TAX SUBSIDIES AND PRICES: ESTIMATING THE IMPACT OF FEDERAL TAX CREDITS FOR NATURAL GAS VEHICLES ON THE U.S. PRICE OF NATURAL GAS

by

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ABSTRACT

The "NAT GAS" bill proposed by Rep. John Sullivan would renew and expand expired federal tax credits for the purchase of natural gas vehicles (NGVs). We estimate the impact of the bill on U.S. natural gas prices. Based on econometric estimates, we find previous federal tax credits had a significant effect on NGV sales. The renewal and expansion of these credits would increase natural gas prices by between 1.13 and 2.98 percent, raising natural gas expenditures between $1.83 billion and $4.78 billion over five years. Roughly 30 percent of the bill's cost would be borne by households with the remaining 70 percent borne by U.S. companies. The bill would be regressive overall, with costs falling disproportionately on low-income households, families over age 75, those in U.S. Midwestern states and single parents with dependent children. The most heavily impacted U.S. industries would be agricultural fertilizers, followed by basic chemical manufacturing, pulp and paper mills and metal ores mining. The legislation raises production costs for U.S. companies by roughly $2.29 billion over the life of the bill. Lawmakers considering renewal of federal tax credits for NGVs should be wary of these hidden costs to U.S. households and firms.

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I. INTRODUCTION

In recent years, the U.S. Congress has begun actively promoting the use of natural gas vehicles (NGVs) as an alternative to traditional gasoline- and diesel-powered vehicles. Many lawmakers view NGVs as having advantages over traditional vehicles, such as lower tailpipe emissions and potentially lower operating costs at today's fuel prices. However, major barriers remain to widespread adoption of natural gas as a transportation fuel. NGVs enjoy much shorter driving ranges than traditional autos, requiring more frequent fill-ups within the nation's limited natural gas refueling infrastructure. Additionally, upfront purchase costs for NGVs range from $7,000 to $80,000 more than their gasoline- and diesel-powered counterparts.

In an attempt to improve the economic viability of NGVs, in 2005 Congress enacted a significant federal income tax credit for the purchase of new NGVs as part of the Energy Policy Act of 2005 (EPAct). The five-year credit was designed to offset higher upfront costs of NGVs, coving up to 80 percent of the incremental cost over traditional vehicles. Maximum credit values ranged from $2,500 to $32,000 depending on the size and emissions rating of the vehicle, providing a powerful economic incentive to potential buyers. Table 1 summarizes the tax credit values for various vehicle classes established by the 2005 law.

TABLE 1. EXPIRED FEDERAL TAX CREDITS FOR NATURAL GAS VEHICLES (ENERGY POLICY ACT OF 2005)

Gross Vehicle Weight	Maximum Tax Credit Value
8,500 lbs. or less	$4,000
8,500–14,000 lbs.	$8,000
14,000–26,000 lbs.	$20,000
Oven 26,000 lbs.	$32,000

Source: Energy Policy Act of 2005.

After five years in place, federal tax credits for NGVs expired December 31, 2010. In an effort to renew the expired credits, Rep. John Sullivan (R-OK) has introduced new legislation that would restore and significantly expand the 2005 credits, titled the "New Alternative Transportation to Give Americans Solutions (NAT GAS) Act of 2011" or H.R. 1380.[1] The bill would establish much higher maximum tax credit values than the 2005 law, doubling the maximum credit for most vehicle classes and largely eliminating the upfront cost differential between many NGVs and their traditional counterparts.

H.R. 1380 is designed to encourage U.S. households and companies to shift from traditional fuels toward compressed and liquefied natural gas. By shifting demand away from gasoline and diesel markets and toward the largely domestic U.S. natural gas market, an unintended consequence of the policy will be to increase U.S. natural gas prices above what they would otherwise be, raising costs for households and firms throughout the economy.

[1] See H.R. 1380, "New Alternative Transportation to Give Americans Solutions Act of 2011." Available at thomas.loc.gov/cgi-bin/bdquery/z?d112:h.r.1380:

Unlike the global market for petroleum-based fuels, the U.S. supply of natural gas is geographically constrained. Roughly 85 percent of natural gas consumed in the U.S. is produced domestically, with some 97 percent produced in North America. This relative isolation limits the ability of natural gas suppliers to quickly respond to short-run changes in demand. In the language of economics, U.S. natural gas supply is "relatively inelastic" compared to the supply of crude oil. As a result, while U.S. tax policies are unlikely to affects the world price of crude oil, domestic policies can have a significant impact on U.S. natural gas prices.

Because of the widespread use of natural gas by U.S. households and companies, shifts in natural gas prices can have far-reaching effects throughout the economy. Households today consume roughly 4.76 trillion cubic feet of natural gas annually for home heating, appliances and other uses, amounting to more than $50 billion in expenditures at today's prices. A variety of U.S. industries consume an additional 19.1 trillion cubic feet, or $111.9 billion per year. Taken together, each one percent rise in natural gas expenditures represents a cost to the U.S. economy of roughly $1.6 billion per year, or roughly $13.50 per household.

By establishing a significant federal tax incentive for new NGVs, H.R. 1380 would encourage a shift from traditional fuels toward compressed and liquefied natural gas, reducing U.S. demand for crude oil and increasing U.S. demand for natural gas. Other things being equal, this shift will place upward pressure on U.S. natural gas prices with little or no corresponding downward pressure on crude oil prices. The goal of this study is to estimate the resulting impact of H.R. 1380 on U.S. natural gas prices, and illustrate the distributional impact of these price increases on U.S. households and companies.

OVERVIEW OF THE LEGISLATION

H.R. 1380 was introduced in the U.S House of Representatives on April 6, 2011, and was referred to three House subcommittees: the Committee on Ways and Means; the Committee on Science, Space, and Technology; and the Committee on Energy and Commerce. As of July 25, 2011, 183 cosponsors were listed for the bill.

The text of the bill is brief by federal standards, spanning just 24 pages. The centerpiece is a five-year renewal of a federal income tax credit for the purchase of NGVs that expired in December 2010. The bill would significantly expand the previous tax credit. The previous maximum credit of $4,000 to $32,000 per vehicle would be increased to $7,500 to $64,000 depending on vehicle weight, effectively doubling previous tax credits. For dedicated NGVs, the credit is equal to 80 percent of the incremental cost compared to similar traditional vehicles, largely eliminating the up-front cost differential for most vehicles. The bill also makes the tax credits transferable, exempts them from the Alternative Minimum Tax and makes them available to U.S. Indian tribes.

In addition to offering tax credits to buyers, the bill would also renew previously expired credits for vehicle manufacturers for five years. H.R. 1380 provides a manufacturer credit equal to the minimum of 10 percent of the production cost of the vehicle or $4000, with the aggregate credit limited to $200,000,000 for any manufacturer. The bill would also increase the previous credit for natural gas refueling stations, establishing a maximum value of $30,000 for properties subject to allowance for depreciation; the minimum of 50 percent of costs or $100,000 for "natural gas properties;" and $2,000 in all other cases.

In addition to direct tax incentives, H.R. 1380 would also promote research and development on alternative-fueled vehicles. The bill instructs the U.S. Department of Energy to establish research grants for natural gas vehicles. It also instructs the U.S. Environmental Protection Agency to streamline the process for certifying natural gas vehicle retrofit kits, and directs EPA regulators to encourage production and use of NGVs by revising emission regulations and standards for measuring greenhouse gas emissions that take NGV usage into account. The main provisions of the "New Alternative Transportation to Give Americans Solutions Act of 2011," are summarized in Table 2.

TABLE 2. KEY PROVISIONS OF H.R. 1380, THE "NEW ALTERNATIVE TRANSPORTATION TO GIVE AMERICANS SOLUTIONS ACT OF 2011"

- Renews the expired 2005 federal tax credits for the purchase of natural gas vehicles, the use of natural gas fuel, and the installation of natural gas refueling stations for five years. Also, allows U.S. Indian tribes to be eligible for all credits.
- Expands and modifies previous tax credits for alternative fuel vehicles and refueling stations.
    - Allows a tax credit equal to 80 percent of the incremental cost for new dedicated natural gas vehicles and some bi-fuel and dual-fuel vehicles.
    - Allows a tax credit equal to 50 percent of the incremental cost for all other natural gas vehicles.
    - Increases the expired maximum tax credit values to the following:

Gross Vehicle Weight	Maximum Tax Credit Value
8,500 lbs. or less	$7,500
8,500–14,000 lbs.	$16,000
14,000–26,000 lbs.	$40,000
Oven 26,000 lbs.	$64,000

    - Increases the tax credit for natural gas refueling stations from the minimum of 30 percent or $30,000, to the minimum of 50 percent or $100,000 per station. Also increases the home refueling tax credit from $1,000 to $2,000.
- Excludes the above tax credits from the Alternative Minimum Tax, and makes them transferable by taxpayers.
- Establishes a production tax credit for manufacturers of natural gas vehicles.
- Clarifies the definition of "Advanced Technology Vehicle," and allows fleets covered under the 1992 EPAct to receive tax credits for repowering vehicles and converting older vehicles to alternative fuels.
- Directs the EPA to reduce the regulatory burden on NGV conversion kits.
- Directs the EPA and the National Highway Transportation Safety Administration to design tax credits for manufacturers of natural gas vehicles as a reward for indirect reductions in greenhouse gas emissions.
- Directs the Department of Energy to provide funding for research on improving the efficiency of natural gas vehicles.

