

A Strategy for U.S. Natural Gas Exports

Michael Levi



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BROOKINGS

Abstract

A surge in low-cost U.S. natural gas production has prompted a flurry of proposals to export liquefied natural gas (LNG). A string of permit applications are now pending at the Department of Energy (DOE), and more can be expected; lawmakers are also debating the wisdom of allowing LNG exports. This paper proposes a framework for assessing the merits of allowing LNG exports along six dimensions: macroeconomic (including output, jobs, and balance of trade), distributional, oil security, climate change, foreign and trade policy, and local environment. Evaluating the possibility of exports along all six dimensions, it finds that the likely benefits of allowing exports outweigh the costs of explicitly constraining them, provided that appropriate environmental protections are in place. It thus proposes that the DOE and the Federal Energy Regulatory Commission (FERC) approve applications to export natural gas. It also proposes steps that the United States should take to leverage potential exports in order to promote its broader trade and foreign policy agendas.

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Chapter 1: Introduction

U.S. natural gas production is booming. Five years ago, most experts assumed that U.S. natural gas output was in terminal decline; today, most believe the opposite. As recently as 2009, the U.S. Department of Energy was projecting indefinite dependence on imported natural gas along with rising prices for decades to come (EIA 2009a). By 2010, after breakthroughs in extracting natural gas from shale, conventional wisdom had flipped. Large-scale gas imports now seem unlikely, and abundant domestic supplies look like they will hold prices in check (EIA 2010a).

The market has signaled its endorsement of this development by hammering natural gas prices. U.S. benchmark natural gas dipped below \$2 for a thousand cubic feet in early 2012, and as of mid-April 2012, delivery of the same amount in March 2015 could be assured for \$4.43. Wellhead prices, meanwhile, fell to levels unseen since 1995.¹

But the world looks different from overseas. In Europe, a thousand cubic feet of gas sold on the spot market for about \$11 as of March 2012, and in East Asia, the price was north of \$15 (Platts 2012). These prices are all the more striking since it costs roughly \$4 to liquefy and ship a thousand cubic feet of natural gas from the United States to Europe, and only about \$2 more to send it to Asia (Morse et al. 2012).

Yet the United States does not export natural gas to those markets. Many have thus argued that it is leaving money on the table. The potential profits from exports have prompted several companies to apply for permits to export liquefied natural gas (LNG) without restriction. In March 2011, the U.S. Department of Energy (DOE) approved the first such permit, for Cheniere Energy, and in April 2012, the Federal Energy Regulatory Committee (FERC) approved Cheniere's Sabine Pass, Louisiana facility. As of May 2012, another eight projects had applied to the DOE for similar permits, and four more had applied for permits to export LNG to countries with which the United States has free trade agreements (DOE 2012). The DOE has signaled that it will begin making decisions on these applications after receiving the results of a contractor study on the possible impacts of LNG exports in late summer 2012. The DOE can be expected to solicit input from several agencies, including the Departments of State and Commerce, the Environmental Protection Agency, and the Office of the U.S. Trade Representative, as well as from the National Economic Council, the National

Security Council, and the Council on Environmental Quality in making its ultimate decisions.

Indeed, if currently anticipated price differences hold up, and fully free trade in natural gas is allowed, several developers will likely attempt to build LNG export terminals. A wide range of analysts have claimed that as many as six billion cubic feet of daily exports by the end of the decade is plausible. That trade could expand U.S. gas production substantially and, in principle, net U.S. producers, exporters, and their suppliers north of \$10 billion a year.² Gas exports could help narrow the U.S. current account deficit, shake up geopolitics, and give the United States new leverage in trade negotiations. This has led many people to advocate for a U.S. policy that allows—or even encourages—natural gas exports.

But there is also great wariness in many quarters about the prospect of allowing exports of natural gas. Americans usually support exports, but natural gas, along with other energy commodities, has recently received special scrutiny. Some fear that allowing exports would dangerously drive up domestic natural gas prices while making the U.S. gas market more volatile. Others would prefer that domestic gas be directed toward boosting manufacturing at home, replacing coal-fired power plants, or taking the place of oil as the ultimate fuel for American cars and trucks. Still more oppose natural gas exports because those exports would result in greater U.S. natural gas production, potentially leading to social and environmental disruption. All of these parties oppose natural gas exports, or at least seek significant constraints. Some are driven by broad visions of the national interest to conclude that natural gas exports would have negative consequences that are not captured by simple economic logic. Others are motivated by more self-interested concerns, particularly the desire to secure cheap energy inputs for their industries.

There is also skepticism in some quarters over whether LNG exports, even if allowed, will ever get off the ground. Yet with a large docket of export applications pending, policymakers will have no choice but to step into this controversy. In this paper, I elaborate a framework for policymakers to use in deciding whether to allow LNG exports (a decision for regulators) or whether to take steps to constrain them (a decision for both regulators and lawmakers). This framework should focus on evaluating six questions:

1. What broad economic gains and losses might allowing LNG exports deliver?
2. How might exports affect energy bills for people of limited economic means?
3. Would LNG exports undermine U.S. energy security by preventing the United States from using more natural gas in its cars and trucks?
4. Would exports help or hurt the fight against climate change?
5. How would different U.S. decisions on exports affect U.S. foreign policy, including broad U.S. access to global markets in particular?
6. Would allowing exports lead to more U.S. natural gas production—and if production increases, what would the consequences be for the local environment?

This paper addresses these questions and argues that the benefits from allowing natural gas exports outweigh the commonly cited risks and costs, assuming that proper steps are taken to protect the environment.

The potential direct economic gains from LNG exports are significant but they are also smaller than many assume. Export terminal construction might employ as many as 8,000 people at different points over the next several years, but these jobs will be temporary. Expanding natural gas production in order to supply export markets could potentially support roughly 25,000 jobs in the natural gas industry, and perhaps 40,000 along the supply chain, but most of these positions would not materialize for at least five more years, and can thus be reasonably expected to be mostly offset by lower employment elsewhere. Profits from greater gas production and export activities could reach several billion dollars each year, while losses to other gas dependent industries would likely be at least an order of magnitude smaller. Indeed, the resurgent petrochemicals industry, which many have assumed would suffer from gas exports, would be more likely to benefit instead from modest export volumes.

Moreover, allowing LNG exports would have benefits for U.S. leverage in trade diplomacy, potentially delivering wider economic benefits. Conversely, placing curbs on U.S. LNG exports could undermine U.S. access to exports from other markets (including to Chinese rare earth metals, which are essential to many segments of the U.S. clean energy industry), and could potentially result in broader trade conflicts, leading to wider U.S. economic harm.

To be certain, changes in world gas markets could reduce opportunities for LNG exports, and thus any benefits from allowing them. But that would not change the fact that those benefits outweigh the costs of explicitly and directly constraining exports through government action.

What about the commonly claimed costs of *allowing* exports? This paper will show that integrating U.S. markets with global ones is as likely to tamp volatility as it is to increase it; that the gains to energy-intensive manufacturing from constraining natural gas exports would be much smaller than the economic opportunities that would be lost; that allowing natural gas exports would likely curb rather than increase global greenhouse-gas emissions; and that whether natural gas will be used to replace oil in U.S. cars and trucks depends little on whether exports are allowed. But the paper also offers warnings on two fronts. Natural gas exports would slightly raise U.S. natural gas prices, with disproportionate consequences for low-income consumers. (Increased tax revenues due to exports should be used to mitigate that effect insofar as possible.) Local environmental risks arising from natural gas production would also rise due to new production for exports. This can, in principle, be safely managed, but that is not inevitable; the prospect of exports should lead industry and regulators to redouble their efforts. This last factor is particularly important: as the controversy over the Keystone XL pipeline demonstrated, export-oriented resource extraction may be particularly vulnerable to local and environmental opposition; if allowing LNG exports were to lead to a backlash against natural gas production in general, the economic fallout could be vast. Conversely, if prudent regulation of natural gas extraction in the public interest raises natural gas prices and, as a result, makes some exports uneconomic, that should be accepted as a desirable outcome.

In light of this analysis, I propose that the United States allow LNG exports. In conjunction with this, the U.S. should take other steps to mitigate potential downsides and leverage these exports to its advantage.

The United States should approve applications to export LNG from the United States, several of which are currently pending, and more of which can be expected in the future. This does not mean that the U.S. government should encourage exports *per se*; it should simply allow them to occur if properly regulated markets steer the economy in that direction.

U.S. law distinguishes between LNG exports to countries with which the United States has relevant free trade agreements (FTAs), which are fast tracked for approval, and exports to other countries, which face more rigorous review and must be judged to be consistent with the U.S. national interest. Some have argued that this distinction should be abolished, since it interferes with free trade. The United States should maintain the distinction, which can give it leverage in trade negotiations without entailing any economic costs.

U.S. natural gas exports can also provide a platform for more effective U.S. foreign and trade policy. To that end, the United States should use foreign access to U.S. gas exports as leverage in trade negotiations, and actively seek to steer global gas trade toward greater transparency and market-based pricing.

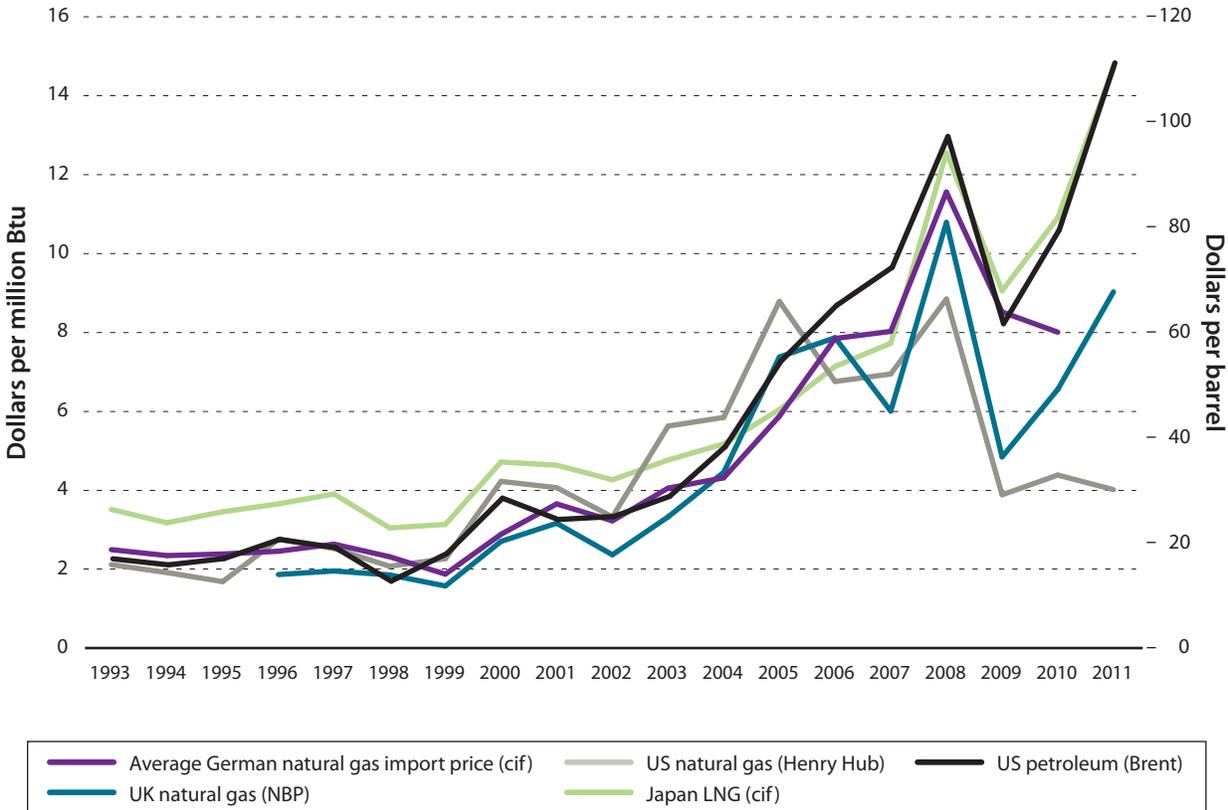
Chapter 2: Natural Gas Markets in the United States and Beyond

