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HOW MUCH HAS SHALE GAS SAVED U.S. CONSUMERS?

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ABSTRACT

It may seem like a distant memory now, but as of the mid-2000s, U.S. natural gas production had been flat for a decade, and the U.S. was importing liquefied natural gas (LNG), with plans to import much more. Then shale gas happened. Advances in hydraulic fracturing and horizontal drilling caused U.S. natural gas production to increase significantly, and the U.S. went from being a net importer of natural gas to being the world's largest exporter. This paper calculates how much shale gas has saved U.S. natural gas consumers. Using price differences between the United States, Europe and Japan, we calculate that U.S. natural gas consumers have saved \$3.1-\$4.3 trillion between 2007 and 2025, equivalent to \$164-\$227 billion annually. Access to low-price U.S. natural gas has been particularly valuable during major supply shocks such as the war in Ukraine, and the benefits of shale gas have been experienced broadly across sectors and states.

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1 Introduction

It may seem like a distant memory now, but back in the mid 2000s, U.S. natural gas production had been flat for a decade, and the U.S. was importing liquefied natural gas (LNG), with plans to import much more. As of February 2007, there were four additional U.S. LNG import terminals under construction and another 10 U.S. LNG import terminals had received approval from FERC.[1]

Then shale gas happened. Advances in hydraulic fracturing and horizontal drilling opened up vast new areas to development and dramatically increased U.S. natural gas production. Figure 1 plots monthly U.S. natural gas production. Since Daniel Yergin and Robert Ineson wrote about "America's Natural Gas Revolution" in the Wall Street Journal in November 2009, U.S. natural gas production has approximately doubled, driven overwhelmingly by shale gas.

Along the way, the United States went from being a net importer of natural gas to the world's largest exporter. The United States has been the world's largest LNG exporter since 2022, and in 2025, the United States exported 9 billion Mcf of natural gas.[2]

This paper calculates how much shale gas has saved U.S. natural gas consumers. We first compare natural gas prices in the United States, Europe, and Japan. Prices diverged sharply in 2007, just as shale gas was accelerating. The paper then uses these price differences, together with information about U.S. natural gas consumption, to calculate various

[1]U.S. Department of Energy, Energy Information Administration, "U.S. Natural Gas Imports and Exports: Issues and Trends 2005", released February 2007.

[2]U.S. Department of Energy, Energy Information Administration, "The United States Became the World's Largest LNG Exporter in the First Half of 2022", July 25, 2022. U.S. Department of Energy, Energy Information Administration, "U.S. Natural Gas Exports". These exports include both pipeline and LNG. In 2025, LNG exports were 61% of total U.S. natural gas exports, with the rest exported via pipeline to Canada and Mexico. U.S. Department of Energy, Energy Information Administration, "International Energy Portal" lists the top five natural gas exporters for 2024 as United States (7.7 billion Mcf), Russia (5.2), Norway (4.5), Qatar (4.4), and Australia (3.7).

measures of savings.

The paper finds that U.S. natural gas consumers have saved \$3.1-\$4.3 trillion since 2007, equivalent to \$164-\$227 billion annually.[3] These large savings reflect that the U.S. natural gas market is very large. U.S. natural gas consumers now use 30 billion Mcf of natural gas annually. Combine this high level of consumption with price differences that have averaged \$9-\$11 per Mcf, and it makes sense that the savings from shale gas would be very large.

The paper then examines the pattern of savings across sectors and geography. Natural gas consumers include electric power, industrial, residential, and commercial. We find that 39% of savings went to electric power customers, with 30%, 18%, and 13% for industrial, residential, and commercial customers, respectively. In terms of geography, Texas has saved more than any other state, and Louisiana has saved the most per capita.

We are aware of only two other papers that calculate how much shale gas has saved U.S. consumers, both written over a decade ago. Mason et al. (2015) assume a constant price elasticity of demand of -0.5 to calculate that the 26% increase in U.S. natural gas production between 2007 and 2014 implies \$71 billion in increased consumer surplus for 2014.[4] Hausman and Kellogg (2015) estimate supply and demand elasticities to calculate that shale gas increased consumer surplus by \$101 billion in 2013.[5] Our calculation of savings is about twice as large. U.S. natural gas consumption has grown 34% since those papers were written, increasing savings proportionally. But more importantly, the larger mag-

[3] All dollar amounts in the paper have been normalized to reflect USD 2025 using the CPI All Items.

[4] Mason et al. (2015) calculate \$4.36 billion (USD 2015) for increased consumer surplus in January 2014, equivalent to \$71 billion annually (USD 2025).

[5] Hausman and Kellogg (2015) use their estimated elasticities to calculate what the price would have been in 2013 (their base year) without the expansion in supply. They conclude that shale gas reduced U.S. natural gas prices in 2013 by \$3.45 per Mcf (equivalent to \$4.70 in USD 2025), with consumer surplus increasing \$74 billion in USD 2013 (equivalent to \$101 billion in USD 2025).

nitude reflects our alternative approach, which uses prices in Europe and Japan as the counterfactual.