Source: H.R. 1380, "New Alternative Transportation to Give Americans Solutions Act of 2011"

II. Economic Theory: Tax Credits and Natural Gas Prices

Economic theory provides a useful framework for understanding how tax credits for natural gas vehicles affects U.S. natural gas prices. In this section we review the economic theory of how tax policy affects the supply and demand for alternative-fueled vehicles, and ultimately the U.S. market for natural gas.

There are two general approaches used by economists to analyze the impact of tax policy on markets. First is known as "partial equilibrium" analysis. Under this approach, we restrict our attention to only one or a small number of markets, analyzing how taxes affect supply and demand while ignoring whatever impact they may have elsewhere. The main advantage of this approach is its simplicity and transparency. Partial equilibrium analysis provides insights about the impact of policies in a simplified setting that in most cases is a useful approximation to reality. For these reasons, partial equilibrium analysis is widely used to estimate the economic impact of federal policy changes.

A second approach is "general equilibrium" analysis. Under this approach, economists study the impact of taxes on all markets simultaneously. This approach can sometimes provide deep insights about complex, real-world feedback effects among markets that are not apparent from a partial equilibrium view alone. Unfortunately, an important disadvantage of this approach is its complexity. General equilibrium analysis typically requires sophisticated economic modeling and computational methods, making it difficult to replicate research findings and to verify which results are useful and which are simply reflections of the analyst's underlying assumptions. General equilibrium models are notorious for their lack of transparency, appearing as a "black box" to outside analysts.

In this study we rely on a combination of the above approaches to estimate the impact of H.R. 1380. First, we review the partial equilibrium theory of how tax credits affect the market for natural gas vehicles and thus demand for U.S. natural gas. We then explore the general equilibrium approach to estimating the bill's impact on overall U.S. energy markets and the broader economy.

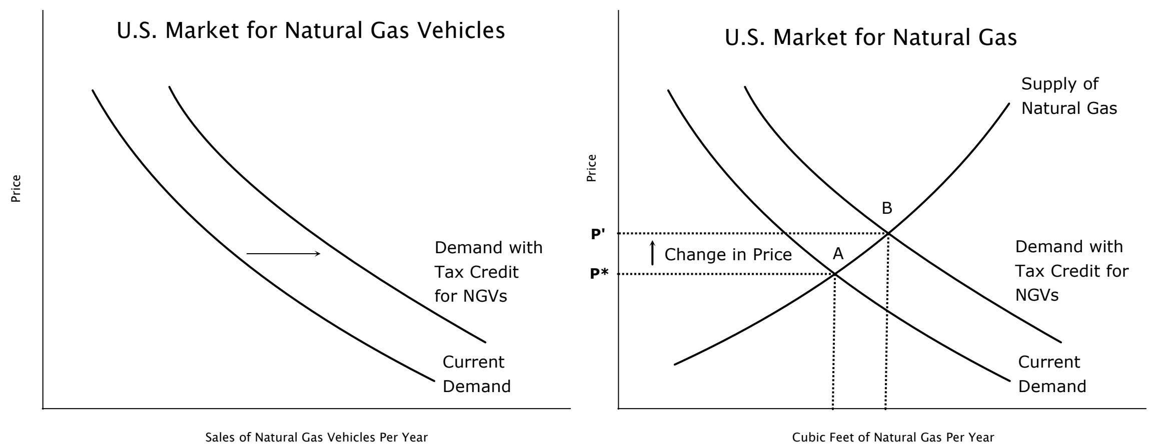
A. Partial Equilibrium Effects: Supply and Demand

H.R. 1380 would renew and extend federal tax credits for the purchase of natural gas vehicles. By lowering the marginal cost of new vehicles, the bill would encourage substitution away from traditional vehicles and toward NGVs. This shift represents a decrease in U.S. demand for gasoline and diesel fuel, and a corresponding increase in demand for compressed and liquefied natural gas. Thus, the partial equilibrium impact of the NAT GAS bill is concentrated in two markets: (1) the market for new natural gas vehicles, and (2) the market for U.S. natural gas.

Figure 1 illustrates the basic economic theory of how H.R. 1380 would affect U.S. vehicle and fuel markets. The left panel shows the impact on the U.S. vehicle market, and the right panel shows the impact on the corresponding natural gas fuel market.

The enactment of a tax credit for NGVs leads to a rightward shift in the demand for natural gas vehicles, illustrated in the left panel. Because natural gas vehicles and natural gas fuel are what economists call “complimentary goods,” rising demand for natural gas vehicles in turn leads to a rightward shift in U.S. demand for natural gas, illustrated in the right panel. The new federal tax credit moves the economy from the original equilibrium point labeled “A” to the new point labeled “B.” At the new equilibrium, more U.S. natural gas is demanded in the form of transportation fuel, and the U.S. price of natural gas rises from *P** to *P’* in the figure.

FIGURE 1. PARTIAL EQUILIBRIUM IMPACT OF A FEDERAL TAX CREDIT FOR NEW NATURAL GAS VEHICLES



Source: Chamberlain Economics, L.L.C.

As is clear from the right panel, two factors influence the magnitude of the bill’s effect on natural gas prices. First is how strongly the credit affects sales of new natural gas vehicles, and thus the size of the rightward shift in demand for U.S. natural gas. The second is how steeply the U.S. supply curve for natural gas is sloped at the economy’s original equilibrium at the point labeled “A”—what economists refer to as the “price elasticity of the supply” of U.S. natural gas.

The elasticity of natural gas supply is a measure of how quickly suppliers of natural gas can respond to sudden changes in demand, such as those introduced by a new federal tax credit. The steeper the slope of the supply curve, the more a given increase in demand raises prices. In general, if natural gas production faces significant short-term bottlenecks, the supply elasticity will tend to be low or “inelastic,” and the supply curve will slope steeply upward. By contrast, if natural gas supply can be easily expanded to meet new demand, the supply elasticity will be high or “elastic,” and the supply curve will have a relatively flat slope.

An important factor determining supply elasticity is the time period being analyzed. For most goods, supply is much more elastic in the long run when firms have time to adjust to new policies than in the short run. In the case of natural gas, U.S. supply faces significant near-term bottlenecks. Unlike the large and flexible global market for crude oil which can quickly transport supply wherever it is needed most, U.S. natural gas is much more geographically constrained. Additionally, while there are more than 6,300 natural gas producers in the United States there are only about 530 natural gas processing facilities, limiting suppliers' ability to quickly bring new supplies online. These characteristics severely limit the short-term flexibility of the U.S. natural gas market.

We expect the short-run supply elasticity of natural gas to be much less elastic than in the long run. This has important implications for estimates of the impact of H.R. 1380 on natural gas prices. If supply is highly inelastic in the short run—which is the appropriate time period for analysis given the bill's five-year life span—the policy may have a disproportionately large effect on prices. By contrast, if natural gas supply were relatively elastic in the short run, the policy may have little or no effect on natural gas prices.

Mathematically, economists define price elasticity of natural gas supply as,

(1) $$E_s = \frac{\%\Delta Q_s}{\%\Delta P} = \left(\frac{\Delta Q_s}{Q_s}\right) \Big/ \left(\frac{\Delta P}{P}\right)$$

where Q_s represents the annual quantity of natural gas supplied, P is the U.S. price of natural gas, and ΔP and ΔQ_s represent observed changes in prices and quantity from the policy. By estimating the number of new natural gas vehicles the bill is likely to add to the nation's vehicle fleet, we can derive an estimate of ΔQ_s in the above expression. Similarly, many previous studies have estimated the supply elasticity of U.S. natural gas, providing an estimate of E_s in the expression.