Any strategy toward U.S. LNG exports must be grounded in an understanding of the often odd workings of the world market for natural gas. (Readers who are familiar with natural gas markets, or who are willing to take on faith that global prices will continue to diverge, can skip to Chapter 3.) The market is dominated by state-owned or state-controlled firms in countries like Russia, Qatar, China, and Korea that make decisions regarding production and consumption based only in part on economics. Overland trade in natural gas is constrained by pipeline geography and capacity, which again gives governments a strong role in shaping outcomes. Seaborne trade in LNG requires large up-front capital investments—a fact that tends to encourage firms to enter long-term contracts that spread risk (Joskow 1987) but also add rigidity to markets.

It also gives government-backed firms another edge due to their access to stable sources of long-term capital. Trade is largely regionalized, a result mainly of the high cost of shipping gas over long distances. Political concerns often motivate an opposition to transparency among major players, who seek to gain informational edges in bargaining, further steering global markets away from the economic ideal.

North America is an exception to this pattern. During the 1970s and 1980s, the U.S. market for natural gas was progressively deregulated. Robust pipeline networks, hub services, and futures markets developed. In 1994, the North American Free Trade Agreement (NAFTA) cemented a liberalized gas market across the continent.

FIGURE 1.
Select Prices of Natural Gas, LNG, and Brent Crude Oil, 1993–2011



Source: BP (2011); ENI (2012); EIA (2012f; 2012g); World Bank (2012).
 Note: cif represents sum of cost, insurance and freight (average).

Yet despite extraordinary differences between U.S., European, and Asian gas markets, spot prices in all three have largely tracked each other for twenty years—and all three have also tracked the price of oil (Figure 1). While Figure 1 primarily shows spot prices, most natural gas trade in Europe and Asia does not occur on spot markets. Economists generally believe, however, that spot and contract prices cannot diverge much over the medium and long run, since those bound by contracts will insist on renegotiating. This intuition is reinforced by comparing U.K. spot prices and German import prices (which are dominated by contracts) in Figure 1.

The historical relationships between the three markets, however, appear to have broken down around 2009. U.S. natural gas output is on the rise as a result of breakthroughs in shale gas production. Total U.S. natural gas production rose from 23.5 trillion cubic feet in 2006 to 28.6 trillion cubic feet in 2011, equivalent to 78 billion cubic feet each day (EIA 2012b). This flood of production has depressed natural gas prices in the United States. Yet, since exports from the United States to Europe and Asia are generally not allowed, overseas prices have not followed.

It is this difference in prices that has sparked interest in U.S. LNG exports: before prices in the three markets blew wide apart, there was no economic incentive for anyone to build an LNG export facility in the United States. If a situation resembling the historical relationship returns, opportunities for exports will vanish.

Economists expect prices for commodities in a competitive environment to converge with the marginal cost of supplying them over the medium term. For natural gas this could mean ample low-priced competition from traditional suppliers within a few years, making U.S. LNG exports uneconomic. Several Middle Eastern producers have marginal costs of production close to zero (excluding shipping), either because natural gas is easy to extract or because it is a byproduct of oil production. Russian and Caspian gas generally costs more than Middle Eastern gas to produce, but, given sufficient pipeline infrastructure, delivering it could be much cheaper than shipping LNG.

Yet there is good reason to believe that prices will not converge any time soon. Global natural gas production is highly concentrated, and strategic producers, including Qatar and Russia, appear to restrain production for export; they would rather sell less gas at higher prices than more gas at lower ones. This restraint is not necessarily explicit: by simply insisting on linking gas prices to oil prices, they implicitly constrain supply by throttling demand. In addition, directing marginal production to subsidized domestic markets can keep export prices high.

Insofar as global natural gas supply and transport are constrained in part by noneconomic factors, prices will be determined by competition in consuming countries between natural gas and substitutes.³ Prices should settle at levels that make gas competitive at the margin with other fuels and technologies than can be used instead. Consumers will not buy natural gas if producers raise prices so high that they would be better off using other fuels or technologies instead; if, however, natural gas is a better deal than the next best option, consumers will buy it.

This framework allows us to better assess whether prices in the three major regional gas markets might converge, and, hence, what the environment for potential U.S. exports might be. Indeed there are several possible ways (not mutually exclusive) for prices in the three big natural gas markets to return to similar levels. Examining them, however, reinforces the real possibility that prices will continue to diverge for the indefinite future.

The first way that prices could converge is through U.S. LNG exports, which could ultimately bring the various prices together, net of transport costs (including an indeterminate risk premium paid to investors in risky LNG projects). Indeed initial natural gas exports themselves will tend to shrink opportunities for subsequent exports. A recent DOE study projects that with moderate U.S. gas resources and twelve billion cubic feet a day of exports, U.S. benchmark prices would rise to more than \$8 per thousand cubic feet by the middle of the next decade (EIA 2012c). When combined with the cost of moving natural gas from the United States to overseas markets, there is a strong chance that some exports would be unprofitable at that price. The same analysis found that if U.S. resources were lower than anticipated, prices could reach \$14 per thousand cubic feet by 2020, making exports undoubtedly uneconomic at the margin. All that said, assuming U.S. LNG exports at the outset of this analysis would make no sense, since their very existence depends on the particular export policy that is adopted.

The second way that prices could converge is through a return of the historically tight link between oil and natural gas prices in the U.S. market. Until recently, high oil prices drove many U.S. manufacturers to substitute natural gas for distillate or residual fuel oil in their operations, while high natural gas prices did the reverse. As a result, natural gas prices followed oil prices up and down. The same thing occurred in Europe and Asia. Since oil prices were the same in all three markets, natural gas prices converged, too.

Today, though, there is very little switchable capacity left in U.S. industry: as of 2006, U.S. manufacturers only had enough switchable oil-based capacity to accommodate an additional

200 million cubic feet of daily natural gas consumption, a figure that has probably fallen since (EIA 2010b; author's calculations). Even if all nonswitchable capacity that currently uses fuel oil were retired and replaced with gas-based facilities (which would require sustained natural gas prices far below oil prices to offset the costs of new equipment), this would absorb less than one billion cubic feet of daily natural gas demand, around one percent of total U.S. production.

Natural gas and oil prices could also become re-linked in the United States through the robust use of natural gas in transportation. This could be more significant: displacing the equivalent of 150,000 barrels a day of refined petroleum products each year (about one percent of U.S. consumption and thus a reasonable prospect within a decade) could absorb the equivalent of about one billion cubic feet of incremental daily natural gas production.⁴ But the link would be different from before: because the equipment needed to utilize natural gas to power cars and trucks is more costly than the equipment needed for oil, a big difference between oil and natural gas prices—as much as \$6-7 per thousand cubic feet—would remain.⁵

The third way for natural gas prices in the three major international markets to converge is for them to all become linked to some new index other than oil. The most likely common anchor point is coal prices. Rising natural gas production is largely being directed toward displacing coal-fired power generation in the United States, and there is still enormous room for that to expand. Europe also uses limited amounts of oil in industry (IEA 2011), so natural gas may end up competing directly with coal there, too, so long as European climate policy or energy security policy do not squeeze both out simultaneously (a nontrivial possibility). Such a situation would tend to drive U.S. and European natural gas prices to similar levels. Because Europe and Asia share large swing LNG suppliers (most notably Qatar), Asian prices could follow.

The biggest barrier to developments along these lines may be institutional. Natural gas is currently sold to European and Asian customers on contracts that are largely tied to spot oil prices, with at most a small part of price tied to spot natural gas prices. This is in large part because no highly liquid spot markets for natural gas exist in either region. (Spot markets for oil, in contrast, are highly liquid and transparent.) Part of this, especially in Europe, is due to constraints in transnational pipeline networks that segment the market, which in turn are a result of European politics. Another part of it, in both regions, stems from the insistence of big suppliers on so-called “destination requirements,” which prohibit buyers from reselling contracted cargoes on the spot market. The concentrated nature of the European and Asian natural gas markets has further enhanced the stability of such arrangements. Finally, there is a chicken-and-egg problem in expanding spot markets: the early movers put themselves at the mercy of idiosyncratic price movements and potential market manipulation, both of which are far less likely to occur once spot markets have eventually grown. The entire scheme has been sustainable in large part because oil-indexed natural gas prices have largely tracked spot market natural gas prices. But, if the two diverge for a sustained period, the pressure to abandon oil indexation could become large.

No sober analyst should confidently claim to be able to perfectly predict the future of global natural gas markets. The best one can say is that prices in the three regional markets could continue to diverge for the indefinite future, but that new developments could lead them to converge even absent U.S. exports. The lesson for those crafting policy toward U.S. LNG exports is that any strategy should be robust to the different possible courses.