The underlying assumption in our calculations is that without shale gas, the U.S. would have been importing LNG and thus U.S. consumers would have been paying the prices observed in Europe or Japan. This does not require any specific assumption about the counterfactual path for U.S. gas production, but it does assume sufficient scarcity of natural gas that the *marginal* unit would have been supplied by LNG in all years.

This is a strong assumption. U.S. LNG imports were growing prior to shale gas but still a tiny share of the market. It is certainly possible that, without shale gas, weak U.S. supply and strong U.S. demand would have led to sharply increasing U.S. LNG imports. But the opposite is also possible. Conventional U.S. natural gas production could have increased or U.S. demand could have decreased, making LNG imports unnecessary, in which case the estimates from Mason et al. (2015) and Hausman and Kellogg (2015) are more appropriate.

This paper contributes to the broader economic literature on shale gas. Previous research has examined, for example, the impact of shale gas on the housing market (Muehlenbachs et al., 2015; Bartik et al., 2019), the labor market (Feyrer et al., 2017), induced innovation (Acemoglu et al., 2023; Dugoua and Gerarden, 2025), the displacement of coal-fired electricity generation (e.g., Knittel et al., 2016; Cullen and Mansur, 2017; Fell and Kaffine, 2018; Linn and Muehlenbachs, 2018), and the mortality impacts of reduced winter heating costs (Chirakijja et al., 2024).

2 Price Differences

Figure 2 plots natural gas prices in the U.S., Europe, and Japan. Between 1995 and 2006, prices followed each other reasonably closely. During that period, prices for Europe and Japan were both within $1 per Mcf of the U.S. price, on average. See Table 1.

Then prices diverged sharply. Every single month between 2007 and 2025, the U.S. price was below or equal to the price in Europe and Japan. Relative to Europe, U.S. prices have averaged $9 lower per Mcf. Relative to Japan, U.S. prices have averaged $11 lower.

Shale gas is the single best explanation for the persistent price differences since 2007. The timing of the divergence closely corresponds with the growth of shale gas, with price differences appearing right at the inflection point for U.S. natural gas production. Prices also reflect other demand and supply shocks. For example, the large spike in European natural gas prices in 2022 reflects the Russian invasion of Ukraine in February 2022.

Prices do not equalize due to transportation constraints. Natural gas takes up a lot of space, so it must be transported by pipeline or cooled to -162°C to liquefy it for ship transport. Several U.S. LNG export facilities came online starting in 2016 and have been operating near 100% utilization, but that was not enough to equate natural gas prices between the United States and the rest of the world. More U.S. LNG export facilities are coming. U.S. exporters have announced new facilities that would double U.S. LNG export capacity by 2029.[6] Increased U.S. LNG exports will put downward pressure on prices in Europe and Japan and upward pressure on U.S. prices.

[6] U.S. Department of Energy, Energy Information Administration, "North America's LNG export capacity could more than double by 2029", October 26, 2025.

3 Savings for U.S. Consumers

U.S. natural gas consumers have benefited enormously from low-price natural gas. We calculate the increase in consumer surplus using a constant elasticity demand function with elasticities -0.25 and -0.5, following Mason et al. (2015) and Hausman and Kellogg (2015).[7] Thus these calculations take into account that in a counterfactual without shale gas, higher prices would have reduced demand relative to what has been observed 2007-2025. Annual data on U.S. natural gas consumption by sector comes from U.S. Department of Energy, Energy Information Administration.[8]

Table 2 reports total and average savings under various assumptions. We calculate that shale gas has saved U.S. natural gas consumers a total of $3.1-$4.3 trillion since 2007. This is equivalent to $164-$227 billion annually, or $494-$685 annually per capita. Savings are 16% higher when calculated relative to the price in Japan, reflecting the higher average price differentials, and savings are 17% lower when using the -0.5 demand elasticity rather than -0.25.[9]

As a point of comparison, LED light bulbs have been calculated to have the potential to save U.S. consumers $72 billion annually.[10] LED light bulbs use 80% less electricity than

[7]Mason et al. (2015) use a constant elasticity demand function with an elasticity of -0.5 and Hausman and Kellogg (2015) use a constant elasticity demand function with elasticities of -0.20, -0.23, -0.57, and -0.47 for the residential, commercial, industrial, and electric power sectors, respectively. Our elasticities -0.25 and -0.5 approximately bound this range. See the online appendix for additional details and year-by-year calculations for the -0.5 case.

[8]We use U.S. Department of Energy, Energy Information Administration, "Natural Gas Delivered to Consumers". The EIA also tracks "Total Consumption" but we prefer natural gas delivered to consumers because it excludes pipeline and distribution use including gas burned by compressors to move gas through pipelines, distribution leaks, and otherwise unaccounted for volumes.