Given these estimates, Equation 1 can be solved for the policy's impact on prices,

(2) $$\Delta P = \left(\frac{\Delta Q_s}{Q_s}\right)\left(\frac{P}{E_s}\right)$$

Because the quantity of natural gas supplied must equal the quantity demanded, in equilibrium we can let Q_s equal Q_d in the above expression. Rearranging terms, we can thus express this relationship as one between the percentage change in natural gas prices and the percentage change in the quantity of natural gas demanded from the policy, or

(3) $$\%\Delta P = (\%\Delta Q_d)\left(\frac{1}{E_s}\right)$$

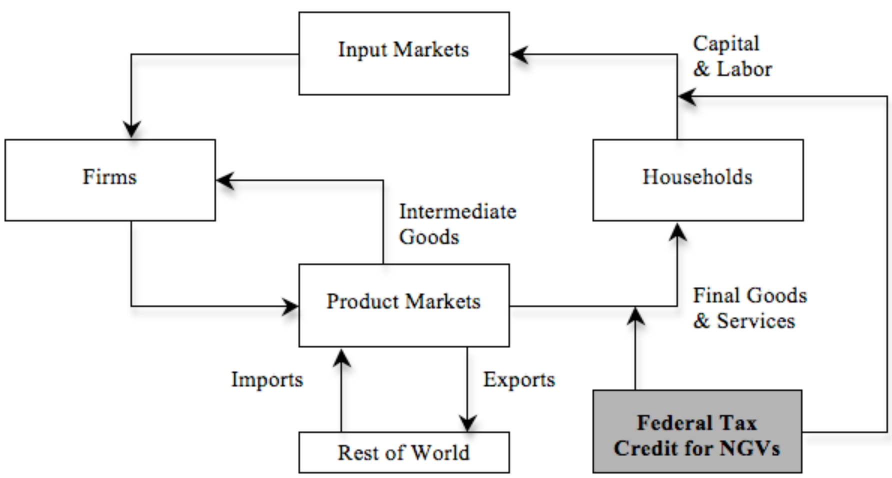
Equation 3 provides the basic theoretical framework for modeling the impact of H.R. 1380 on U.S. natural gas prices. It says that the percentage change in natural gas prices from the bill is equal to the percentage change in the demand for natural gas from the policy—corresponding to the rightward shift in demand from Figure 1—times the inverse supply elasticity for U.S. natural gas. Using empirical estimates for the terms in Equation 3, we can therefore approximate the impact of H.R. 1380 on U.S. natural gas prices.

B. General Equilibrium Effects: The Broader Economy

While the partial equilibrium view described above provides a useful approximation of the bill's impact on prices, there may be other important effects not captured by this analysis. Once the bill increases natural gas prices, those price changes potentially affect many other markets throughout the economy. Natural gas is used extensively as a productive input by a variety of U.S. industries, including agricultural fertilizers, basic chemicals, iron and steel production and more. Rising natural gas prices have a significant effect on these industries, in turn affecting prices, output, and potentially wages in these and other industries.

A further complication is that although NGVs typically have higher upfront purchase costs compared to traditional vehicles, they sometimes enjoy lower operating costs at today's fuel prices. That suggests NGV subsidies can also provide some offsetting long-run savings to industries that operate large NGV fleets. Also, by encouraging a shift from traditional fuels to natural gas, H.R. 1830 may have important effects on the petroleum refining and gasoline distribution industries, both of which will in turn affect prices, wages and investment in those industries.

Figure 2. General Equilibrium Impact of Federal Tax Credits for Natural Gas Vehicles



Source: Chamberlain Economics, L.L.C.

Figure 2 illustrates the interdependent nature of markets potentially affected by H.R. 1380. From a partial equilibrium view, tax credits for NGVs affect two areas of the economy, illustrated by arrows from the shaded box in the figure. In the product market, H.R. 1380 lowers the costs of new NGVs consumed by households. In the productive inputs market, the bill subsidizes investment in new NGVs by companies. However, because of the interlinked nature of the economy, the bill could potentially affect U.S. imports and exports, household decisions to supply capital and labor to firms, product markets for related goods such as gasoline-powered vehicles and crude oil, and more.

Just as medical treatment for one physical ailment can lead to complications elsewhere, tax credits targeting NGVs may lead to adjustments in many other markets.

Understanding how these complex and overlapping adjustments affect U.S. households is no simple task. The most common approach used by economists is known as "general equilibrium" analysis, which typically involves constructing a simplified mathematical model of the economy characterized by a system of equations describing the behavior of households, firms, government and the rest of the world. These equations can then be calibrated to match certain stylized facts about the U.S. economy and solved to simulate the impact of policies on households and firms throughout the economy.

In this study we explore the general equilibrium impact of H.R. 1380 in two ways. First, we make use of recent simulations from the U.S. Energy Information Administration's National Energy Modeling System (NEMS), a large-scale general equilibrium model of U.S. energy markets, to explore ways in which the general equilibrium impact of H.R. 1380 differs from the partial equilibrium impact. Second, when estimating the distributional impact of the bill on U.S. households, we use a Leontief input-output model of the U.S. economy to simulate how higher natural gas prices lead to complex interactions among industries, ultimately affecting consumer prices throughout the economy.

III. Estimating the Impact of H.R. 1380 on Natural Gas Prices

In this section we estimate the likely impact of H.R. 1380 on U.S. natural gas prices. In Section A we analyze the bill's impact in a partial equilibrium framework, examining the short-run effects on the market for NGVs and natural gas fuel. In Section B we broaden the analysis and explore the bill's impact in a general equilibrium setting over many years using simulation results from the U.S. Energy Information Administration.

A. Partial Equilibrium Impact on Prices

Estimating the impact of H.R. 1380 on natural gas prices requires estimating two parameters: (1) the percentage change in the quantity of natural gas demanded from the policy; and (2) the inverse elasticity of supply for U.S. natural gas for each year the policy is in effect.

There are two general approaches to estimating the impact of H.R. 1380 on the number of NGVs in use. One method follows a "top-down" approach, projecting the size of the total U.S. vehicle market and estimating what fraction can reasonably be expected to convert to NGVs following the tax credit. This is the approach used by the U.S. Energy Information Administration in their 2010 modeling of the impact of federal tax incentives for NGVs.[2] The main advantage of this approach is that it provides simple, order-of-magnitude bounds on the likely impact of the bill. However, the main disadvantage is that such estimates are often based on *ad hoc* projections rather than empirical evidence.

A second method follows a "bottom-up" approach that relies on statistical data and econometric methods. Under this approach, analysts study the empirical relationship between previous federal tax credits and sales of NGVs using a multiple regression model. By controlling for the effects of changing prices and other economic factors, this approach can be used to forecast the effects of H.R. 1380. The main advantage of this approach is that it is scientifically well-grounded and makes use of the best data available to policymakers. However, a major disadvantage is that models based on historical relationships can provide unreliable forecasts of the effect of new policies.

In this section we follow a hybrid of the above approaches. We first explore the "bottom-up" approach, analyzing the econometric evidence for how the U.S. sales of NGVs were affected by previous federal tax credits. We then explore other "top-down" forecasts of the bill's impact provided by advocates of H.R. 1380 in U.S. Congressional testimony. Based on these estimates, we develop a range of likely effects of the bill and quantify the resulting impact on U.S. natural gas prices under four policy scenarios.

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[2] See U.S. Energy Information Administration, "Annual Energy Outlook 2010". Available at http://www.eia.gov/oiaf/archive/aeo10/index.html.

i. Econometric Evidence from Previous Tax Credits

One approach to forecasting the number of new NGVs from H.R. 1380 is to estimate the historical relationship between NGV sales and previous federal tax credits. Since 1992, the U.S. Energy Information Administration has compiled data on the number of natural gas vehicles in use in the United States through its Form EIA-886, "Annual Survey of Alternative Fueled Vehicles."[3] These data are summarized in Table 3.

Historically, most NGVs have been powered by compressed rather than liquefied natural gas. Although liquefied natural gas can be stored more compactly and allows for greater traveling distances, it requires storage tanks capable of cooling fuel to roughly -260 degrees Fahrenheit, making them much more costly than compressed fuel tanks. NGV usage in the United States peaked in 2003 at 136,018 vehicles, with most of these vehicles consisting of private and government fleets, municipal busses, waste disposal trucks and other light- and medium-duty vehicles. As of 2009, roughly 117,446 NGVs were in use in the United States.

TABLE 3. NUMBER OF U.S. NATURAL GAS VEHICLES IN USE, 1992-2009

Year	Compressed Natural Gas (CNG) Vehicles	Liquefied Natural Gas (LNG) Vehicles	Total Natural Gas Vehicles in Use
1992	23,191	90	23,281
1993	32,714	299	33,013
1994	41,227	484	41,711
1995	50,218	603	50,821
1996	60,144	663	60,807
1997	68,571	813	69,384
1998	78,782	1,172	79,954
1999	91,267	1,681	92,948
2000	100,750	2,090	102,840
2001	111,851	2,576	114,427
2002	120,839	2,708	123,547
2003	114,406	2,640	136,018
2004	118,532	2,717	121,249
2005	117,699	2,748	120,447
2006*	116,131	2,798	118,929
2007*	114,391	2,781	117,172
2008*	113,973	3,101	117,074
2009*	114,270	3,176	117,446

* indicates federal tax credits for natural gas vehicles were in effect.
Source: U.S. Energy Information Administration.

A casual reading of Table 3 does not give the impression that previous federal tax credits for NGVs were effective at encouraging their use. Federal tax incentives were in place from January 2006 through December 2010, a general period of decline and stagnation in the U.S. NGV market. During this period, the number of natural gas vehicles in use declined roughly 2.5 percent, from 120,447 vehicles just before the federal credit went into effect to just 117,446 vehicles in 2009.