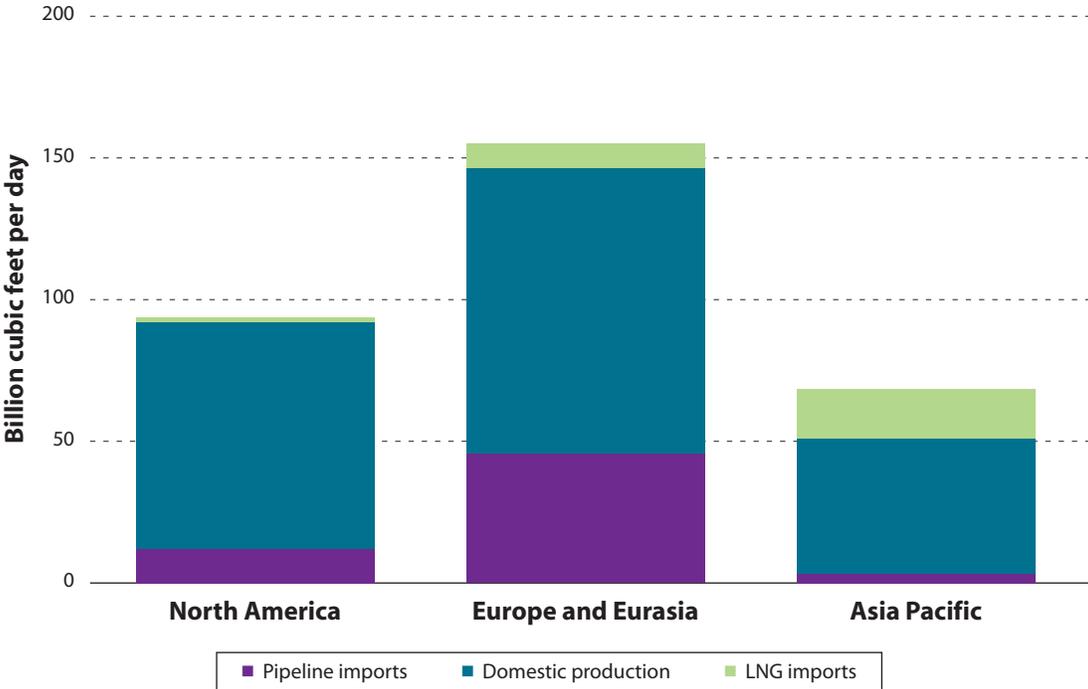
Chapter 3: The Problem and Potential of LNG Exports

There is a real possibility that prices in the United States, Europe, and Asia will continue to diverge, creating opportunities for U.S. LNG exports. Yet exporting natural gas overseas is not a straightforward endeavor. Gas must be liquefied before it can be transported in specially built ships and then regasified at its destination. Building liquefaction facilities in particular can cost as much as \$4 billion for each billion cubic feet of daily export capacity—several times the cost of building an import terminal of similar scale (Ratner et al. 2011). Investment on this scale can be risky: if natural gas price spreads collapse, multibillion-dollar investments can quickly become worthless. Adding to the dangers involved in building any terminal is regulatory risk associated with safety and security concerns.

Anticipating demand for LNG imports prior to the shale gas boom, several companies began to develop LNG import terminals. With the change in market conditions, most have applied for and received permits from the DOE to export LNG to countries with which the United States has applicable Free Trade Agreements (FTAs). These permits are essentially automatic.⁶ The approved facilities, once fully built, could process 10.9 billion cubic feet of exports each day, and, as of May 2012, applications for another 2.8 billion cubic feet of daily exports were pending (DOE 2012).

However, no major LNG importer other than South Korea has an applicable FTA with the United States (Ratner et al. 2011). Would-be exporters have thus sought approval to export

FIGURE 2.
Regional Natural Gas Consumption by Type, 2010



Source: BP (2011).
Note: Natural gas consumption by region as of 2010. Figures for pipeline and LNG volumes include intraregional trade.

without restriction. Cheniere Energy's Sabine Pass Facility has received DOE and Federal Energy Regulatory Commission (FERC) approval for 2.2 billion cubic feet of daily LNG exports to non-FTA countries, and applications totaling another 10.3 billion cubic feet per day are under review. These combined applications involve total volumes similar to current U.S. LNG *import* capacity (Guegel 2010). Exports from the first facilities would start no earlier than 2015.

It is far from clear that all or even most of this export volume would be used even if it were approved. A recent MIT study looked at nine scenarios for U.S. and world natural gas markets; none of them led to the emergence of significant U.S. natural gas exports, in large part because other lower cost producers undercut prices offered by the United States in distant markets (MIT 2011). Other forces, discussed in Chapter 2, could also lead global natural gas prices to converge even without U.S. exports, removing opportunities for economically attractive U.S. LNG sales.

Indeed, most analysts anticipate that less LNG will be exported than currently pending permits would allow, even

if all of those were approved. (They also expect to see more permit applications, since the plans behind many of the pending ones are expected to eventually fizzle.) For example, Citigroup analysts foresee up to 5 billion cubic feet a day of LNG exports by the end of the decade, barring regulatory barriers (Morse et al. 2012). UK gas producer BG has projected up to six billion cubic feet a day by then (Gismatullin 2012), the same volume that Deloitte (2011) analysts have focused their modeling on. Given this consistent view among market analysts on the maximum likely volume of LNG exports from the United States, the main analysis in this paper focuses on the possibility of up to six billion cubic feet of daily exports. This is approximately half the capacity currently awaiting approval and almost ten percent of current U.S. natural gas production. I consider the possibility of significantly greater or lesser exports in Chapter 6; the qualitative conclusions do not change, though the specific costs and benefits of allowing LNG exports do. To provide some context, Figure 2 shows natural gas consumption and LNG trade by region.

Chapter 4: Costs and Benefits of LNG Exports

Having been presented with a large docket of applications to ship LNG abroad, U.S. policy-makers are now faced with a simple question: should they approve large-scale exports of U.S. natural gas? Theory says yes: liberalized trade is desirable, since it delivers economic gains to all parties. Real-world complications, though, make the answer less straightforward.

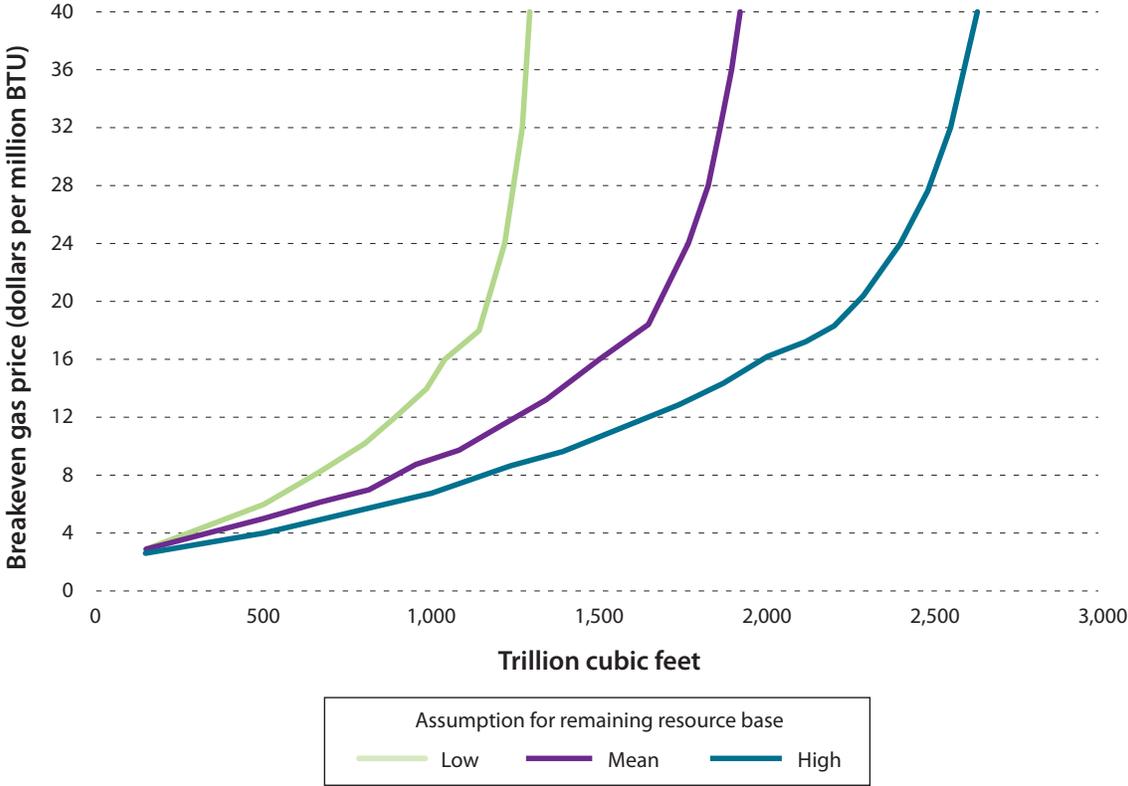
In this chapter, I put forward a framework for thinking about whether or not to approve U.S. LNG exports, centered around six questions:

1. What macroeconomic consequences would natural gas exports have?

- 2. What would the distributional impacts of natural gas exports be?
- 3. Would natural gas exports undermine U.S. oil security?
- 4. What impact would natural gas exports have on climate change?
- 5. What foreign policy consequences might natural gas exports entail?
- 6. What would the local environmental consequences of gas exports be?

The case for approving exports is strong only if the macroeconomic, climate, and foreign-policy benefits outweigh those distributional, oil security, and environmental downsides that cannot be effectively mitigated.

FIGURE 3.
Possible Shapes for the U.S. Natural Gas Supply Curve



Source: MIT (2011). Reprinted with permission of the MIT Energy Initiative.

ASSUMPTIONS AND LIKELY CONTRACT STRUCTURES

Allowing natural gas exports has the potential to help the U.S. economy by increasing U.S. economic output and, most likely, by narrowing the U.S. current account deficit, if actual exports occur. Yet the expected impact would be relatively small in the context of the overall U.S. economy. Exports would produce short-term employment gains but would have minimal impact on long-term employment.

To estimate the gains from trade in natural gas, one needs to estimate the long-run impacts of exports on U.S. natural gas prices. An increment of approximately 10 to 20 cents per thousand cubic feet for every billion cubic feet a day of exports is consistent with most published projections for the impact of gas exports (Pickering 2010; EIA 2012c). These projections reflect a broad range of possible shapes for the natural gas supply curve that are consistent with evidence from drilling done to date and current understanding of shale gas deposits. Deloitte (2011) is an outlier in projecting substantially smaller price impacts; I consider that possibility in detail in Chapter 6. Figure 3 shows several possibilities for the long-run U.S. supply curve.

One also needs to know how natural gas exports would affect domestic natural gas production and consumption. The Energy Information Administration (EIA) has projected that U.S. natural gas exports would draw roughly 20 percent from existing natural gas production and 80 percent from new production incentivized by access to export markets (EIA 2012c). The 20 percent drawn from existing production would come at the expense of power and industrial consumption in roughly equal amounts. These estimates are mostly insensitive to detailed assumptions about natural gas availability; they depend mainly on cost assumptions for well-understood applications of natural gas, including in power generation and industry. In any case, as I show below, they do not affect the net cost-benefit analysis here.