[9]We have also considered two alternative specifications: (1) perfectly inelastic demand and (2) demand fixed at 2006 levels. Under (1) calculated savings are 22% larger than with demand elasticity -0.25. Under (2) calculated savings are similar to the estimates in Table 2, about halfway between the savings with demand elasticity -0.25 and -0.5. See the online appendix for details.

[10]U.S. Department of Energy, Energy Efficiency and Renewable Energy, "Adoption of LEDs in Common Lighting Applications", August 2020. Their calculation is based on 100% saturation of LED lightbulbs

traditional incandescents, have been called a “once in a century disrupter” and were the basis of the 2014 Nobel Prize in Chemistry. We are finding that the annual savings from shale gas are about 3 times larger.

Figure 3 plots annual savings per capita by sector. We find that 39% of savings went to electric power customers, compared to 30%, 18% and 13% for industrial, residential, and commercial customers, respectively. The pattern for electric power highlights the large savings in the Southeast, where states like Mississippi have a particularly high per capita level of natural gas used in electricity generation. The pattern for the industrial sector highlights Louisiana, a state with a high concentration of petrochemical production and petroleum refining. For residential and commercial customers, the pattern reflects the natural gas used for heating, which is particularly common in the upper Midwest.

This geographic pattern is calculated based on state-level consumption of natural gas. This makes sense for the residential and commercial sectors because natural gas is used primarily for space heating, which is then enjoyed at the same location. But it makes less sense for the electric power and industrial sectors. Electricity generated in one state is often consumed in another state. Similarly, fertilizers, chemicals, and plastics produced in one state are often consumed throughout the United States and beyond.

Relatedly, an implicit assumption in these calculations is that natural gas prices pass through to retail prices. Hausman and Kellogg (2015) document one-to-one pass-through for natural gas retail prices but close to zero pass-through for ammonia and plastic. Their results suggest that for globally-traded commodities such as ammonia and plastic, the benefits of low-price natural gas have likely gone mostly to U.S. manufacturers.

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throughout all residential and commercial applications, assumes no rebound effect, and calculates savings using retail electricity prices. The report calculates total savings of \$56 billion (2018 USD), equivalent to \$72 billion (2025 USD).

4 Discussion

Our approach for calculating savings is simple, transparent, and supported by the evidence presented earlier with regard to U.S. LNG imports and the lack of price differences prior to 2007. However, several important caveats are in order.

First, these calculations assume that in the counterfactual without shale gas, the prices in Europe and Japan would not have changed. But, had the U.S. been importing LNG, that would have pushed those prices further upward, resulting in even larger measures of savings. Quantifying this effect would require understanding the long-run supply curve for natural gas in LNG exporting countries. We do not attempt to model this explicitly, but it is worth emphasizing again that this would increase calculated savings.

Second, and relatedly, these calculations ignore that the observed non-U.S. prices reflect U.S. LNG exports. For example, were it not for U.S. LNG exports, prices in Europe and Japan would have gone even higher in 2022 with the Ukraine war. We do not attempt to model this explicitly, but this would further increase the calculated savings from shale gas, particularly after 2016 as U.S. LNG exports increased.

Finally, and most importantly, these calculations ignore environmental impacts. A comprehensive analysis of the broader welfare impacts of shale gas would incorporate direct effects of shale gas including groundwater contamination (Hill and Ma, 2022) and methane leaks (Sherwin et al., 2024), indirect effects of natural gas displacing other forms of energy with higher or lower carbon intensity (e.g., Knittel et al., 2016), and possible longer-run impacts on clean-energy innovation (Acemoglu et al., 2023). A recent paper looks at the related question of the carbon impacts of U.S. LNG exports (Abuin, 2025), but more research is needed.