However, what Table 3 does not reveal is that during the period in which the previous federal credits were in effect, U.S. investment in transportation equipment was sharply declining overall. As the U.S. economy fell into a deep recession in 2007 through 2009, overall sales of new vehicles declined sharply. Thus, any analysis of the impact of

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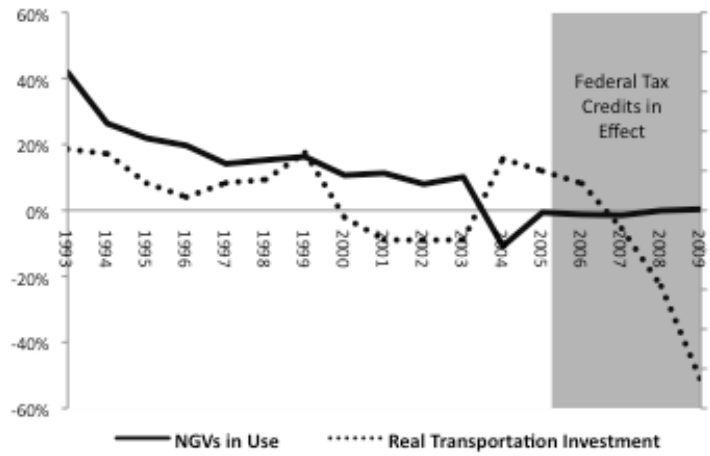
[3] See U.S. Energy Information Administration. (April 2011). "Alternatives to Traditional Transportation Fuels 2009." Available at www.eia.gov/renewable/alternative_transport_vehicles/index.cfm.

previous tax credits must control for this overall trend in vehicle sales during the period, as well as other potentially confounding factors such as the relative price of NGVs compared to traditional vehicles.

Figure 3 illustrates the importance of controlling for trends in transportation equipment investment when analyzing the impact of tax credits for NGVs. It shows the annual percentage change in NGVs in use compared to the annual percentage change in real U.S. investment in transportation equipment between 1993 and 2009.[4] The period in which previous federal tax credits for NGVs were in effect is shaded. Viewed in this way, federal tax credits appear to have played a more important role in NGV markets in the late 2000s than is apparent from data on NGV usage alone.

FIGURE 3. PERCENTAGE CHANGE IN NATURAL GAS VEHICLES IN USE VS. REAL TRANSPORTATION EQUIPMENT INVESTMENT, BEFORE AND AFTER FEDERAL TAX CREDITS



Source: U.S. Energy Information Administration; U.S. Bureau of Economic Analysis.

Prior to the enactment of the 2005 credits, the stock of NGVs and the level of real investment in transportation equipment tracked each other closely. Between 1993 and 2005 the two series displayed a positive correlation of 0.752. However, between 2006 and 2009 when the federal tax credit was in effect and expenditures on new transportation equipment fell sharply, the correlation fell to just 0.421. It appears that the enactment of federal tax credits effective January 1, 2006 played some role in stabilizing the market for NGVs compared to overall vehicle sales.

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[4] See U.S. Bureau of Economic Analysis, NIPA Table 5.3.3. "Real Private Fixed Investment by Type, Quantity Indexes (Transportation Equipment)."

The Model

To quantify the impact of previous federal tax credits on NGV sales, we estimate a simple econometric model of the demand for natural gas vehicles. The model is given by the following,

(4) $$NGVs_t = \beta_0 + \beta_1 \cdot price\_gas\_autos_t + \beta_2 \cdot tax\_credit_t + \beta_3 \cdot trans\_invest_t + \varepsilon_t$$

where $NGVs_t$ is the number of natural gas vehicles in use at time t, $price\_gas\_autos_t$ is the real price of gasoline and diesel-powered automobiles, $trans\_invest_t$ is real U.S. investment in transportation equipment, and ε_t is mean-zero error term. β_1, β_2 *and* β_3 are the coefficients we aim to estimate by ordinary least-squares (OLS) methods.

Ideally, the above model would be specified using the real price of NGVs relative to traditional autos. Unfortunately, due to the limited size of the U.S. NGV market no consistent data set of NGV prices exists at the time of this writing. Because NGVs and gasoline- and diesel-powered vehicles are close substitutes, we use the price of traditional vehicles as a proxy for NGV prices. That is, because NGVs and traditional vehicles are substitute goods, the quantity of NGVs demanded should be increasing in their price, just as it should be decreasing in the price of NGVs.

We expect the coefficients β_1, β_2 *and* β_3 to be positive, reflecting the facts that: (1) NGVs and traditional vehicles are substitute goods; (2) federal tax credits should have a positive effect on NGV usage; and (3) NGV usage should be positively correlated with overall U.S. investment in transportation equipment.

The Data

Data on the number of natural gas vehicles in use over time is drawn from the U.S. Energy Information Administration's "Annual Survey of Alternative Fueled Vehicles" from 1992 through 2009. Price data for new gasoline- and diesel-powered vehicles is drawn from monthly data from the U.S. Bureau of Labor Statistics' "Consumer Price Index" (All Urban Consumers, U.S. City Average).

The value of previous federal tax credits is indexed to zero from January 1992 through December 2005 and to unity from January 2006 through December 2009. Data on U.S. investment in transportation equipment is from the U.S. Bureau of Economic Analysis' NIPA Table 5.3.3. All non-monthly data are interpolated to be on a consistent basis with monthly auto price data. The resulting data set consists of 216 monthly observations between January 1992 and December 2009.

Estimation Results

We estimate Equation 4 using a standard OLS regression model in levels. The results are presented in Table 4. Overall, the model provides a reasonable fit given the limited data available. As expected, all coefficients are positive with two of the three statistically significant at the 1 percent level. We report autocorrelation- and heteroskedasticity-robust Newey-West standard errors in parentheses.

TABLE 4. ECONOMETRIC ESTIMATES OF THE IMPACT OF TAX CREDITS ON U.S. NATURAL GAS VEHICLES IN USE, 1992-2009

Variable	Coefficient	t-Statistic
Constant	-64,613.5 (145,886.1)	0.44
Price of Gasoline-Powered Vehicles	595.8 (1,103.6)	0.54
Tax Credit	36,039.3*** (10,782.6)	3.34
Real Trans. Investment	797.7*** (230.4)	3.46
R-Squared	0.413	
Number of Observations	216	

Note: Newey-West standard errors are reported in parentheses.
*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.
Source: Chamberlain Economics, L.L.C

The variable of interest is "Tax Credit." The coefficient of 36,039 is statistically significant at the 1 percent level, suggesting previous federal tax credits did indeed have a measurable effect on the number of NGVs in use. The coefficient can generally be interpreted as the number of NGVs in use that can be attributed to the enactment of federal tax credits on average during this period, holding transportation investment and the price of traditional vehicles constant. Based on this estimate, roughly 36,039 of the 117,446 NGVs in use in 2009 can be statistically attributed to the enactment of tax credits in the 2005 EPAct.

H.R. 1380 would effectively double the maximum value of previous credits for most vehicle classes. A rough approximation of the impact of H.R. 1380 is thus to assume the policy would double the estimated "Tax Credit" coefficient from Table 4. Following this approach, we would expect the bill to add roughly 2 x 36,039 = 72,079 NGVs to the nation's vehicle stock over the life of the bill, a 61 percent increase in the number of NGVs in use.

Despite the statistical significance of the above estimates, there are important reasons to be cautious about such a simple forecast based on econometric estimates. First, the small sample size and generally poor quality of the underlying data on which the above estimates are based warrants caution in the interpretation of the results. Second, the proposed credits in H.R. 1380 differ in material ways from previous credits not captured by historical data, and a simple doubling of regression coefficients ignores these differences. Finally, because econometric estimates are inherently backward-looking, they provide good evidence about the historical impact of credits but may not provide reliable forecasts of the effect of future policies.

For these reasons, it is unclear whether the historical record of previous credits for NGVs provides useful guidance about the likely impact of H.R. 1380. The above econometric estimates are primarily useful for forecasting the impact of small changes in federal tax credits. By contrast, H.R. 1380 would implement a major increase in previous credits, effectively doubling their value. As a result, forecasts based on the above regression model risk significantly understating the bill's impact on sales of new NGVs.

In the next section, we turn to non-econometric estimates of the bill's impact contained in U.S. Congressional testimony from proponents of the bill. While these estimates are informal, they have been widely cited throughout debate over H.R. 1380, establishing them as the *de facto* consensus view among policymakers of the likely impact of the bill. In the remainder of the study we focus our attention on these estimates, illustrating the impact on U.S. natural gas prices implied by them.

ii. Estimates from Congressional Testimony

As of July 2011, no official estimate had been released of the impact of H.R. 1380 by the U.S. Congressional Budget Office, the Joint Committee on Taxation, or any other federal agency. Aside from the econometric estimates above, the only published forecasts of the likely impact of the bill on NGV sales are contained in U.S. Congressional testimony given by supporters of the bill.

In April 2010, longtime energy investor and Chairman of BP Capital T. Boone Pickens testified before the U.S. House Committee on Ways and Means on proposed legislation to encourage the use of natural gas as a transportation fuel. The testimony focuses on the likely impact of what was then H.R. 1385, the previous 2010 version of the NAT GAS bill. Although the 2010 bill differs in some ways from H.R. 1380—for example, it would have extended many expired tax credits though 2027 rather than 2016—the structure of the bill's NGV credits is similar to those in the current legislation.