Estimating the specific economic benefits to the United States of natural gas exports also requires some assumptions about the prices that those exports will fetch. The prices at which natural gas currently sells in Europe and Asia provide a crude upper bound, but there are three large complications with assuming these prices. Overseas prices could fall substantially if the oil-linked pricing schemes currently used were substantially abandoned or modified; this would squeeze U.S. gains. Rising U.S. exports should also put downward pressure on overseas natural gas prices, eroding the potential gains from trade as exports expand. Perhaps most importantly, even if overseas natural gas prices were to hold up, the division of the surplus (the difference between prevailing U.S. and overseas prices) between the United States and gas-importing

countries will depend on the arrangements that are used to price any exported natural gas.

Contracts concluded by Cheniere Energy, the only company that had received a permit to export LNG to non-FTA countries as of May 2012, provide some insight into how that pie might be divided. These contracts price exported natural gas at 115 percent of the Henry Hub spot price (the main U.S. benchmark), in addition to a fixed liquefaction fee of \$2.25-\$3/MMBtu; the 15 percent markup reflects the cost of natural gas used to fuel the liquefaction facility (SEC 2012; ICIS Heren 2012). (This price is “free on board” i.e. exclusive of shipping and regasification costs.) This pricing arrangement appears attractive to Cheniere because the arrangement keeps Cheniere’s exposure to unexpected changes in U.S. or overseas natural gas prices minimal, which allows the company to secure financing. Its main source of risk is the credibility of its counterparties, something that it has likely insured (at least partially) against.

Most other sellers outside the United States have chosen to price their LNG differently. The Asian market, which may hold the greatest prospects for U.S. exporters, is particularly instructive. Asian LNG prices are tied to the price of oil, a pattern that prevails not only for traditional state-controlled suppliers, but for market-based producers, too. In particular, Australian companies, rather than rejecting the use of oil-linked prices, have followed it. So long as Australian production costs stay below Asian sales prices (net of transport costs), this approach will remain attractive there.

But there is good reason to expect that most U.S. exporters will follow a path similar to the one beaten by Cheniere. Would-be U.S. exporters who contract at Asian prices would be taking at least five risks: one tied to uncertainty over U.S. natural gas prices, another tied to uncertainty over overseas prices, a third associated with the unpredictable cost of LNG transport, a fourth tied to counterparty risk, and a fifth related to U.S. regulatory risk. Most companies that want to succeed prefer to take as few risks (ideally one) at a time as possible, and those considering extending financing to these companies tend to prefer that they minimize the number of sources of risk, too. All of this weighs in favor of U.S. exporters selling their natural gas at U.S. prices plus some fixed markup (including a charge for liquefaction services), thus eliminating most but not all sources of risk that they face.

Why expect different outcomes in the United States and Australia? Australia is a relatively small country in a large LNG market, which makes it safer for its customers to take prices from the broader market rather than to be exposed to potentially quirky domestic Australian prices. The U.S. situation is the opposite. Australian LNG business also tends to be vertically integrated, with natural gas producers

participating in exports, too. Pricing exports off of foreign markets, rather than domestic ones, diversifies their exposure to changing prices. The U.S. market, in contrast, is currently far more vertically segmented, largely by an accident of history: U.S. LNG terminal owners originally planned to import gas, not export it, and hence had no reason to link up with U.S. gas producers. If more U.S. gas producers began to take ownership stakes in export terminal operators, one might see a partial move to different pricing structures evolve, for similar reasons to those that have driven Australian decisions. But this does not seem to be occurring yet on a significant scale.

Most of my calculations will thus assume a similar pricing approach to that adopted by Cheniere. Cheniere (2011) marketing materials estimate a fixed liquefaction cost of \$1.75 per thousand cubic feet; I thus assume a markup of \$1 per thousand cubic feet to reconcile this estimate with contracts that have been signed so far. (Other assumptions about the likely markup are also possible, though a zero markup beyond liquefaction costs, including profit, would probably not make business sense.) I will also examine what would happen if a substantial fraction of U.S. exporters ultimately contracted at overseas prices instead of U.S. prices.

I also assume a U.S. natural gas price of \$5 per thousand cubic feet, exclusive of the domestic price impact of any exports. This is consistent with a wide range of opinions on where U.S. natural gas prices will likely settle: it is widely believed that a large part of the U.S. natural gas resource base is profitable to produce around this price.

MACROECONOMIC CONSEQUENCES

Gains from trade

Current U.S. gas prices are determined by U.S. supply and demand. If exports from the United States are allowed, the U.S. price will rise and the United States will produce more gas. The gains from trade are then the extra money earned by U.S. producers on what they would have sold anyway, minus the extra amount that U.S. consumers pay and what they lose from consuming less (for example, because they produce less steel), plus the net economic gain from the new production.

Consider first one billion cubic feet of daily LNG trade. Roughly 200 million cubic feet of natural gas will shift from the domestic market to exports. Producers will make \$80 million to \$90 million off these sales.⁷ At the same time, higher prices will spur lower domestic natural gas consumption in power generation and industry, which will offset that amount by approximately \$4 million to \$7 million. Roughly 800 million cubic feet a day of new production will also find its way to export markets, delivering an additional surplus of approximately \$300 million to \$320 million. The net annual value to the U.S. economy of allowing a billion cubic feet a day

of natural gas exports would thus be approximately \$380 to \$400 million. (The ranges in these estimates are due primarily to the fact that the impact of exports on domestic prices is uncertain.)

For a full six billion cubic feet a day of exports, using the same approach and assumptions as above, the estimated surplus for the U.S. economy would be \$2.7 billion to \$3.2 billion each year. The gains from selling gas overseas rather than at home would be approximately \$700 million to \$1 billion; the gains from new gas production would be roughly \$2.3 billion to \$2.8 billion; and the losses from lower domestic consumption would be approximately \$300 million to \$500 million. The precise numbers here depend on the sources of exported gas (displaced consumption or increased production), but the fact that the net economic impact is positive does not.

Additional gains would be realized because natural gas exports would exploit existing LNG infrastructure (i.e. some parts of existing import terminals) that would otherwise go unused and thus be worthless. These gains should approximately equal the value of the utilized LNG terminals (not including the value of their regasification facilities, which are not useful for exports), which are typically on the order of \$1 billion for each billion cubic feet a day of capacity. Spread over a notional fifteen-year use period, this would add approximately \$70 million a year for each billion cubic feet a day of exports. This brings the total estimated surplus from six billion cubic feet a day of exports to \$3.1 billion to \$3.7 billion.

How confident can we be in these figures? The largest remaining uncertainty is the price that U.S. producers fetch for their output. If U.S. gas were sold at domestic prices plus the cost of liquefaction services with no markup beyond normal profits (an extreme unlikely to be realized intentionally in practice, but a possibility if exporters underestimate their costs and thus misprice their services in long-term contracts), gains from trade would be far lower. Still, they would be positive.

On the other extreme, U.S. producers might fetch much higher prices. Imagine that half of U.S. LNG exports were sold on contracts tied to overseas prices rather than to the U.S. spot market, and assume that those overseas prices averaged \$12 per thousand cubic feet over the long term, near the current European forward price. Assume further, as assumed earlier, that liquefaction, transport, and regasification collectively cost \$5 for a thousand cubic feet of gas. Then the net surplus from six billion cubic feet a day of LNG exports would be approximately \$3.9 billion to \$4.1 billion, which is similar to the figure calculated above. (The two figures are similar because as U.S. exports expand, domestic prices rise, and margins in contracts that are based on overseas prices thus erode.) That surplus would increase by \$1.1 billion for every one-dollar increase in the overseas natural gas price.

Current account balance

The impact of LNG exports on the U.S. current account balance depends again on how gas exports are priced. Superficially, using the same assumptions as above, six billion cubic feet a day of exports would yield export revenues of about \$20 billion. This is equal to about 5 percent of the 2010 and 2011 current account deficits (BEA 2012). The actual impact of exports on the current account balance would be smaller (perhaps much smaller), since without changes in individual behavior, increased U.S. output would lead to increased U.S. consumption, part of which would be consumption of imports. Moreover, increased gas exports would reduce exports of other goods by raising the cost of producing gas-intensive products, and by diverting people and (to a lesser extent) capital from other productive activities.

Employment impacts

Building new LNG export facilities would create a substantial number of temporary construction jobs. Cheniere estimates that its 2.2 billion cubic feet per day facility will take roughly two years to build and support roughly 3,000 jobs at its peak (Oil & Gas Monitor). Scaling this up suggests that allowing LNG exports could lead to as many as 8,000 temporary construction jobs if enough capacity for six billion cubic feet of daily exports was developed in the next several years.

There is no reason to believe, however, that increased LNG exports would have a significant long-term impact on broader U.S. employment levels, which are determined by more fundamental factors. Still, one can crudely estimate the impact that LNG exports would have on industries that would be directly affected.

I estimate that expanded natural gas production due to a six-billion-cubic-foot-per-day increase in exports would support approximately 25,000 jobs in the natural gas industry, along with approximately 40,000 jobs along the supply chain, in areas like steel, rig manufacturing, and elsewhere.⁸ At the same time, employment in energy-intensive manufacturing would contract. This impact is much more difficult to quantify, since a much more elaborate model is required to know the scale of output losses in those sectors. Still, I can put a loose upper bound on the potential impact. Aldy and Pizer (2009) estimate (in the context of studying carbon pricing) that an 8 percent increase in the price of electricity would cause a 0.2 percent decrease in overall manufacturing sector employment. The U.S. EIA (2012c) projects an ultimate increase of 1 percent to 2 percent in commercial electricity prices (and a transient increase of 2 percent to 4 percent in the early 2020s) from

six billion cubic feet of daily LNG exports, which translates to a 0.025 percent to 0.050 percent decline in manufacturing employment. Total U.S. manufacturing employment in 2010 was approximately eleven million people (BEA 2011). These figures collectively suggest that higher natural gas prices due to exports could reduce manufacturing employment by between 3,000 and 6,000 jobs, primarily in energy intensive sectors like steel and cement. Impacts in these sectors would be partly offset by increased demand for their products by the natural gas industry—about one-fifth of shale gas capital expenditures, for example, go to purchasing steel, while about one-tenth are used to buy cement (IHS 2011).

These estimates should all be taken with a large grain of salt: the markets involved are complex and difficult to predict. The bottom line, though, is robust: job gains in directly affected

...the total estimated surplus from six billion cubic feet a day of exports [is] \$3.1 billion to \$3.7 billion.

markets are highly likely to be greater than job losses in markets hurt by higher natural gas prices.

Natural gas exports would also affect employment through the price level and its impact on monetary policy. Allowing LNG exports would raise prices for natural gas and products produced with it, but would lower prices for imports by strengthening the dollar. The net impact is unclear, but since the impacts of exports on consumer prices and on the trade balance are both minimal, both effects would be very small.

Price volatility

These analyses of economic impacts have at least one important limitation. In principle, producers and consumers both anticipate volatility in natural gas supply and prices, and adjust their behavior accordingly. In practice, producers and consumers both tend to imperfectly anticipate volatility, exposing themselves and the broader economy to greater risk of harm. To the extent that allowing exports would increase volatility in domestic gas prices, the economic gains from increasing exports would be reduced.

