe.

In conclusion, deeper energy trade can strengthen US ties to important allies and trading partners thereby enhancing US geopolitical influence while weakening the relative importance of bi-lateral energy links between key economies in Europe and Asia with Russia and the Middle East. Greater Asian dependence on US energy supply could also moderate the US trade deficit and help to improve Chinese cooperation with Washington on a wider range of international issues including conflict resolution in the Middle East. To achieve a deeper international trade in natural gas, the US should promote greater liberalization of gas markets around the world. This includes enhancement of capital flows into the upstream sector and deepening of supply chains around the world. In the context of current geopolitical concerns, this would ultimately limit Russia's ability to use energy as a wedge between the US and its European allies. By corollary, such an outcome would also shield the global economy from disruptions that might come about in the aftermath of political unrest in key energy producing regions by enhancing the diversity of supply of natural gas to global markets.

References

[1] Michael Levi, A Strategy for US Natural Gas Exports, The Hamilton Project, June 2012, http://www.hamiltonproject.org/files/downloads_and_links/06_exports_levi.pdf.

[2] NERA, Macroeconomic Impacts of LNG Exports from the United States, December 2012. http://energy.gov/sites/prod/files/2013/04/f0/nera_lng_report.pdf.

[3] Kenneth B. Medlock III, US LNG Exports: Truth and Consequence, working paper, James A. Baker II Institute for Public Policy, August 10, 2012, http://bakerinstitute.org/files/842/.

[4] Howard Rogers, The Impact of a Globalising Market on Future European Gas Supply and Pricing: the Importance of Asian Demand and North American Supply, The Oxford Institute for Energy Studies, January 2012. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2012/01/NG_59.pdf.

[5] Kenneth B. Medlock III, Natural Gas Price in Asia: What to Expect and What it Means, working paper, James A. Baker II Institute for Public Policy, February 18, 2014, http://bakerinstitute.org/media/files/Research/3d101582/CES-pub-NaturalGasPriceAsia-021814.pdf.

[6] Tom Choi, Peter Robertson, Exporting the American Renaissance: Global Impacts of LNG Exports from the United States, Report by the Deloitte Center for Energy Solutions and Deloitte MarketPoint LLC, 2013.

[7] James Henderson, The Potential Impact of North American LNG Exports, The Oxford Institute for Energy Studies, October 2012. http://www.oxfordenergy.org/wpcms/wp-content/uploads/2012/10/NG-68.pdf.

[8] James T. Jensen, US Shale Gas: A New Option for Japanese LNG Supply, Middle East Economic Survey (MEES), February 10, 2014, http://www.mees.com/en/articles/9048.

[9] H.V. Rogers, J. Stern, Challenges to JCC Pricing in Asian LNG Markets, NG 82, The Oxford Institute for Energy Studies, February 2014.

[10] Seksun Moryadee, et al, Investigating the potential effects of US LNG exports on global natural gas markets, Energy Strategy Rev. 2 (3/4), 273–288.

[11] Amy Myers Jaffe, Edward L. Morse, Liquefied natural profits: the United States and the remaking of the global Energy economy, Foreign Aff. (September 16, 2013). http://www.foreignaffairs.com/articles/139932/amy-myers-jaffe-and-edward-l-morse/liquefied-natural-profits.

[12] Nick Cunningham, The geopolitical implications of US natural gas exports, Am. Secur. Proj. (March 2013). http://www.americansecurityproject.org/the-geopolitical-implications-of-u-s-natural-gas-exports/.

[13] John Deutch, The good news about gas: the natural gas revolution and its consequences, Foreign Aff. (January 1, 2011). http://www.foreignaffairs.com/articles/67039/john-deutch/the-good-news-about-gas.

[14] Kenneth B. Medlock III, et al., Shale Gas and US National Security, working paper, James A. Baker III Institute for Public Policy, July 2011, http://www.howardenergypartners.com/pdf/resources_shalegassecurity.pdf.

[15] Songying Fang, et al., New alignments? the geopolitics of gas and oil cartels and the changing Middle East, J. Econ. Energy Environ. Policy 3 (1) (January 24, 2014).