The testimony offers one of the only specific forecasts to date of the impact of the NAT GAS bill on the market for NGVs:

> "Specifically, over the next five years the NAT GAS Act can help get approximately 236,000 clean natural gas trucks (heavy, medium and light-duty) on America's roads and augment the existing natural gas fueling infrastructure. This alone would help displace approximately 5 percent, or nearly 2 billion gallons, of diesel every year. Equally important, this program can create more than 600,000 direct and indirect jobs."[5]

An appendix to the testimony offers detailed estimates of the number and type of new natural gas vehicles likely to be added to the nation's vehicle stock from the bill, including the impact on fuel consumption and the number of new U.S. jobs in related industries. Table 5 presents the testimony's five-year estimates of the number of new NGVs likely to be put into use from the legislation.

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[5] See Pickens, T. Boone. (April 14, 2010). "Energy Tax Incentives Driving the Green Job Economy." Statement to the United States House of Representatives Committee on Ways and Means. Available at democrats.waysandmeans.house.gov/Hearings/Testimony.aspx?TID=8370.

TABLE 5. ESTIMATED NUMBER OF NEW NGVS FROM THE POLICY BASED ON U.S. CONGRESSIONAL TESTIMONY

Vehicle Type	Projected Number of New Vehicles
Class 8	78,000
Class 7	32,000
Class 5 & 6	31,000
Class 1, 2, 3 & 4	100,000
Total	241,000

Source: "Energy Tax Incentives Driving the Green Job Economy," (April 14, 2010). Statement before the United States House of Representatives Committee on Ways and Means.

Over the life of the bill, the testimony estimates 241,000 additional NGVs would be put into service in the United States, roughly doubling the existing fleet of 117,446 vehicles. Since the 2010 testimony, these figures have been widely cited both by proponents and opponents of H.R. 1380. According to some estimates, the budgetary cost of H.R. 1380 in the form of lost tax revenue would fall between $5 billion and $9 billion over five years.[6] These order-of-magnitude estimates are consistent with the number of new NGVs projected by the Pickens testimony.

iii. Range of Likely Effects of H.R. 1380

Rather than focusing on a specific forecast of new NGVs from the policy, we illustrate the overall relationship between H.R. 1380's effectiveness and U.S. natural gas prices, highlighting the real policy tradeoff faced by lawmakers. This approach allows analysts with differing beliefs about the efficacy of federal tax credits to assess the consequences of those views, and quantify the resulting impact on U.S. natural gas prices.

We model the following four scenarios of the impact of H.R. 1380 on the demand for U.S. natural gas vehicles.

- *Baseline Scenario*: As a baseline estimate, we adopt the projection from the April 14, 2010 U.S. Congressional testimony of 241,000 new natural gas vehicles from H.R. 1380. This figure has been sufficiently cited throughout debate over the bill to serve as an informative baseline for modeling its effects.

- *High and Low Scenarios:* To illustrate the sensitivity of the baseline estimate, we model high and low scenarios that differ from the baseline by three historical standard deviations of the number of NGVs in use since 1992. This results in high and low estimates of new NGVs from the policy of 348,670 and 133,330 new vehicles over five years, respectively.

- *Econometric Scenario:* For completeness, we model an "econometric" scenario that relies on the historical econometric evidence from previous tax credits. This

[6] See Horner, Chris. (June 15, 2011). "Republicans dropping like flies from new Soros subsidy bet," *The Daily Caller*. Available at dailycaller.com/2011/06/15/republicans-dropping-like-flies-from-new-soros-subsidy-bet/.

scenario assumes a highly conservative estimate of 72,079 new NGVs from the policy over five years.

In each scenario, we assume new NGVs from the policy exhibit similar average fuel economy to existing NGVs. In 2010, total U.S. demand for vehicle fuel natural gas was 32.85 billion cubic feet. Given a vehicle stock of 117,446, that amounts to an average increase in natural gas consumption of 279,700 cubic feet per NGV per year. Based on total natural gas demand of 24.1 trillion cubic feet, we convert the above scenarios into estimated percentage changes in quantity demanded for natural gas. This provides an estimate of the term "$\%\Delta Q_d$" in Equation 3 for the impact on U.S. natural gas prices.

iv. Supply Elasticity for U.S. Natural Gas

The final step in estimating the impact on natural gas prices is to develop an estimate of the elasticity of supply for U.S. natural gas, denoted E_s in Equation 3. As noted above, it is important to distinguish between short- and long-run supply elasticities. Because the bill's tax credits span a five-year horizon, the short-run supply elasticity is the most appropriate measure for estimating H.R. 1380's impact on natural gas prices.

There is a large previous literature estimating the supply elasticity of natural gas, which is surveyed extensively in Wiser, Bolinger and St. Clair (2005) and elsewhere.[7] Most previous estimates have been *long-run* supply elasticities, as they have been developed for use in large-scale general equilibrium models designed for long-term forecasting and policy analysis. However, a recent study by the American Council for an Energy-Efficient Economy (ACEEE) provides estimates of the short-run supply elasticity of natural gas that are ideally suited for estimating the impact of H.R. 1380 on natural gas prices.[8]

The ACEEE study examines the impact on natural gas prices of various energy efficiency measures designed to lower U.S. demand for natural gas. The study is based on a general equilibrium model of U.S. natural gas markets developed by ICF International (formerly Energy and Environmental Analysis, Inc.), an economic research and consulting firm based on Fairfax, Virginia. The model solves for monthly natural gas prices by equilibrating the supply and demand for natural gas at each of the model's 106 supply nodes throughout North America. By simulating the effect on natural gas prices and quantities from various energy efficiency measures, the results of the study provide implied estimates of the short-run elasticity of supply for U.S. natural gas.

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[7] See Wiser, Ryan *et al*. (2005). "Easing the Natural Gas Crisis: Reducing Natural Gas Prices through Increased Deployment of Renewable Energy and Energy Efficiency," Ernest Orlando Lawrence Berkeley National Laboratory, for the U.S. Department of Energy. Available at http://eetd.lbl.gov/ea/ems/reports/56756.pdf.

[8] Elliot, R. Neal *et al*. (2003). "Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies," Report Number E032, American Council for an Energy-Efficient Economy. Available at www.ef.org/documents/Nat_Gas_ACEEE.pdf.

Table 6 presents the short-run supply elasticities implied by the ACEEE study.[9] The study models the impact on prices for five years following the implementation of energy efficiency measures. This makes the ACEEE study's estimates of short-run supply elasticity ideal for modeling the impact of H.R. 1380, due to the identical five-year horizon of the bill.

TABLE 6. IMPLIED SHORT-RUN SUPPLY ELASTICITIES FOR U.S. NATURAL GAS (AEEEE STUDY)

	Year of Policy				
	Year 1	Year 2	Year 3	Year 4	Year 5
Short-Run Elasticity of Supply	0.088	0.112	0.093	0.345	0.390
Inverse Elasticity	11.35	8.94	10.75	2.90	2.56

Source: Elliot, R. Neal et al. (2003).

As is clear from the table, U.S. natural gas supply is highly inelastic in the short-run, with an implied elasticity of 0.088 in the first year of the policy. As expected, supply elasticity rises over time as firms are able to adjust to the policy. By years four and five, natural gas supply is much more responsive with an implied elasticity of 0.345 and 0.390, respectively. To estimate the impact of H.R. 1380 on prices, we make use of the inverse supply elasticity presented in Table 6. This provides an estimate of the term "$1/E_s$" in Equation 3 for the impact on natural gas prices.

v. Impact on Natural Gas Prices

Table 7 presents the estimated impact of H.R. 1380 on U.S. natural gas prices under the four scenarios described above. In each scenario, we assume new vehicles from the policy are added proportionally over time, with one-fifth of the projected five-year total number of new NGVs added each year.

Overall, the impact on U.S. natural gas prices ranges from 1.13 percent over five years in the low scenario to 2.98 percent in the high scenario. In the baseline case in which 241,000 new NGVs are added by the bill, U.S. natural gas prices rise by 2.06 percent. Under the "econometric" scenario based on the historical impact of previous federal tax credits, natural gas prices would rise by a much lower 0.61 percent over five years.

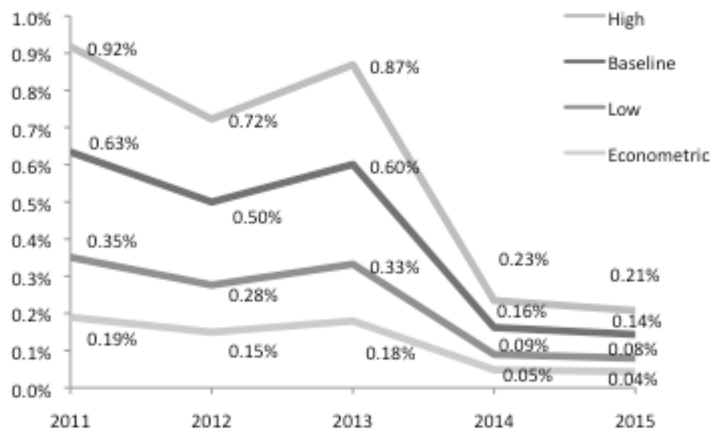
TABLE 7. ESTIMATED IMPACT OF H.R. 1380 ON U.S. NATURAL GAS PRICES, 2011-2015

	Annual Percentage Change in U.S. Natural Gas Prices					
Scenario	2011	2012	2013	2014	2015	5-Year Compounded Price Increase
Baseline	0.63%	0.50%	0.60%	0.16%	0.14%	2.06%
High	0.92%	0.72%	0.87%	0.23%	0.21%	2.98%
Low	0.35%	0.28%	0.33%	0.09%	0.08%	1.13%
Econometric	0.19%	0.15%	0.18%	0.05%	0.04%	0.61%

Source: Chamberlain Economics, L.L.C.