This is not a significant risk for the foreseeable future. In order for volatility beyond North America to affect U.S. natural gas prices, there has to be a possibility that U.S. gas exports will change quickly as a result of shifts in international conditions. As long as potential U.S. exports are fully subscribed (i.e. form part of base-load U.S. demand), though, no such possibility exists. This will continue to be the case so long as natural gas prices in export markets exceed the sum of U.S. natural gas prices and transport costs (including liquefaction and regasification). Given current trends in international natural gas prices, this condition is likely to be comfortably satisfied for at least the next decade—though, as discussed in Chapter 6, it is not guaranteed.

This insulated state may eventually go away. Indeed one of the motivations behind interest in natural gas exports is the possibility of creating a more coherent global gas market in which prices in different markets partly converge. Such a market would be one in which U.S. prices become linked to

Exported natural gas is also likely to displace coal. Indeed, since allowing natural gas exports appears to primarily increase the volume of gas produced, rather than displace gas previously destined for domestic consumption, allowing natural gas exports could ultimately reduce global emissions.

global ones. Yet such a market would also bring a countervailing upside to the United States: the same arbitrage opportunities that could transmit international volatility into the U.S. market would also help absorb domestic supply and demand shocks. In the face of a sudden increase in domestic demand or decline in domestic supply, the United States could reduce exports, helping balance the market while limiting price hikes. The former might happen, for example, if a nuclear accident prompted a sudden increase in gas-fired generation, while the latter might result from extreme weather in gas drilling areas.

It is essentially impossible to predict whether full linkage between the U.S. and international markets would increase or decrease volatility in U.S. prices, particularly since such a development is likely to be at least a decade away. It thus makes little sense to alter near-term U.S. decisions regarding LNG exports based on volatility concerns.

DISTRIBUTIONAL CONSEQUENCES

Allowing natural gas exports could have small but regressive distributional consequences. As of 2005, households with less than \$20,000 a year in income consumed an average of 8,700 kWh of electricity and 33,000 cubic feet of natural gas each year (EIA 2005a). A one-dollar rise in natural gas prices, near the upper end of likely impacts from the scenarios explored here, would cost each such household an average of \$33 each year in natural gas costs. A corresponding 0.2-cent rise in electricity rates would cost such households another \$17, for a total of \$50 each year. The average household with income in excess of \$100,000, in contrast, would see its natural gas bill rise by \$59, and its electricity bill would rise by \$31, for a total of \$90, a far smaller share of its income. The gains from trade, in contrast, would accrue mostly to shareholders and to landowners in gas-rich regions, which would fail to even the balance sheet for most lower- and middle-class consumers. The impacts on both sets of consumers would of course rise (or fall) if natural gas exports had greater (or lower) impacts on domestic natural gas prices.

These consequences, in principle, should be addressed along with other inequalities through broad-based policies (such as adjustments to the tax code) that focus on ameliorating undesirable inequality regardless of its source. In practice, though, the U.S. political system has been averse to such policies in recent years. Earmarking slightly more than half of federal revenues from higher federal corporate tax collections due to exports (estimated in Chapter 6) could make consumers with household incomes under \$40,000 whole (EIA 2005b).

A final notional option might be to levy a tax on natural gas exports and use that to assist low-income energy consumers. This would, however, be contrary to the U.S. Constitution, which asserts that “No Tax or Duty shall be laid on Articles exported from any State” (U.S. Constitution). The U.S. Supreme Court has reaffirmed this as recently as 1998 (*U.S. v. U.S. Shoe Corp.*).

OIL SECURITY

The analysis of net economic benefits presented above ignores the potential positive externalities from substituting natural gas for oil in the transport sector, a development that might in principle be undermined by allowing natural gas exports.

Every time natural gas is used to back out a barrel of oil, the market price of crude falls, and the price paid by all U.S. consumers for oil imports drops as a result. The precise magnitude of this effect

is a subject of considerable debate, but recent U.S. regulatory impact assessments have used a value of \$12.91 for each barrel of oil displaced, or 31 cents for each gallon of gasoline, with a range of \$4.67 to \$23.40/bbl (NHTSA 2011, 647). In principle, then, it might make sense to reorient gas volumes destined for export to the domestic transport market.

Each thousand cubic feet of natural gas converted to gasoline or diesel and used in U.S. cars and trucks would deliver a positive externality of about \$1.30.⁹ This is less than the gain from selling the same natural gas overseas, even with conservative assumptions about pricing.

The same thousand cubic feet of natural gas used in compressed natural gas (CNG) vehicles would produce an external benefit of about \$1.90 due to lower oil prices (CNG is a more energy efficient technology than gas-to-liquids), along with an estimated benefit of \$1.10 due to reduced exposure to oil price volatility (NHTSA 2011, 647), for a total external benefit of about \$3, though this would be offset in part if public spending were needed to establish CNG fueling infrastructure.¹⁰ (This benefit of reduced exposure to volatile oil prices is not included in the previous estimate since the price of liquid fuels produced from natural gas will fluctuate with the price of oil.) This brings the benefits of directing natural gas into the transport sector closer into line with the benefits of allowing natural gas to be exported. The gains from allowing exports, though, are still likely to be larger than those of using the gas in cars and trucks.¹¹

Some will likely observe that substituting natural gas for oil has the added benefit of reducing income for major oil exporters, many of whom are hostile to the United States. That is true, but displacing others' natural gas exports would do the same. Indeed many major oil exporters, like Iran and Russia, are also major natural gas exporters. That fact makes substitution of natural gas for oil an ineffective way to starve oil-exporting regimes of revenues.

In any case, barring exports would probably not push significant volumes of natural gas into the transport sector; instead, it would simply keep them in the ground. The main forces currently affecting decisions to invest in infrastructure to move natural gas into the transport sector are oil-price uncertainty, the risk associated with the large up-front capital investments required, and lack of policy promoting adoption of natural gas vehicles. For context, a one-dollar change in the price of natural gas—roughly what might eventually be expected from large-scale LNG exports—would be offset by a \$7 to \$10 dollar drop in oil prices. Actual uncertainty about future oil prices is much greater than that.

CLIMATE CHANGE

Natural gas is a mixed blessing for climate change. By displacing coal, it reduces greenhouse-gas emissions, but by

undercutting renewable and nuclear energy and lowering energy prices, it increases greenhouse-gas emissions. It is generally agreed, though, that the main consequence of abundant gas in the U.S. energy system is displacement of coal.

A simple estimate indicates the likely scale of the impact of natural gas exports on U.S. emissions. I observed earlier that roughly 20 percent of U.S. LNG exports would be drawn from natural gas that would otherwise be used in the United States. If, for example, that exported gas was replaced 80 percent by coal and 20 percent by zero-carbon fuels and reduced energy consumption, and emissions for coal were double those for gas, the result would be approximately 2 million tons of additional U.S. greenhouse-gas emissions for each billion cubic feet of daily exports.¹² This is broadly consistent with estimates produced by complex models (EIA 2012c).

Natural gas, though, has the same climate consequences whether it is burned in the United States, Europe, or Asia. Exported natural gas is also likely to displace coal. Indeed, since allowing natural gas exports appears to primarily increase the volume of gas produced, rather than displace gas previously destined for domestic consumption, allowing natural gas exports could ultimately reduce global emissions. I estimate this impact as, at most, approximately 15 million tons of reduced global emissions for each billion cubic feet of daily natural gas exports. For six billion cubic feet a day of exports and a value for damages from emissions of a modest \$21 per ton of carbon dioxide—the figure used in U.S. regulatory impact assessments (Greenstone, Kopits, and Wolverton 2011)—the avoided climate damages would be \$2 billion annually. Global greenhouse-gas emissions from energy use would be reduced by 0.3 percent relative to 2008 levels. On the other hand, if exported natural gas displaced as much renewable energy and energy conservation as it did coal, the impact on non-U.S. emissions would be neutral.

Climate policy also has an important international political dimension. Global climate diplomacy tends to focus on what happens within individual countries' borders. If a U.S. decision to allow natural gas exports reduced global emissions but raised U.S. emissions—indeed the most likely outcome—the United States could, in principle, suffer diplomatically. But this is highly unlikely in practice. The export volumes examined here would raise U.S. emissions by at most approximately 0.3 percent, a trivial difference in the context of climate diplomacy, which tends to focus on changes on the order of 10 percent or more of national emissions.

FOREIGN AND TRADE POLICY

The surge in U.S. shale gas production has already had major consequences for geopolitics. There was a widespread expectation, only a few years ago, that the United States would become a major natural gas importer. Potential suppliers, most

prominently Qatar, began to develop LNG export infrastructure in anticipation of serving the U.S. market. The U.S. shale boom, however, has quickly eliminated the prospect of significant U.S. demand for imported LNG (UPI 2011). (Some residual demand remains for logistical reasons.) With would-be suppliers to the United States looking for new markets, consumers have gained greater bargaining power. A leading indicator of this growing bargaining power has been the attempt, starting in 2011, of Germany's main natural gas importer, E.ON Ruhrgas, to renegotiate its politically charged gas contracts with Russia's Gazprom (Powell 2011). Many analysts now expect Europe to move gradually from a system of negotiated gas prices, which inevitably draws in politics, to a system where natural gas is priced transparently through markets.

Asia has not been so fortunate, and the reasons for this are not entirely clear. Asian natural gas prices are still tied closely to crude oil prices, normally through politically involved negotiations. Asian buyers still have fewer options for large-scale imports than European buyers do—key buyers, including Japan and Korea, do not have access to pipeline imports—which reduces their relative power. In addition, at the same time that European customers were gaining new leverage in 2011, Japan, the largest LNG importer in Asia, was paralyzed by the disaster at its Fukushima nuclear power plant. As that accident led to widespread nuclear shutdowns, Japan massively increased its demand for LNG to meet critical electricity needs. Japan, desperate to avoid further economic harm, was not in a position to negotiate aggressively with natural gas suppliers.

Many analysts in both the United States and Asia have speculated that U.S. entry into the Asian LNG market as a major supplier (along with others) could help create the conditions for a move toward market pricing of natural gas, or at least to a lessening of individual producers' market power and, hence, political influence. Predicting political influence is a near-impossible business, but to examine whether U.S. exports might help encourage such a transformation, it is useful to compare the potential magnitude of U.S. LNG deliveries to other important scales in the natural gas market. As of 2010, the world's top five LNG exporters were Qatar (8.2 bcf/d), Indonesia (3.3 bcf/d), Malaysia (3.3 bcf/d), Australia (2.7 bcf/d), and Nigeria (2.6 bcf/d) (IGU 2010). The top supplier to Japan was Indonesia (2.0 bcf/d), and the top supplier to Korea was Qatar (1.1 bcf/d). The spot market accounted for slightly more than a fifth of traded LNG, totaling slightly less than seven billion cubic feet a day.