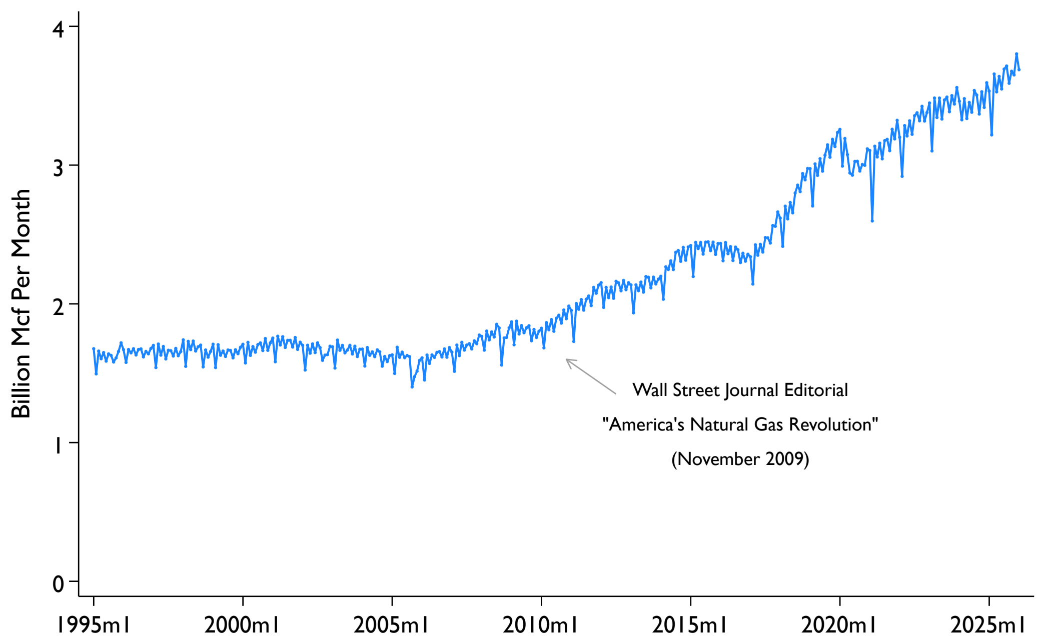
5 Conclusion

Shale gas was initially hailed as a “revolution”, yet by 2026, we almost take for granted the vast amounts of natural gas production made possible by advances in hydraulic fracturing and related technologies. As with many innovations, nobody was talking about it, then everyone was talking about it, and then it became commonplace.

Major supply shocks are an important reminder. The war in Ukraine sent natural gas prices through the roof in Europe, while U.S. prices increased only modestly. The Iran war is similar. Our data do not include 2026, but prices in Europe and Japan doubled in the first 10 days of March 2026, and attacks on LNG infrastructure in Qatar and elsewhere pushed prices up further. In contrast, U.S. prices barely budged. This insulation from major supply shocks is, in a large way, the result of shale gas.

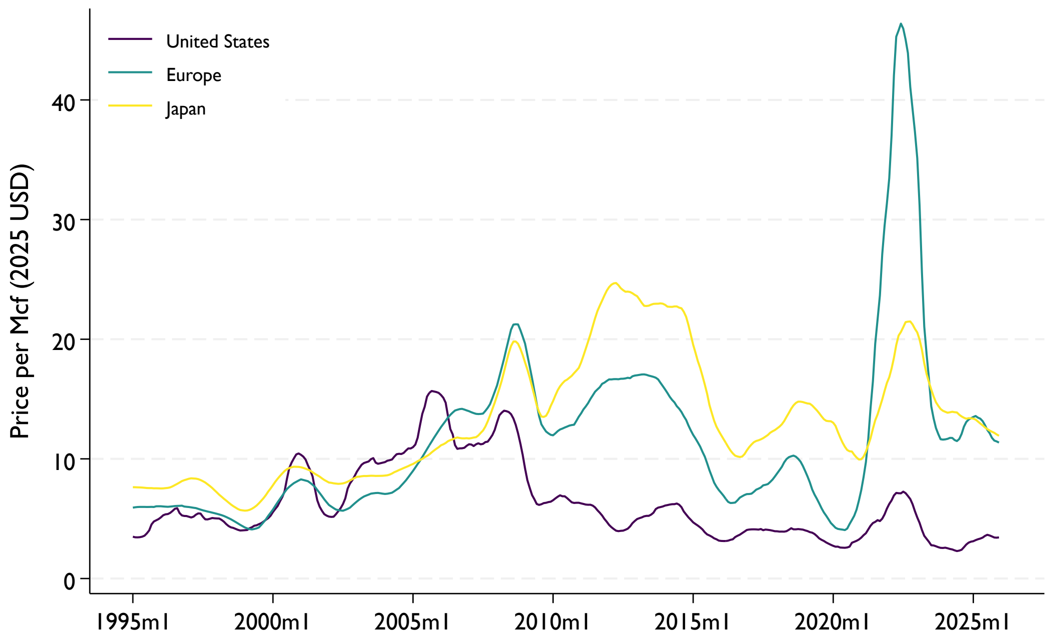
The economic benefits of shale gas have been widely enjoyed by virtually everyone in the United States. If you heat your home with natural gas and use a lot of electricity, plastic and fertilizer then you have benefited more than average. However, because natural gas is an important input into so many production processes, it is not an exaggeration to say that every single person in the U.S. has enjoyed lower prices because of shale gas.