[9] Implied elasticities are calculated as a weighted average of the price impacts in individual natural gas sectors, relative to the overall national change in the quantity demanded from the various efficiency measures. For more detail, see Appendix C of Elliot, R. Neal *et al*. (2003).

FIGURE 4. ESTIMATED IMPACT OF H.R. 1380 ON U.S. NATURAL GAS PRICES, 2011-2015



Source: Chamberlain Economics, L.L.C.

Figure 4 presents the bill's estimated impact on U.S. natural gas prices graphically. As expected, the largest effect on prices would occur in the early years of the policy, in 2011 through 2013. This is due to the much smaller supply elasticity for U.S. natural gas during those years, compared to the more moderate elasticities in later years when U.S. natural gas suppliers are more able to respond to changes in the demand for natural gas transportation fuel.

TABLE 8. ESTIMATED IMPACT ON TOTAL U.S. NATURAL GAS EXPENDITURES FROM H.R. 1380, 2011-2015

	Annual Increase in U.S. Natural Gas Expenditures					
Scenario	2011	2012	2013	2014	2015	*5-Year Total Increase in Expenditures*
Baseline						
Households	$318,756,185	$249,225,292	$298,920,790	$80,118,712	$71,594,729	*$1,018,615,708*
Firms	$709,570,764	$551,697,974	$676,107,519	$182,801,253	$166,603,628	*$2,286,781,139*
Total Expenditures	$1,028,326,950	$800,923,266	$975,028,309	$262,919,966	$238,198,356	*$3,305,396,847*
High						
Households	$461,164,809	$360,570,052	$432,467,684	$115,912,827	$103,580,639	*$1,473,696,012*
Firms	$1,026,581,072	$798,176,484	$978,167,671	$264,470,179	$241,036,045	*$3,308,431,451*
Total Expenditures	$1,487,745,882	$1,158,746,536	$1,410,635,355	$380,383,006	$344,616,684	*$4,782,127,463*
Low						
Households	$176,347,561	$137,880,532	$165,373,896	$44,324,597	$39,608,818	*$563,535,404*
Firms	$392,560,456	$305,219,464	$374,047,368	$101,132,328	$92,171,210	*$1,265,130,827*
Total Expenditures	$568,908,017	$443,099,996	$539,421,263	$145,456,925	$131,780,028	*$1,828,666,231*
Econometric						
Households	$95,334,552	$74,539,045	$89,402,123	$23,962,144	$21,412,765	*$304,650,629*
Firms	$212,220,544	$165,003,478	$202,212,257	$54,672,745	$49,828,311	*$683,937,335*
Total Expenditures	$307,555,096	$239,542,523	$291,614,380	$78,634,889	$71,241,076	*$988,587,964*

Source: Chamberlain Economics, L.L.C.

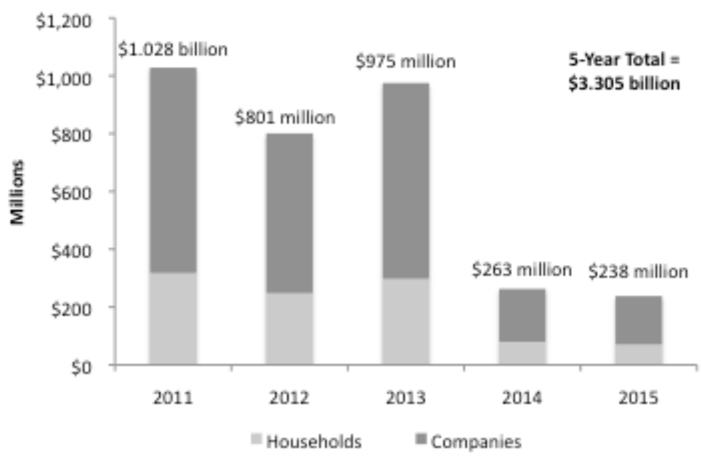
To illustrate the magnitude of the above changes in U.S. natural gas prices, Table 8 presents the impact of H.R. 1380 on total U.S. natural gas expenditures under the assumption of inelastic short-run demand for natural gas. The figures are based on long-term projections of natural gas consumption and prices from the U.S. Energy Information Administration's "Annual Energy Outlook 2011."[10]

Under the baseline scenario, U.S. natural gas expenditures would rise by roughly $3.305 billion in real 2009 dollars over five years from the bill, ranging from $238 million to $1.028 billion per year. This total is divided between $1.018 billion in higher natural gas expenditures for U.S. households, and $2.287 billion higher production costs for companies relying on natural gas as an input—costs we assume will also ultimately be borne by households in the form of higher consumer prices.

Under the high scenario, total U.S. natural gas expenditures would rise by roughly $4.782 billion over five years, ranging from $345 million to $1.49 billion per year. Under the low scenario, total spending would rise by $1.829 billion, ranging from $132 million to $569 million per year. Even under the highly conservative "econometric" scenario, total U.S. natural gas spending would still rise by nearly $1 billion over five years from H.R. 1380.

Figure 5 presents the baseline estimates from Table 8 graphically. The vast majority of the bill's economic impact occurs in the first three years after enactment, with roughly 85 percent of the impact on prices occurring between 2011 and 2013. By the fourth year of the policy, U.S. suppliers of natural gas have much more flexibility to adjust to increased demand for natural gas fuels, largely mitigating the bill's impact on prices. In each year of the policy, U.S. companies bear roughly 70 of the bill's increased natural gas costs in the form of higher production costs. U.S. households bear the remaining 30 percent directly in the form of higher home utility costs.

FIGURE 5. ESTIMATED IMPACT OF H.R. 1380 ON U.S. NATURAL GAS EXPENDITURES, 2011-2015 (BASELINE SCENARIO)



Source: Chamberlain Economics, L.L.C.

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[10] U.S. Energy Information Administration. (2011). "Annual Energy Outlook 2011 with Projections to 2035," EIA Report No. DOE/EIA-0383(2011). Available at http://www.eia.gov/forecasts/aeo/.

The above estimates depend crucially on the projected number of new NGVs from the policy. As noted above, the future effects of policy are highly uncertain, and different policymakers may have different beliefs about the efficacy of federal tax credits for NGVs. Some may believe H.R. 1380 will encourage few households and companies to shift from traditional vehicles to NGVs, while others may foresee dramatic shifts in the nation's vehicle stock from the policy.

To illustrate how the bill would affect U.S. natural gas prices under a variety of assumptions about its effectiveness, Table 9 summarizes the bill's impact on prices and natural gas expenditures for a range of projected new NGVs from the policy. The table shows estimated price and spending impacts for a 13 scenarios ranging from 10,000 new NGVs from the policy—an increase of just 9 percent in the existing NGV stock—to an ambitious projection of one million new NGVs over five years.

TABLE 9. ESTIMATED IMPACT OF H.R. 1380 ON NATURAL GAS PRICES AND EXPENDITURES FOR A VARIETY OF FORECASTS OF NEW NGVS FROM THE POLICY

		Annual Increase in U.S. Natural Gas Prices						
Projected Number of New NGVs from H.R. 1380 (5-Year Total)	Percentage Increase in Number of U.S. Natural Gas Vehicles	2011	2012	2013	2014	2015	Increase in U.S. Natural Gas Prices (Compounded 5-Year Percentage)	Increase in U.S. Natural Gas Expenditures (5-Year Total)
10,000	9%	0.03%	0.02%	0.02%	0.01%	0.01%	0.1%	$137,153,396
50,000	43%	0.13%	0.10%	0.12%	0.03%	0.03%	0.4%	$685,766,981
100,000	85%	0.26%	0.21%	0.25%	0.07%	0.06%	0.8%	$1,371,533,961
150,000	128%	0.39%	0.31%	0.37%	0.10%	0.09%	1.3%	$2,057,300,942
200,000	170%	0.53%	0.41%	0.50%	0.13%	0.12%	1.7%	$2,743,067,923
250,000	213%	0.66%	0.52%	0.62%	0.17%	0.15%	2.1%	$3,428,834,903
300,000	255%	0.79%	0.62%	0.75%	0.20%	0.18%	2.6%	$4,114,601,884
350,000	298%	0.92%	0.73%	0.87%	0.24%	0.21%	3.0%	$4,800,368,864
400,000	341%	1.05%	0.83%	1.00%	0.27%	0.24%	3.4%	$5,486,135,845
450,000	383%	1.18%	0.93%	1.12%	0.30%	0.27%	3.9%	$6,171,902,826
500,000	426%	1.32%	1.04%	1.25%	0.34%	0.30%	4.3%	$6,857,669,806
750,000	639%	1.97%	1.55%	1.87%	0.50%	0.45%	6.5%	$10,286,504,710
1,000,000	851%	2.63%	2.07%	2.49%	0.67%	0.59%	8.7%	$13,715,339,613

Source: Chamberlain Economics, L.L.C.