All of these figures will increase in the future. EIA projections are far from definitive, but they are instructive. World natural gas production is projected to increase by 26 percent over the next decade (EIA 2011). Korean imports are expected to rise from to 4.1 billion cubic feet a day, while Japanese imports are

expected to hold fairly steady at their present level. Chinese imports, including pipeline gas, are expected to rise from a negligible amount to over nine billion cubic feet each day by the end of the decade, while daily Indian imports are expected to reach three billion cubic feet per day.

These figures suggest that U.S. LNG exports could become influential if they increased to toward the higher end of the range discussed thus far in this paper, and if exports were priced off the U.S. benchmark. The United States could potentially assume a large market share in several pivotal markets, and perhaps be dominant in one or more. This would give consumers greater leverage in their negotiations with other suppliers. At a minimum, by diversifying the pricing of their imports, it would partly insulate LNG importers from oil market fluctuations.

Potential U.S. exports might also be exploited for wider strategic gain under the right conditions. Current U.S. law makes approval of exports to markets with which the United States has free-trade agreements essentially automatic, but requires extensive review and subsequent approval for exports to others. This ought to give the United States leverage in broader trade negotiations with would-be importers. For example, Japanese officials and market participants have noticed that the recent U.S.-South Korea free-trade agreement will give South Korea special access to U.S. natural gas exports, and have inquired as to whether Japanese participation in the Trans-Pacific Partnership (TPP) trade arrangement would give them similar privileges (Interviews 2011). Regardless of whether Japanese and other policymakers are wise in wanting direct access to U.S. exports, this sort of dynamic can only strengthen the U.S. hand in international trade negotiations, which can lead to broader gains for U.S. consumers and firms.

Conversely, if the United States were to restrain LNG exports, it would almost certainly face wider trade-related problems. The consequences could be broad, affecting support for open trade in general, but they would likely have special impact on other resource-related disputes. Article XI of the General Agreement on Tariffs and Trade (GATT) prohibits sustained quantitative restrictions on energy exports unless they are related "to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption" (Selivanova 2007). U.S. policy would be the opposite: it would be made in conjunction with efforts to encourage both domestic production and consumption of natural gas.

Indeed, the United States has recently joined Europe and Japan in challenging Chinese restrictions on exports of rare earth metals—which are critical to a variety of defense, electronics, and energy technologies—at the World Trade Organization (WTO) (Palmer 2011). The arguments that the

United States would need to invoke in order to restrain LNG exports—particularly the prospects of environmental damage and harm to domestic industry—are precisely those that China would like to use to defend its own restrictions on rare earths exports; China could all but take the U.S. justification of curbs on LNG exports, change a few words, and use it in its own defense. It would likely be difficult for the United States to sustain limits to U.S. LNG exports while fighting Chinese limits on exports of rare earth metals.

Making U.S. curbs on LNG exports effective would also require actions that could precipitate significant conflict with Canada and Mexico. Even then, those curbs might be undermined. The North American natural gas market is tightly integrated. Constraints on U.S. LNG exports might thus be circumvented in a straightforward manner by sending natural gas by pipeline to Canada or Mexico before exporting it from there as LNG. In that case, the U.S. economy would suffer all the downsides of LNG exports (through higher prices and environmental risks from increased production), but would forgo most of the benefits (aside from small profits from new natural gas output).

The United States could, if it wished, attempt to block this export route: Chapter 6 of NAFTA allows the United States to require that any exports of natural gas to Canada or Mexico be consumed there so long as Washington “maintains a restriction” on exports of natural gas to some destinations outside North America (NAFTA 1993). This was written to facilitate the effective imposition of economic sanctions on specific countries, and the legality of its application in conjunction with a restrictive policy on LNG exports would be questionable. (There is no related case history upon which to base future expectations.) Independent of this legal question, the political fallout of such a move would likely be large—particularly with Canada—in the wake of the U.S. decision in early 2012 to deny a permit for the Keystone XL oil pipeline.

Even if the United States invoked its NAFTA privileges, the existence of otherwise integrated North American natural gas markets could undermine a U.S. effort to reap any benefits that might come from curbing LNG exports. Canada or Mexico could import U.S. natural gas by pipeline, consume it domestically, and export freed-up domestic natural gas as LNG. The United States would need to block pipeline exports in general to prevent this, creating severe political friction. Substantial cross-border natural gas pipeline capacity already exists, particularly between the United States and Canada: in 2011, an average of eleven billion cubic feet of natural gas

flowed across the border each day (EIA 2012d, EIA 2012e).¹³ Much of this capacity could ultimately be used to move U.S. natural gas to Canada, freeing up Canadian natural gas for export as LNG. As of 2009, roughly four billion cubic feet a day of capacity operated from the United States to Canada, and about three billion cubic feet a day of capacity ran to Mexico (EIA 2009b). Reversing additional pipelines would require modifications (such as new pumping stations) that would need to be approved by the U.S. FERC, which considers specific environmental risks as well as broader national interest issues in doing so (U.S. Department of State 2012). Obtaining approval has typically been a routine exercise; a pair of March 2011 applications to reverse pipeline flows and send gas from the Marcellus Shale (in Pennsylvania) to Canada were approved in October of that year (FERC 2011). Yet recent conflict over the Keystone XL oil pipeline, which was once also expected to face a routine regulatory process suggests that approval of future trans-border pipelines should not be taken for granted. That said, using the independent FERC

Conversely, if the United States were to restrain LNG exports, it would almost certainly face wider trade-related problems. The consequences could be broad, affecting support for open trade in general, but they would likely have special impact on other resource-related disputes.

to block exports to Canada and Mexico, thereby extensively fragmenting previously integrated markets, would be costly, both politically and potentially economically.

Ultimately, were the United States to restrain LNG exports while not blocking pipeline exports to Canada, the net impact would be to expose the United States to the downsides of LNG exports (particularly higher prices) while denying it most of the benefits (direct profits from trade as well as leverage in trade negotiations).

ENVIRONMENTAL IMPACTS

Shale gas production has attracted public criticism over environmental risks and local impacts. Allowing natural gas exports would expand production, which would only intensify that concern. Indeed, one need only look at the fight in 2011 over the Keystone XL pipeline, which would have transported diluted bitumen from Canada to Texas refineries in part to produce diesel fuel for sale abroad, to see that production

TABLE 1.

Costs and Benefits of Allowing Natural Gas Exports

		Benefits	Costs
What macroeconomic consequences would natural gas exports have?	Economic Output	Estimates suggest that the U.S. economy will gain up to \$4 billion annually from exports, primarily from overseas sales of increased natural gas production.	Exports raise the cost of natural gas, resulting in less domestic gas consumption, and hence less economic output in some sectors. Estimates suggest that these losses are in the range of \$500 million annually, primarily from reduced output in energy intensive industries.
	Current Account Balance	Total export revenues could be up to \$20 billion higher each year, but the current account balance is likely to be unchanged absent more fundamental shifts in savings and consumption.	
	Employment	Exports could create up to 8,000 near-term jobs in export facility construction. In the long run, they could also support up to 60,000 jobs in natural gas production and along the supply chain.	Estimates indicate that approximately 6,000 jobs could be lost in energy intensive industries in the long run due to higher natural gas prices. In the long run as the economy returns to full employment, job gains due to LNG exports will be offset by losses elsewhere in the economy for no net impact on employment.
	Price Volatility	Allowing exports could help link U.S. natural gas markets with world markets. This provides a buffer against domestic shocks.	Linking domestic and world natural gas markets could increase U.S. exposure to overseas shocks in natural gas prices.
What would the distributional impacts of natural gas exports be?	None	Exports are projected to slightly raise the cost of domestic natural gas. This would have a disproportionate effect on lower-income households, who would face additional costs that are estimated to be around \$50 annually.	
How would natural gas exports affect U.S. oil security?	None	Domestic natural gas could in principle be used as a substitute for oil. If exports are constrained, the United States would use marginally less oil in transport.	
What impact would natural gas exports have on climate change?	Natural gas exports could displace dirtier coal-fired power overseas. It could also, however, lead to greater energy consumption abroad by lowering energy costs.	Higher domestic prices would marginally weaken the incentive to displace coal-fired power in the United States, but would also lower U.S. electricity demand.	
What foreign policy consequences might natural gas exports entail?	U.S. exports could disrupt opaque and politically entangled natural gas markets, potentially reducing revenues to Russia, Iran, and others. Exports also give the United States new leverage in trade negotiations. Finally, allowing exports avoids creating major ruptures in NAFTA and WTO, including in the ongoing U.S. efforts to remove Chinese minerals export quotas.	None	
What would the local environmental consequences of natural gas exports be?	None	Increased shale gas production can have negative environmental consequences such as water contamination and local pollution in the absence of appropriate environmental regulation.	

of fossil fuels for export is a ripe target for many concerned communities and environmental advocates. Moreover, some economic simulations suggest that a large part of increased production spurred by export demand would be in the Northeast, where opposition to shale gas development has been strongest (EIA 2012c).

Traditional environmental concerns have focused primarily on potential contamination of aquifers by methane migration, fluids injected during the hydraulic fracturing (or “fracking”) process, and poor disposal of contaminated water produced from wells. Worries have also centered on the impacts to local infrastructure, particularly roads, and on large inward migration to productive areas, which has disrupted communities. These issues have become far more pronounced since 2010 as natural gas development has expanded from states that have long been home to large-scale drilling, such as Texas, Arkansas, and Oklahoma, to states without the same oil and gas culture, particularly Pennsylvania and potentially New York.

The potential economic gains from natural gas trade are small compared to the potential losses from a large-scale backlash against shale gas development. The consultancy IHS-CERA, in a study prepared for a natural gas industry group, estimated that shale gas development (including the industry itself along with its suppliers) had added \$51 billion to U.S. output in 2010, would add \$81 billion in 2015, and could contribute \$158 billion by 2035 (Bonakdarpour et al. 2011). This likely overestimates the supply side contribution of shale gas development, since it assumes that all net industry revenues represent new output,

but it also underestimates the demand side impact, since it does not account for the economic benefits of lower natural gas prices. Taking the CERA numbers at face value, six billion cubic feet of daily natural gas exports would increase the net contribution of shale gas to U.S. GDP by less than 5 percent. Shale gas production itself is far more valuable than natural gas exports.

The prospect of exports thus strongly reinforces the importance of ensuring that shale gas development proceeds in ways that gain the support of local communities and environmental skeptics. Specific measures for doing that are beyond the scope of this paper, but a long list of wise steps that should be taken can be found in a recent report of the Secretary of Energy Advisory Board Natural Gas Subcommittee, “Improving the Safety and Environmental Performance of Hydraulic Fracturing” (DOE 2011). It will be several years at the earliest until natural gas exports might commence; authorities should use the intervening time to ensure that gas development is done to the highest standard.