Figure 1: U.S. Natural Gas Production



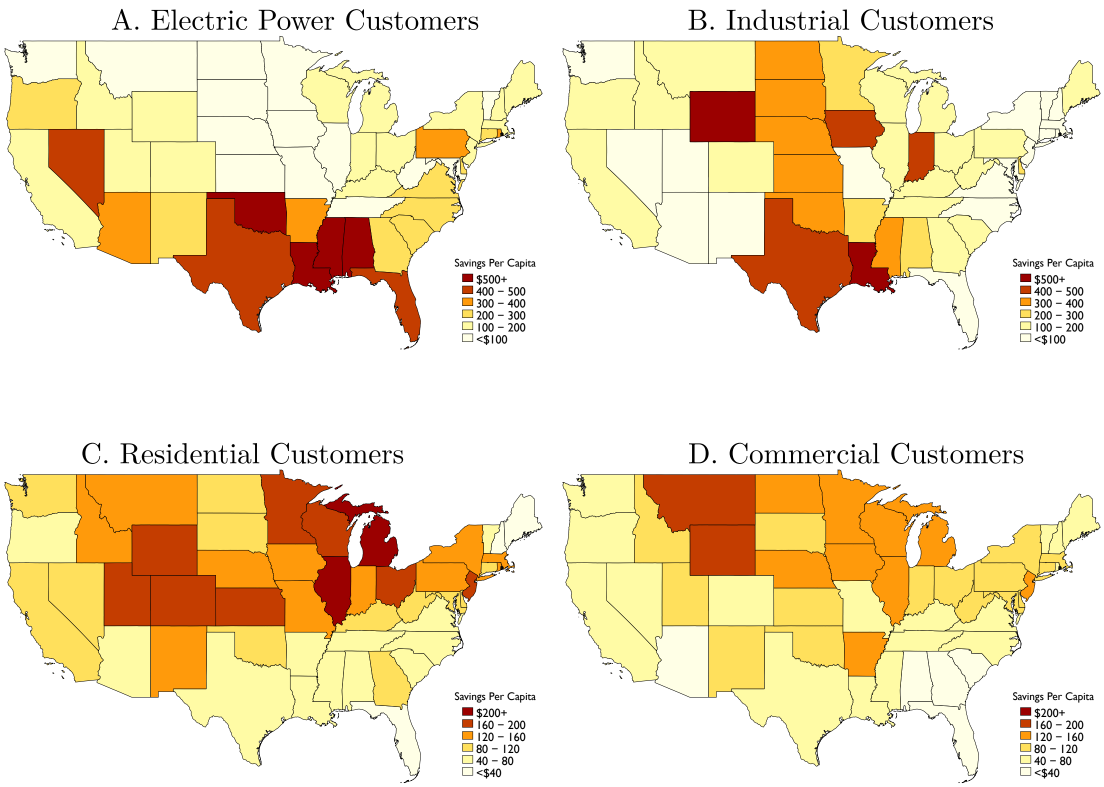
Notes: This figure plots monthly data from U.S. Department of Energy, Energy Information Administration, “U.S. Natural Gas Marketed Production”.

Figure 2: Natural Gas Prices in the U.S., Europe and Japan



Notes: This figure plots 12-month rolling averages based on monthly data from the World Bank, Commodity Markets Outlook, Historical Data, "Pink Sheet". The three price benchmarks are (1) U.S. natural gas prices at Henry Hub, (2) European natural gas prices at Netherlands Title Transfer Facility, and (3) LNG import prices in Japan. Prices have been normalized to reflect 2025 dollars.

Figure 3: Annual Savings Per Capita, By Sector



Notes: These maps plot annual savings per capita by sector, averaged over the period 2007-2025, relative to the price in Europe assuming a demand elasticity of -0.5. Overall, 39%, 30%, 18%, and 13% of savings went to electric power, industrial, residential, and commercial customers, respectively. See appendix tables 3 and 4 for calculated savings by sector and state.

Table 1: Natural Gas Prices in the U.S., Europe & Japan

	U.S.	Europe	Japan
Pre-Shale (1995-2006)	7.7	7.3	8.5
Post-Shale (2007-2025)	5.3	14.4	16.1

Note: This table reports average natural gas prices per Mcf for three price benchmarks. Monthly data from the three price benchmarks come from the World Bank, Commodity Markets Outlook, Historical Data, "Pink Sheet". Prices have been normalized to reflect 2025 dollars.

Table 2: Savings for U.S. Consumers, 2007-2025

	(1)	(2)	(3)	(4)
	Demand Elasticity -0.25		Demand Elasticity -0.5	
	Relative to Europe	Relative to Japan	Relative to Europe	Relative to Japan
Total Savings (in Trillions)	$3.7	$4.3	$3.1	$3.6
Average Annual Savings (in Billions)	$196	$227	$164	$189
Average Annual Savings Per Capita	$590	$685	$494	$569

Note: Annual savings were calculated using a constant elasticity demand function with elasticities -0.25 and -0.5, relative to prices in Europe and Japan, as indicated in the column headings. Annual data on U.S. natural gas consumption comes from U.S. Department of Energy, Energy Information Administration, "Natural Gas Delivered to Consumers". Per capita savings were calculated using the U.S. population as of 2020. Dollar values have been normalized to reflect 2025 dollars.