The figures in Table 9 illustrate a striking fact about federal tax credits for NGVs. The more successful the policy, the more costly its effects in terms of rising U.S. natural gas prices for households and firms. Even under the most ambitious projection of one million new vehicles over five years, NVGs would still represent less than one-half of one percent of the nation's 250 million stock of passenger vehicles. Yet this modest success at transforming the nation's vehicle stock would represent a tremendously costly policy, raising U.S. natural gas prices by an estimated 8.7 percent and overall natural gas expenditures $13.7 billion over five years. This dual-edged nature of federal tax credits makes them a blunt instrument for encouraging the use of alternative transportation fuel in the U.S.

B. GENERAL EQUILIBRIUM IMPACT ON PRICES

In this section, we briefly consider the general equilibrium impact of the bill based on a recent simulation from the U.S. Energy Information Administration. As part of their "Annual Energy Outlook 2010," EIA analysts estimated the impact of federal tax incentives for natural gas vehicles using the National Energy Modeling System (NEMS).[11] The NEMS model is a large-scale, integrated model of the U.S. energy system used to forecast U.S. energy consumption and prices for budgetary purposes and to analyze new energy policies. As part of the 2010 simulation, EIA analysts modeled the impact of federal tax credits for NGVs that are similar to those proposed in H.R. 1380.

The EIA simulation modeled the impact of federal tax incentives for new NGVs equal to 100 percent of the incremental cost over traditional vehicles, which are slightly more aggressive than H.R. 1380's credits equal to 80 percent of the incremental cost. The simulation also modeled incentives for natural gas refueling stations of $100,000 per facility and credits for natural gas fuel of $0.50 per gallon, which are similar to those proposed in H.R. 1380. The EIA study models two scenarios: (1) NGV tax credits expiring in 2019, with the market for NGVs remaining roughly the same size as today's market; and (2) NGV tax credits expiring in 2029, with an expanded market for NGVs.

For the purposes of illustration, we present results from the expanded market sceario in which NGV tax credits remain in place through 2029. While H.R. 1380's credits have only a five-year lifespan, to illustrate their potential long-term impact on the broader economy it is reasonable to assume Congress will renew the policy when it reaches expiration in 2016, as has currently been proposed for federal tax credits that expired in December 2010.

Table 10 presents EIA's simulation results for the impact of federal tax credits on new NGV sales. The simulation is highly conservative in the short-term, assuming essentially no impact from federal credits on NGV sales for several years after the policy is enacted. In the first five years, the modeled tax incentives add just 32,980 NGVs—a small fraction of the 241,000 new vehicles predicted by advocates of H.R. 1380 and less than half the number predicted by the "econometric" scenario modeled in this study. Only after a decade do federal incentives generate the number of new NGVs forecasted by the bill's advocates. However, the EIA predicts dramatic effects if incentives are left in place until 2029, with the simulation predicting more than 3.5 million new NGVs by 2035 or one percent of the existing U.S. passenger vehicle fleet.

[11] See U.S. Energy Information Administration, (2010). "Annual Energy Outlook 2010," Report No. DOE/EIA-0383(2010). The simulations discussed above appear in the section titled, " Natural gas as a fuel for heavy trucks: Issues and incentives" Available at www.eia.gov/oiaf/archive/aeo10/natgas_fuel.html.

TABLE 10. EIA SIMULATION OF THE IMPACT ON U.S. NGVS IN USE

Year	Thousands of New NGVs Baseline	Thousands of New NGVs Policy (Federal Tax Credits with 2027 Phase-Out)	New NGVs from the Policy (Thousands of Vehicles)
2011	0.4	1.27	0.87
2012	0.62	3.46	2.84
2013	0.79	6.64	5.85
2014	1.89	11.04	9.15
2015	2.07	16.34	14.27
2016	4.3	24.7	20.40
2017	6.29	38.22	31.93
2018	7.32	58.53	51.21
2019	8.39	84.23	75.84
2020	9.35	111.91	102.56
2021	9.98	137.77	127.79
2022	10.44	160.84	150.40
2023	10.98	183.31	172.33
2024	11.67	206.06	194.39
2025	12.35	226.74	214.39
2026	12.96	242.46	229.50
2027	15.96	252.9	236.94
2028	16.4	251.36	234.96
2029	16.82	247.92	231.10
2030	17.27	246.72	229.45
2031	17.62	250.55	232.93
2032	17.89	251.73	233.84
2033	18.33	256.53	238.20
2034	21.69	263.22	241.53
2035	22.27	269.52	247.25
Total	n.a.	n.a.	3,529.92

Source: U.S. Energy Information Administration.

Table 11 presents EIA's simulation results for the impact of federal tax incentives on the U.S. price of natural gas. The natural gas price modeled by EIA is the average lower 48 wellhead price, and all figures are in real 2009 dollars.

TABLE 11. EIA SIMULATION OF THE IMPACT ON NATURAL GAS PRICES

Year	Natural Gas Price (Average Lower 48 Wellhead, 2009 Dollars/1000 c.f.) Baseline	Natural Gas Price Policy (Federal Tax Credits with 2027 Phase-Out)	Percentage Increase in Natural Gas Prices	Increased U.S. Natural Gas Expenditures (2009 Dollars)
2011	5.16	5.16	0.00%	$0
2012	5.61	5.63	0.36%	$571,734,403
2013	5.57	5.58	0.18%	$291,445,242
2014	5.53	5.54	0.18%	$293,428,752
2015	5.7	5.72	0.35%	$583,409,474
2016	5.79	5.81	0.35%	$581,281,174
2017	5.8	5.82	0.34%	$586,525,172
2018	5.84	5.86	0.34%	$592,294,521
2019	5.91	5.95	0.68%	$1,190,575,973
2020	6.03	6.09	1.00%	$1,797,804,975
2021	6.12	6.22	1.63%	$3,005,222,222
2022	6.29	6.22	-1.11%	($2,086,313,831)
2023	6.32	6.22	-1.58%	($3,035,686,709)
2024	6.28	6.39	1.75%	$3,444,728,822
2025	6.35	6.58	3.62%	$7,274,592,126
2026	6.5	6.78	4.31%	$8,801,963,692
2027	6.62	6.98	5.44%	$11,380,230,816
2028	6.84	7.24	5.85%	$12,445,929,825
2029	7.06	7.45	5.52%	$11,936,518,980
2030	7.31	7.74	5.88%	$12,919,388,235
2031	7.62	8.03	5.38%	$12,028,625,197
2032	7.72	8.15	5.57%	$12,675,325,000
2033	7.75	8.15	5.16%	$11,956,129,032
2034	7.94	8.23	3.65%	$8,636,601,763
2035	8.06	8.38	3.97%	$9,636,938,958

Source: U.S. Energy Information Administration.

In the first five years of the policy, the simulation finds natural gas prices rise modestly, with increases from zero to 0.036 percent. These modeled price impacts are below those estimated in this study, and are due to the EIA's conservative projection of the number of new NGVs added during the early years of the policy. Only after the first decade of the policy does the EIA simulation find natural gas prices rising by one percent.

While the EIA simulation is more conservative in early years, it predicts a more aggressive impact of the policy in later years than we find in this study. In 2020 through 2035, the EIA estimates between 103,000 and 247,000 new NGVs would be added by federal tax incentives each year. In those years, they estimate natural gas prices would rise between 1 percent and 5.88 percent compared to the baseline forecast. Despite the differences in timing, these estimates are generally of the same magnitude as those developed in this study.

While the EIA simulation predicts small changes in natural gas prices, these translate into significant increases in overall expenditures in the economy. During the first five years of the policy, the EIA estimates imply that total U.S. natural gas expenditures would rise between $291 million and $583 million per year, a figure that lies between the low and "econometric" scenarios modeled in this study. After ten years these costs rise to $3 billion per year in higher natural gas expenditures, rising to as high as $12.9 billion per year in 2030.

A surprising conclusion is that despite significant differences in the underlying methodology, the general equilibrium and partial equilibrium approaches to estimating the impact of H.R. 1380 provides similar overall conclusions about the policy's effects. The two approaches differ in the timing of natural gas price increases, but generally are in agreement about the magnitude of the bill's effects. Most notably for policymakers weighing the costs and benefits of H.R. 1380, natural gas prices rise significantly under either approach, with larger price increases the more effective is the policy at encouraging the use of NGVs throughout the economy.