OVERALL COSTS AND BENEFITS

Table 1 summarizes the overall costs and benefits of allowing natural gas exports in six different dimensions, as discussed in this chapter. The colors in the table correspond to their net effects, with green indicating that the benefits outweigh the costs, and purple indicating the opposite. Stronger shades indicate items where the imbalance between cost and benefit is more pronounced. These considerations will all inform the policy proposal detailed in the next chapter.

Chapter 5: Natural Gas Export Policy

Recommendations

POLICY PROPOSAL: APPROVE PERMITS FOR LNG EXPORTS

In Chapter 4, I laid out a framework for consideration of the wisdom of allowing LNG exports. An examination of these components indicates that the benefits of allowing LNG exports outweigh the risks and costs, so long as downside risks to the local environment are mitigated, as discussed previously. Allowing exports would boost the U.S. economy, create jobs, reduce greenhouse-gas emissions, and create new geopolitical leverage for the United States. In particular, the likely benefits to the U.S. economy outweigh the benefits that would be realized by trapping natural gas in the United States in the hope that it will be used to replace oil. Barring exports would also weaken the U.S. hand in international trade diplomacy, including in the ongoing fight over Chinese restrictions on minerals exports. Strongly constraining U.S. gas exports would also require substantial interference in the currently integrated North American energy market, with the potential for economically and politically damaging fallout.

The most acute risks associated with allowing natural gas exports are distributional and environmental; both could also spur a backlash against natural gas production more broadly. Both can and should be mitigated, however, with appropriate policies, as outlined earlier. The details are largely beyond the scope of this paper, but options include the many steps outlined in DOE (2011), severance taxes or impact fees that fund infrastructure and regulatory capacity, and bonding requirements for drillers that help communities recover damages from bankrupt operators (Davis 2012).

I thus propose that, to facilitate potential natural gas exports, the DOE should approve applications for LNG exports to non-FTA countries that are pending before it, barring specific concerns about individual applications that are not related to the broader wisdom of allowing LNG exports. In doing so, the DOE is required to find that allowing exports is in the “public interest.” The framework outlined in this paper provides one way of presenting such an assessment.

The FERC must also approve modifications to terminals in order for exports to be allowed (Ebinger et al. 2012). I propose that it approve any applications to operate export terminals that have been approved by the DOE, barring problems with

individual applications that are unrelated to the broader wisdom of allowing LNG exports.

Implementing these steps will not require any new staffing, funding, or action by Congress, which has already put in place the legislative framework needed to approve and monitor LNG exports. Congress need only refrain from placing new statutory restrictions on LNG exports.

OTHER POLICY STEPS

Leverage Exports in Trade Talks

The prospect of further exports beyond those initially approved to non-FTA countries will be attractive to many potential importers, including Korea, Japan, India, and China. This will be the case even if the United States approves enough capacity to theoretically cover plausible export demands, since many firms that have received approval to export LNG may not actually succeed in building export facilities.

U.S. trade negotiators should use the prospect of preferential access to future exports in trade negotiations with those countries, which could create an opportunity to further increase the economic benefits to the United States of natural gas exports. In particular, the United States should make access to U.S. LNG a part of ongoing TPP negotiations with Japan, something Japan has signaled that it desires. The specific “asks” in return for preferential access should be determined by broader U.S. priorities in these negotiations. State Department diplomats should also emphasize the value of FTA access to U.S. LNG exports in their engagement with those Korean policy-makers who are skeptical of the U.S.-Korea Free Trade Agreement (KORUS).

Use Exports To Create More Transparent LNG Markets

The prospect of a more diverse LNG market—which U.S. entry as an exporter would contribute to—carries with it the prospect of introducing more transparent market-based pricing to gas trade, particularly in Asia. That would help disentangle natural gas trade from political relationships, particularly between Asian consumers and Middle Eastern suppliers, to the broader benefit of the United States. The U.S. government has limited influence over the geopolitical impact of LNG exports, but it can take several steps to improve the odds of success.

- **Maintain a preference for exports that are likely to use market-based pricing.** In selecting export permits to approve, the DOE should maintain a preference for applicants that foresee using transparent pricing based on U.S. (or emerging Asian) spot market prices (rather than traditional oil-linked pricing) in their contracts. Maintaining such a preference is consistent with the DOE mandate to approve only exports that are in the public interest.
- **Support widening of the Panama Canal if necessary.** The United States should provide any necessary support to the ongoing widening of the Panama Canal, which would lower the cost of U.S. LNG exports to Asia, and thus make them more likely and potentially more profitable. (LNG tankers departing the Gulf of Mexico or the East Coast of the United States currently need to travel all the way around South America to reach Asia, adding considerable cost to their trips and eroding potential gains from trade.) Slightly less than half of the Panama Canal Expansion Project is financed by governmental and intergovernmental institutions, including the Japan Bank for International Corporation (JBIC), the European Investment Bank (EIB), the Inter-American Development Bank (IDB), and the International Finance Corporation (IFC) (JBIC 2008). If additional public financing becomes necessary to successfully complete the project (currently an unlikely need), the United States should help ensure that financing is provided, either directly through the Export-Import Bank, or through its influence at the IDB and IFC.
- **Lead initiatives and studies on the importance of transparent international natural gas markets.** U.S. policymakers should also exploit available opportunities to promote transparent, market-based LNG trade. This would help the competitive position of U.S. exporters, who will likely be more transparent than many others, and leverage the new U.S. role in LNG markets for broader gain. There are no silver-bullet solutions here, but there are many opportunities to influence the political evolution of LNG trade at the margin. The DOE or State Department, for example, could fund an International Energy Agency (IEA) study of the benefits of transparent markets, and the United States could seek G8 or G20 agreement on increased transparency in LNG contracts and trade flows. U.S. diplomats, particularly in the new State Department Bureau of Energy and Natural Resources, should also maintain an active dialogue with their counterparts in Australia, the dominant LNG exporter in Asia and a potential partner in promoting transparent trade. At a minimum, this would enhance U.S. understanding of LNG market evolution; in principle, it might also reveal opportunities for focused cooperation.

Chapter 6: Questions and Concerns

WHAT HAPPENS IF GAS PRICES TURN OUT TO BE MORE OR LESS SENSITIVE THAN ASSUMED?

The analysis in this paper has focused on the potential for six billion cubic feet of daily natural gas exports. This is consistent with high end estimates of export potential by market analysts. It is also consistent with mainstream natural gas price projections: analysts widely expect such a volume of exports to largely close the gap between U.S. and overseas prices (net of liquefaction and transport costs).

If the current transformations under way in natural gas teach us anything, though, it is to be modest about our ability to predict the future course of energy markets. It is possible that U.S. natural gas prices could turn out to be either far more or far less sensitive to additional export demand than most assume.

If prices turned out to be far more sensitive to export demand than what was assumed in Chapter 4, the opportunity for exports would become correspondingly smaller, since the gap between U.S. and overseas prices would close quickly as export volumes rose. The potential benefits from exports would be lower as a result, but the potential downsides would fall, too. Exports would still remain attractive on balance, but their net value—economically and strategically—would be reduced.

More intriguing is the possibility that U.S. natural gas prices will turn out to be far less sensitive to export volumes than most expect. This might allow much larger quantities of exports. Deloitte (2011) projects a mere 12-cent increase in the price of a thousand cubic feet of natural gas were the United States to export six billion cubic feet of natural gas each day. Such high elasticity would likely mean that U.S. exports would rise until the gap between U.S. and overseas prices was fully closed, net of liquefaction and transport costs (including normal profits), through a combination of rising U.S. prices and falling prices overseas.

In this case, the macroeconomic benefits to the United States would be higher than those estimated above, both because of larger export volumes, and because export volumes would be sourced more from increased production than from decreased domestic use. The climate benefits might also be greater, because more natural gas would be available to displace coal overseas, and less would be drawn away from U.S. power

plants. And the geopolitical and trade policy benefits would be larger, since greater U.S. LNG exports would give U.S. exporters a more dominant position in overseas markets. On the flipside, the consumer consequences would not change: the price impact of exports would remain the same; it is only export volumes that would increase. The greatest risk from much larger exports would be to the local environment; greater exports would further reinforce the importance of ensuring that proper protections for water, air, and local communities were in place.

WHY ASSUME THAT PRICE SPREADS BETWEEN MARKETS WILL REMAIN LARGE?

Chapter 2 discussed the possibility that prices might converge across markets absent large-scale U.S. LNG exports. Indeed, one should not assume that prices will remain sharply divergent in the different regional markets—and one should not assume that large-scale exports will materialize. This does not, however, change the bottom lines. The possibility of price convergence absent U.S. LNG exports lessens the benefits of allowing those exports, since actual U.S. exports would not occur if all markets had similar gas prices. The United States would thus miss out on gains in economic output and jobs, and not have the same impact on global geopolitics or greenhouse-gas emissions. At the same time, the possibility of price convergence absent U.S. LNG exports also reduces the costs of allowing exports, since there would be no harm to domestic industry, consumers, or the environment if no exports took place. Moreover, regardless of whether exports materialize, the United States will suffer if rejecting export permits causes fallout for its broader international trade agenda. Allowing exports remains the right policy choice, even given the possibility that no or few exports will occur.

WHAT IMPACT WOULD GAS EXPORTS HAVE ON GOVERNMENT REVENUES?

Allowing natural gas exports would increase government revenues by raising taxable U.S. output. In addition, increased natural gas production resulting from exports would raise state revenues in places that are home to drilling. I estimated earlier that allowing six billion cubic feet of daily U.S. natural gas exports would increase net annual U.S. output by approximately \$4 billion. Assuming a 35 percent marginal tax

rate on corporate profits, this would raise approximately \$1.4 billion each year; in practice, since a part of the profits would accrue to individual property owners and workers who face lower rates, the net increase in revenues would be less. This total would, of course, be reduced if actual export volumes turned out to be lower.

Increases in state tax revenues would depend on the states in which production increased, but would total at most approximately \$400 million each year (based on the corporate tax rate for Pennsylvania, which is the highest among major gas-producing states). More significantly, increased production would also boost state revenues from severance taxes. Typical severance taxes in major producing states are on the order of 5 percent to 8 percent of sales revenues (Allegheny Conference 2009). A full six billion barrels a day of natural gas exports could thus be expected to generate increased severance tax revenues of \$1 billion to \$2 billion each year, including revenues from new production and larger revenues from existing production due to higher prices.

WHAT IMPACT WOULD GAS EXPORTS HAVE ON GAS-DEPENDENT INDUSTRY?

Cheap natural gas fuels industry in two important ways. Natural gas is extracted together with ethane, which is used as a feedstock in chemicals manufacturing. Natural gas can also be used to generate inexpensive electricity for heavy industry, such as steel production. Analysts and industry advocates have generally assumed that both industries would suffer as a result of exports.