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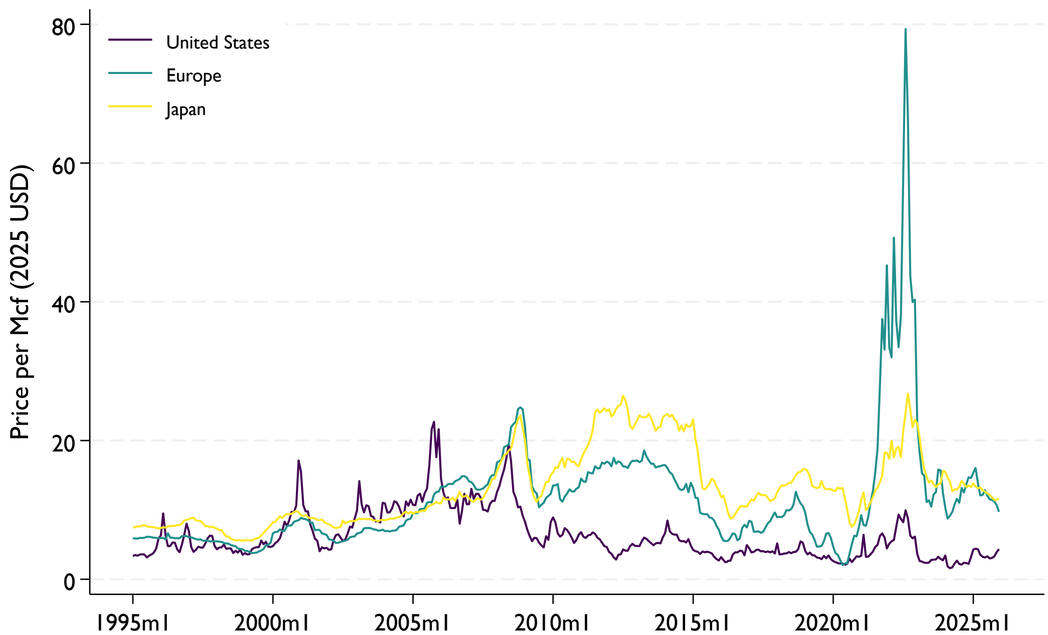
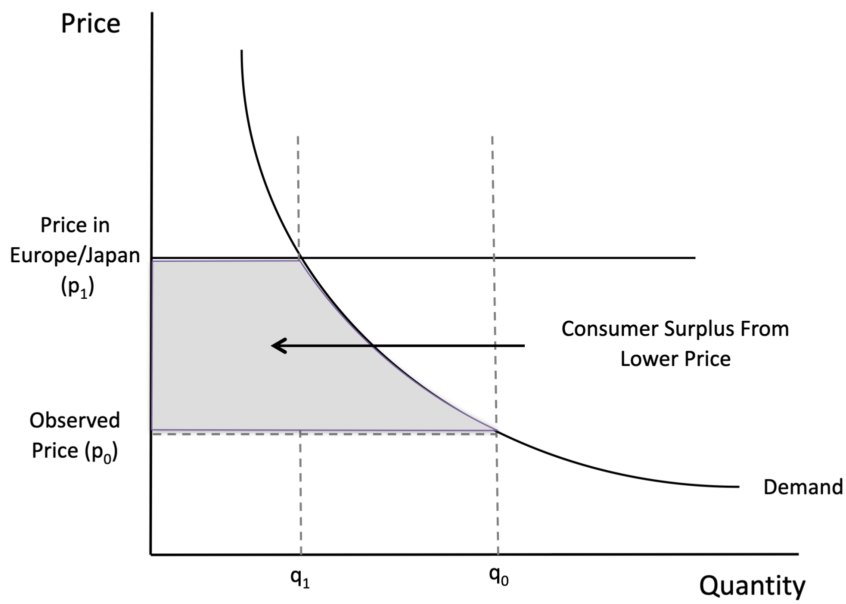
Appendix Figure 1: Natural Gas Prices in the U.S., Europe and Japan, Without Smoothing

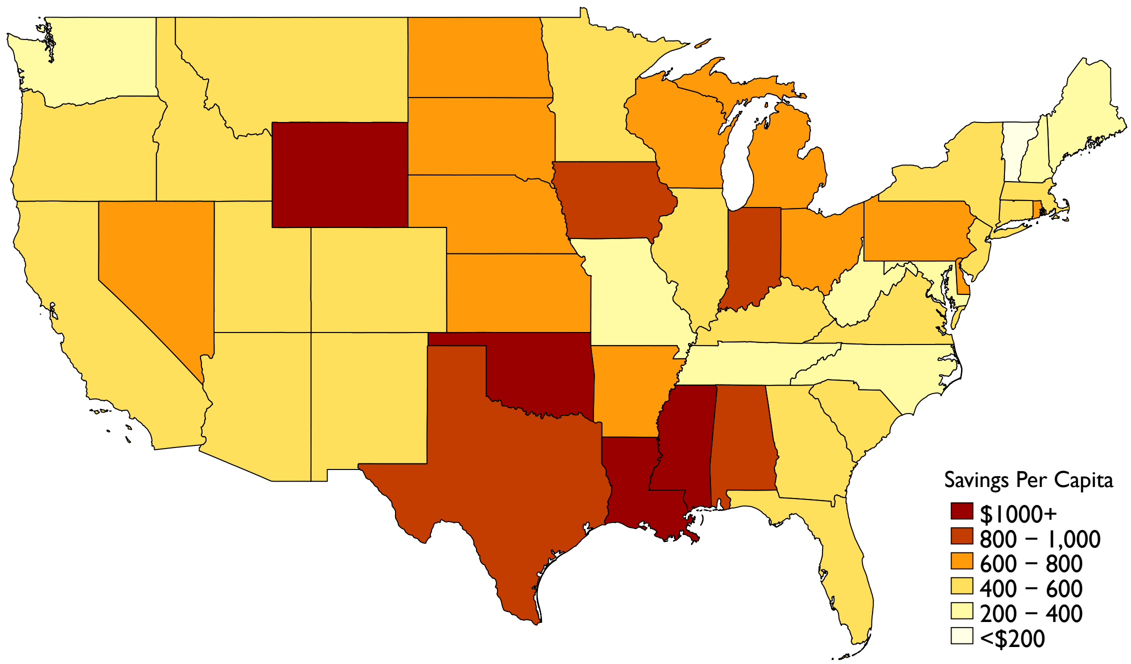


Notes: This figure is identical to Figure 2 except it plots raw monthly prices rather than 12-month rolling averages. As with the figure in the paper, prices have been normalized to reflect 2025 dollars.

Appendix Figure 2: Consumer Surplus From Lower Price



Appendix Figure 3: Annual Savings Per Capita, Across All Sectors



Notes: This map is similar to Figure 3 but plots total savings per capita by state 2007-2025, rather than sector-by-sector. As with the figure in the paper, savings are calculated relative to the price in Europe assuming a demand elasticity of -0.5. Louisiana and Mississippi have the highest savings per capita due to the large amount of natural gas used in those states by electric power and industrial customers. States with the lowest savings per capita include Vermont, New Hampshire, and Maine, which have relatively little natural gas consumption in the electric power or industrial sectors and historically have used more heating oil than natural gas for heating.

Appendix Table 1: Consumer Surplus Calculations Year-by-Year

Year	Price in the U.S. ($ per Mcf)	Price in Europe ($ per Mcf)	Observed Deliveries to Consumers (billions Mcf)	Counterfactual Deliveries to Consumers (billions Mcf)	Consumer Surplus ($ billions)
2007	11.3	13.8	21.3	19.2	51
2008	13.7	20.8	21.4	17.4	136
2009	6.2	13.6	21.0	14.1	125
2010	6.7	12.7	22.1	16.1	111
2011	5.9	15.6	22.5	13.9	166
2012	4.0	16.7	23.4	11.5	195
2013	5.3	16.9	23.8	13.4	198
2014	6.2	14.2	24.4	16.1	155
2015	3.7	9.6	25.0	15.5	113
2016	3.5	6.4	25.2	18.6	62
2017	4.0	7.8	24.8	17.9	78
2018	4.2	10.2	27.6	17.7	130
2019	3.4	6.3	28.3	20.7	70
2020	2.6	4.2	27.7	21.9	39
2021	4.7	19.6	27.7	13.6	271
2022	7.3	46.0	29.2	11.6	642
2023	2.8	14.4	29.4	12.9	209
2024	2.3	11.7	29.8	13.3	172
2025	3.7	12.4	30.2	16.4	186
Average	**5.3**	**14.4**	**25.5**	**15.9**	**164**

Note: This table provides year-by-year calculations for consumer surplus relative to the price in Europe based on an assumed demand elasticity of -0.5.

Appendix Table 2: Annual Savings for U.S. Consumers, Alternative Specifications

	(1)	(2)	(3)	(4)
	Demand Perfectly Inelastic		Quantity Fixed at 2006 Levels	
	Relative to Europe	Relative to Japan	Relative to Europe	Relative to Japan
Total Savings (in Trillions)	\$4.5	\$5.3	\$3.4	\$4.1
Average Annual Savings (in Billions)	\$237	\$276	\$180	\$215
Average Annual Savings Per Capita	\$716	\$834	\$543	\$649

Note: The calculations in columns (1) and (2) assume that U.S. demand for natural gas is perfectly inelastic. Thus, consumer surplus is a rectangle with height equal to the price difference and width equal to total U.S. natural gas deliveries. We use price difference between the U.S. and one of the two other price benchmarks, as indicated in the column headings. For example, in 2025 total U.S. gas deliveries to consumers were 30 billion Mcf, and U.S. natural gas prices averaged \$8.7 per Mcf lower than European natural gas prices, so the implied savings for 2025 were \$261 billion. Annual savings in columns (3) and (4) were calculated similarly but using U.S. natural gas deliveries as of 2006. In 2006 total U.S. gas deliveries to consumers were 20 billion Mcf, which is 34% lower than 2025 deliveries. Per capita savings were calculated using the U.S. population as of 2020. Dollar values have been normalized to reflect 2025 dollars.