This conclusion is likely incorrect for chemicals feedstocks. Natural gas production that results from allowing natural gas exports will lead to increased production of natural gas liquids (NGLs), including ethane, that are extracted with the gas. When natural gas is used for domestic consumption, those NGLs are removed and sold separately. If the fraction of NGLs in the gas produced is low enough, though, the NGLs may be left in the gas when it is shipped, reducing domestic ethane supplies. However, if the fraction of NGLs is high enough, at least some must be removed prior to shipping as LNG to avoid problems with liquefaction. Those separated NGLs are then available on the domestic market. Indeed, NGL production increases by between 5 and 10 percent for all twelve export scenarios explored in a recent EIA analysis of natural gas exports. This suggests that allowing natural gas exports will benefit, rather than harm, domestic chemicals manufacturers.

In contrast, energy intensive manufacturers like steel producers will likely be harmed by natural gas exports as a result of higher natural gas prices, though only by a small amount. Those damages are far more likely to hurt corporate profits than to affect decisions regarding whether to locate

plants in the United States. If natural gas exports raised domestic natural gas prices by \$1 per thousand cubic feet, that would raise the cost of producing a ton of steel using a new state-of-the-art facility by approximately \$8 (ABB 2011). That compares to typical steel prices on the order of \$800 per ton.

Further insight can be gained by following the approach used in Chapter 4 and comparing the electricity price increase due to LNG exports to that due to a carbon price. I noted earlier that the EIA (2012c) projects a long-run increase in commercial electricity prices of 1 percent to 2 percent due to six billion cubic feet of daily LNG exports. Aldy and Pizer (2009) estimate that an 8 percent increase in electricity prices would reduce glass production by 3.4 percent, paper by 3.3 percent, iron and steel by 2.7 percent, aluminum by 2 percent, and other industries' outputs by smaller amounts. This translates into output reductions of less than 1 percent in each of these energy intensive industries as a result of LNG exports. (Employment losses would be even lower.) This reduction would come primarily from lower consumption of energy-intensive goods rather than through loss of competitiveness. It is fully accounted for in the estimates of macroeconomic consequences of natural gas exports presented above.

WOULD ALLOWING EXPORTS DEplete U.S. NATURAL GAS RESOURCES?

The amount of natural gas in the ground is finite and fixed. By increasing present consumption, U.S. natural gas exports would reduce the amount of natural gas left. Some may worry that the United States could become dependent on imports at an undesirably early date if, due to excessive consumption, production began to fall sooner than it would have otherwise.

This is not a large problem. According to recent EIA (2012c) modeling, were the United States to export LNG at the highest rates discussed in this paper, it would produce as much natural gas in nineteen years as it otherwise would have in twenty. If U.S. reserves were far smaller to start with than that analysis assumes, prices would rise and the economic incentive to export would erode.

WHY NOT APPROVE LNG EXPORTS BUT LIMIT THEIR QUANTITIES?

Experts involved in discussions of LNG exports occasionally suggest that approving LNG exports in limited quantities (perhaps the five to six billion cubic feet per day that most experts project is the likely maximum in the next decade) could provide a foundation for political compromise. Limiting export volumes would limit possible domestic price increases, along with their consequences for consumers and energy-intensive industry. It would also put a cap on new shale gas development resulting from export demand, thus assuaging local environmental concerns. At the same time, limiting

LNG exports could close off opportunities for job creation at export facilities and for economic gains from new natural gas production and overseas sales. Moreover, the steps necessary to make any limits bind would still create problems for the United States within NAFTA and the WTO.

Regardless of the balance of costs and benefits associated with approving exports in limited quantities, there are practical difficulties associated with imposing a quota on exports. Such a quota would presumably be enforced by approving only a limited number of export permit applications. But how would the DOE choose which permits to approve? A “first-come, first-served” approach would likely lead to problems down the road when one or more of the approved facilities did not pan out. (Most firms that received permits to build LNG import facilities in the 1990s and 2000s were unable to put together viable business plans and financing schemes, and thus never reached actual construction.) Indeed, such an approach would likely prompt a stampede of applications from under-qualified operations. The DOE could evaluate applications and select those that it deemed to have the most promising business prospects, but this would be fraught with risk, ranging from weak DOE capacity to do such analysis to

inevitable accusations of decisions made based on political connections rather than merit. To be certain, there is some precedent for similar feasibility evaluations in the context of utility regulation, but the uncertain and immature nature of the LNG export business would make it difficult to translate this method to the present challenge.

In principle, these problems might be partly mitigated by auctioning off export permits. Companies would be forced to carefully scrutinize their own prospects before attempting to grab part of any export allowance. Yet the courts would likely consider this tantamount to an export tax. As noted above, though, federal export taxes are unconstitutional.

In practice, to the extent that allowing exports leads to potentially worrisome rises in domestic natural gas prices, exports are likely to be self-limiting without quotas. Strong increases in domestic prices will make exports less attractive overseas. Large export volumes would also reduce overseas prices. The combination would most likely close off additional exports before U.S. prices could rise too far. In essence, export quotas would become relevant when they would have little effect anyway.

Chapter 7: Conclusions

A revolution in U.S. natural gas production has forced policymakers to decide whether they should allow exports of LNG from the United States. They should say yes, within prudent limits, and leverage U.S. exports for broader gain. Yet the mere fact that the benefits of allowing exports would outweigh the costs does not mean that the political fight over allowing LNG exports will be tame. Operators of natural gas power plants will likely oppose exports, as will energy intensive manufacturers, though chemicals producers, if they are sufficiently enlightened, may take a more moderate stance. Most environmental advocates who are concerned with the local impacts of shale gas development will likely join in opposition, as will those who are convinced that gas should

be trapped for use in cars and trucks, and those who believe that any rise in consumer energy prices is unacceptable. The most prominent proponents of exports will likely be oil and gas companies and advocates of liberal trade, perhaps along with a broader group of foreign policy strategists that finds the prospect of disrupting relations between gas-producing and gas-consuming countries appealing, as well as supporters of renewable power who see cheap natural gas as competition (Schrag 2012). Any decision on LNG exports is likely to be controversial. Enlightened leadership and a strategy that mitigates downsides for poorer consumers and the local environment are essential to a smart strategy for constructively moving exports forward.

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Endnotes

1. Based on EIA (2012a) data for wellhead prices deflated with BLS (2012) CPI data.
2. Estimate based on \$4 gas price, \$4 for liquefaction, shipping, and regasification, and \$15 sale price. If one assumes that the full difference between U.S. and overseas prices is captured by U.S. producers, the estimated U.S. surplus is \$20 billion. Contracts already concluded make clear, however, that the surplus will be divided between buyer, seller, and middlemen (such as shippers); in addition, prices in distant markets should fall due to trade.
3. This competition is not entirely based on simple economics, since many consuming countries do not have pure market economies, but economics plays a central role.
4. Based on a simple energy equivalence calculation. If GTL were used, a substantial efficiency penalty would increase the amount of natural gas needed.
5. Imagine, for example, that natural gas was used to displace oil through conversion of gas to liquid fuels (GTL). Jaramillo et al (2008) estimate that capital and operating costs would total about \$20 per barrel of petroleum products produced. With natural gas priced at \$5/MMBtu, the gas needed to operate the GTL facility would cost roughly another \$20 per barrel of products (Jaramillo et al 2008; author's calculations). Even if all economic opportunities to convert natural gas to liquids were exploited, U.S. natural gas prices would thus remain about \$6-\$7/MMBtu below oil prices — certainly a wide enough gap to keep LNG exports attractive. A similar pattern should be expected for compressed natural gas vehicles, which are more expensive than conventional cars and trucks.
6. Most of the projects already have terminals built; one of the projects, at Jordan Cove, has not yet built an import terminal, but its backer had invested substantial effort in developing the project prior to the emergence of the U.S. natural gas glut.
7. This and all other estimates of gains and losses from exports are based on the simple assumption that the price paid to domestic gas producers is equal to their marginal cost of production, and the price paid by domestic consumers is equal to their marginal benefit from consumption.
8. To reach this estimate, I infer from the IHS (2011, pp. 15, 20) projections of shale gas output and employment from 2010 to 2030 that each increase of 1 bcf/d in natural gas production supports approximately 5,300 jobs in the oil and gas industry, and about 8,900 indirect jobs along the supply chain.
9. A thousand cubic feet of natural gas has roughly the same energy content as 0.17 barrels of oil. Assuming a typical conversion efficiency of 60 percent results in the reported figure.
10. This is based on an assumed energy penalty of 15 percent for CNG.
11. This estimate depends on the natural gas price impact of gas exports — and the cost of moving natural gas into CNG vehicles. The greater the price impact of gas exports, the larger the likely profits to the United States from exports; the same drivers of that dynamic would also imply larger costs for producing natural gas for use in cars and trucks. The cost of moving natural gas into CNG vehicles is also important to the net assessment, since it offsets the external benefit of any shift in that direction.
12. Emissions from natural gas are assumed to be 53 kgCO₂/MMBtu.
13. This figure is gross, not net, since I am interested in knowing total pipeline capacity. Pipelines between the United States and Canada do not generally switch direction during the year.

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Highlights

Michael Levi of the Council on Foreign Relations weighs the economic and other benefits of liquefied natural gas (LNG) exports against the costs, and argues that the upsides of allowing LNG exports outweigh the downsides, providing that the U.S. government takes steps to mitigate risks to the local environment and low-income consumers. Levi proposes that the United States should allow exports of LNG, and offers recommendations for using access to exports to advance U.S. foreign and trade policy goals.

The Proposal

Apply a broad framework to assess the wisdom of liquefied natural gas exports. Federal regulators and lawmakers can determine the potential impacts of applications for natural gas exports by considering the following six questions:

- What macroeconomic consequences would natural gas exports have?
- What would the distributional impacts of natural gas exports be?
- How would natural gas exports affect U.S. oil security?
- What impact would natural gas exports have on climate change?
- What foreign policy consequences might natural gas exports entail?
- What would the local environmental consequences of natural gas exports be?

Unlock the gains from trade created by natural gas exports. Allowing LNG exports will allow U.S. producers and workers to extract additional natural gas and sell it overseas at higher prices, bringing economic benefits to the United States. Blocking exports could have consequences for broader U.S. access to foreign markets, damaging U.S. growth. Therefore, the Department of Energy should approve current applications to export LNG, and the Federal Energy Regulatory Commission should approve applications to build or modify export terminals.

Benefits

Using his framework, Levi estimates that allowing exports of LNG could result in roughly \$4 billion in gains from trade annually, and bolster U.S. leverage in trade negotiations. Pushing for more transparent natural gas markets could reduce international dependence on the small group of countries that currently provide most natural gas. Finally, allowing exports of LNG would enhance ongoing U.S. efforts to promote access for U.S. firms and workers to other markets.



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