Appendix Table 3: Annual Savings By Sector in Billions, 2007-2025

	(1)	(2)	(3)	(4)
	Demand Elasticity -0.25		Demand Elasticity -0.5	
	Relative to Europe	Relative to Japan	Relative to Europe	Relative to Japan
Electric Power Customers	\$76	\$87	\$64	\$72
Industrial Customers	\$59	\$69	\$49	\$57
Residential Customers	\$36	\$42	\$30	\$35
Commercial Customers	\$25	\$29	\$21	\$24
Total	**\$196**	**\$227**	**\$164**	**\$189**

Note: This table reports annual savings by sector in billions (USD 2025). Calculations are identical to Table 2, but done sector-by-sector. EIA also tracks a fifth category of customer "vehicle fuel delivered" but this category is very small and has been combined with commercial customers.

Appendix Table 4: Annual Savings By State in Billions, 2007-2025

	(1)	(2)	(3)	(4)
	Demand Elasticity -0.25		Demand Elasticity -0.5	
	Relative to Europe	Relative to Japan	Relative to Europe	Relative to Japan
1. Texas	\$28	\$33	\$24	\$27
2. California	\$16	\$19	\$13	\$16
3. Louisiana	\$11	\$12	\$9	\$10
4. Florida	\$10	\$12	\$9	\$10
5. New York	\$9	\$11	\$8	\$9
6. Pennsylvania	\$9	\$10	\$8	\$8
7. Ohio	\$8	\$9	\$7	\$7
8. Illinois	\$8	\$9	\$6	\$8
9. Michigan	\$7	\$8	\$6	\$6
10. Indiana	\$6	\$7	\$5	\$5
All Other States	\$84	\$97	\$70	\$81

Note: This table reports annual savings for the top ten states in billions (USD 2025). Calculations are identical to Table 2, but done state-by-state using EIA data on natural gas deliveries by state.

A Additional Details About Calculating Consumer Surplus

We calculate the increase in consumer surplus using a constant elasticity demand function with elasticities -0.25 and -0.5. In particular, we assume that U.S. demand for natural gas is described using a constant elasticity demand function, $q = Ap^{\epsilon}$ with a scale parameter A that varies across years, price p, and elasticity ϵ.

Let p_0 and p_1 denote the observed price and the counterfactual price, respectively, and let q_0 and q_1 denote the observed and counterfactual quantities.

The demand function is used to predict the deliveries to consumers under counterfactual prices and to calculate the change in consumer surplus. We first calculate the scale parameter (A) for each year, using the assumed demand elasticity (ϵ) and the observed price (p_0) and deliveries to consumers (q_0).

We then use the demand function, including the calculated scale parameter (A), to predict q_1. The change in consumer surplus for a particular year can then be calculated as the shaded area in Appendix Figure 2. This can be described by the following equation,

$$CS = \int_{p_0}^{p_1} Ap^{\epsilon} dp.$$

Evaluating the integral yields,

$$CS = \frac{A}{(1+\epsilon)} [p_1^{(1+\epsilon)} - p_0^{(1+\epsilon)}].$$

It is helpful to go through an example. In 2025, the price of natural gas (p_0) in the United States was \$3.66 per Mcf, and deliveries to consumers (q_0) was 30.2 billion Mcf. Assuming a demand elasticity of -0.5 and rearranging the demand function to solve for A yields,

$$A = q_0 {p_0}^{-\epsilon} = 30.2 * 3.66^{0.5} = 57.8.$$

At the counterfactual price \$12.42 the demand function implies that deliveries to consumers would be equal to,

$$q_1 = A{p_1}^{\epsilon} = 57.8 * 12.42^{-0.5} = 16.4.$$

Thus, the demand function implies that at this higher counterfactual price, natural gas deliveries to consumers in 2025 would have been 16.4 billion Mcf.

Using the equation above, consumer surplus is equal to,

$$CS = \frac{57.8}{(0.5)}[12.42^{(.5)} - 3.66^{(.5)}] = 186$$

Thus, the consumer surplus from the lower price in 2025 is calculated to be \$186 billion.

Appendix Table 1 provides year-by-year calculations. These calculations assume a demand elasticity of -0.5 and are calculated relative to the price in Europe. We do not include a table with year-by-year calculations for a demand elasticity of -0.25, but average annual savings are \$196 billion rather than \$164 billion.