IV. DISTRIBUTIONAL IMPACT ON HOUSEHOLDS

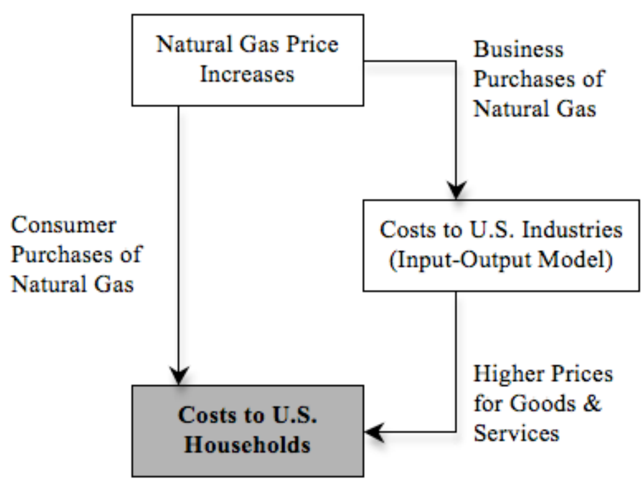
In this section we provide estimates of the distributional impact of H.R. 1380 on U.S. households, illustrating how the baseline estimates of the bill's impact on natural gas prices would affect income groups, age groups, U.S. regions, and various family types.

A. IMPACT OF HIGHER NATURAL GAS PRICES ON HOUSEHOLDS

U.S. consumers are affected by rising natural gas prices through two distinct channels: (1) directly through purchases of natural gas for home heating and appliances; and (2) indirectly through higher production costs for goods and services that use natural gas as an input. Estimating the impact of rising natural gas prices from H.R. 1380 requires dividing the impact into the portion directly affecting households and the portion indirectly affecting them through production costs for firms throughout the economy.

Figure 6 illustrates the conceptual framework for tracing the impact of rising natural gas prices to households. The distributional impact of the portion directly consumed by households can be easily estimated using household surveys of consumption patterns. However, estimating the indirect impact though higher business costs is more complex, requiring us to trace the effects of rising natural gas prices through the various input-output linkages of the economy.

FIGURE 6. CONCEPTUAL FRAMEWORK FOR ESTIMATING HOUSEHOLD IMPACTS FROM NATURAL GAS PRICE INCREASES



Source: Chamberlain Economics, L.L.C.

To estimate the bill's distributional impact, we first divide the policy's impact into the portion borne directly by households and the portion borne indirectly by firms. The household portion is distributed to various income, age, and other demographic groups on the basis of annual natural gas expenditures as reported by U.S. Bureau of Labor Statistics' "Consumer Expenditure Survey." For the portion borne by firms, we make use of a standard 134-industry Leontief model of the U.S. economy, estimating the impact of higher natural gas costs on U.S. industries and ultimately the impact on consumer prices faced by households.[12]

TABLE 12. INCREASED NATURAL GAS EXPENDITURES DISTRIBUTED TO U.S. HOUSEHOLDS (BASELINE SCENARIO)

	2011	2012	2013	2014	2015	*5-Year Total*
Increased Natural Gas Expenditures (2009 Dollars)	$1,028,326,950	$800,923,266	$975,028,309	$262,919,966	$238,198,356	*$3,305,396,847*
Households (Direct)	$318,756,185	$249,225,292	$298,920,790	$80,118,712	$71,594,729	*$1,018,615,708*
Firms (Indirect)	$709,570,764	$551,697,974	$676,107,519	$182,801,253	$166,603,628	*$2,286,781,139*

Source: Chamberlain Economics, L.L.C.

Table 12 summarizes the increased natural gas costs distributed to households. The estimates represent the five-year direct and indirect impact of H.R. 1380 on total natural gas expenditures under the baseline scenario of 241,000 new NGVs from the policy. These figures serve an approximate upper bound of the likely impact on households, as the bill may provide some offsetting savings in the from of reduced tax liabilities and lower vehicle operating costs that are beyond the scope of this study.

i. Impact by Income Group

As with most consumer goods, rising natural gas prices would impose a disproportionate burden on low- and middle-income families. These households typically spend the largest fraction of income on basic utilities such as natural gas, as well as on other goods and services that use natural gas as an input. As a result, policies affecting natural gas prices will typically fall most heavily on the U.S. households least able to bear them.

Under the baseline scenario, we estimate H.R. 1380 would increase natural gas expenditures by $3.305 billion over five years. Table 13 presents estimates of the distributional impact of these costs by cash income quintile as defined by the U.S. Bureau of Labor Statistics' "Consumer Expenditure Survey." Each quintile contains equal numbers of households, and all figures are in real 2009 dollars.

TABLE 13. IMPACT OF INCREASED NATURAL GAS PRICES FROM H.R. 1380 BY INCOME QUINTILE (BASELINE SCENARIO; 2009 DOLLARS)

		Quintiles of Household Cash Income				
	All Households	Lowest 20 Percent	Second 20 Percent	Third 20 Percent	Fourth 20 Percent	Highest 20 Percent
Lower Bound of Household Income	n.a.	n.a.	$19,175	$35,598	$57,295	$93,784
Per Household Increased Natural Gas Expenditures	$27	$13	$20	$24	$32	$48
Increased Expenditures as a % of Income	0.04%	0.14%	0.07%	0.05%	0.04%	0.03%
Aggregate Increased Expenditures ($ million)	$3,305.4	$322.9	$471.7	$589.1	$758.9	$1,162.8

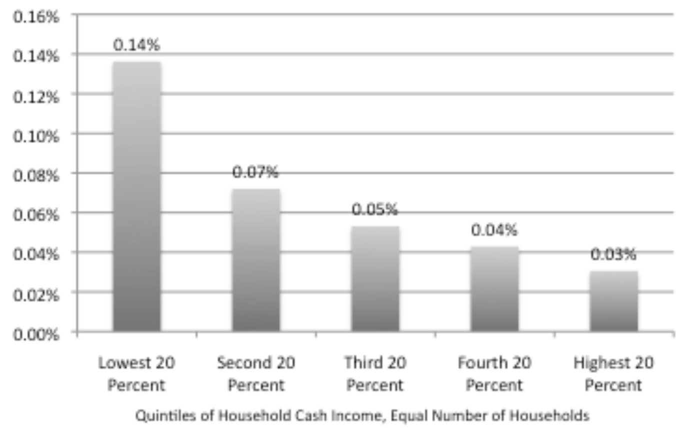
Source: Chamberlain Economics, L.L.C. Input-Output Model; U.S. Bureau of Labor Statistics' "Consumer Expenditure Survey"

Overall, middle- and upper-income groups would bear the largest dollar burden from H.R. 1380, while lower-income groups would bear the heaviest burden as a percentage of

[12] The underlying methodology and data sources for the Chamberlain Economics, L.L.C. Input-Output Model are available in Chamberlain, Andrew. (2009). "Who Pays for Climate Policy? New Estimates of the Household Burden and Economic Impact of a U.S. Cap-and-Trade System," *Tax Foundation Working Paper No. 6*. Available online at www.taxfoundation.org/files/wp6.pdf.

income. Households earning over $93,784 in cash income fall into the highest-earning quintile, and would pay in the aggregate $1.16 billion in higher natural gas costs from the bill, or 0.03 percent of household income. Households in the middle quintile earning between $35,598 and $57,295 would pay in the aggregate $589.1 million in higher natural gas costs, or 0.05 percent of income. And households in lowest-earning quintile earning less than $19,175 per year would pay an aggregate $322.9 million in higher natural gas costs, or 0.14 percent of income.

FIGURE 7. IMPACT OF INCREASED NATURAL GAS PRICES FROM H.R. 1380 AS A PERCENTAGE OF HOUSEHOLD INCOME (BASELINE SCENARIO)



Source: Chamberlain Economics, L.L.C.

Figure 7 presents graphically the impact of H.R. 1380 as a percentage of income. Overall, the bill's impact is regressive across income groups. The lowest-earning households in the nation would shoulder the heaviest burden from the policy as a percentage of income. Households in the lowest income group bear an estimated burden from H.R. 1380 that is 4.7 times larger than the highest-earning 20 percent of households—an unfortunate side-effect of the short-run natural gas price increases from the policy.

ii. Impact by Age Group, U.S. Region and Family Type

The distributional impact of H.R. 1380 can be viewed in a variety of ways beyond cash income groups. In this section we illustrate the bill's impact on a variety of the nation's age groups, U.S. regions, and different family types.

Tables 14, 15 and 16 present a detailed view of the distributional impact of H.R. 1380. Table 14 presents the impact on households by age group, while Table 15 and 16 present the impacts on U.S. regions and different family types, respectively. Overall, the results are a mirror image of the regressive impact of the bill by income groups. The heaviest burdens as a percentage of income are borne by elderly households aged 75 years and older, households in Midwestern U.S. states, and families comprised of single parents with at least one child under age 18.[13] Not surprisingly, these households also generally fall into the bottom three quintiles of the nation's income distribution.

TABLE 14. IMPACT BY AGE GROUP (BASELINE SCENARIO)

		Age of Household Head						
	All Households	Under 25 Years	25-34 Years	35-44 Years	45-54 Years	55-64 Years	65-74 Years	75 Years and Older
Per Household Increased Natural Gas Expenditures	$27	$15	$25	$30	$32	$30	$26	$22
Increased Expenditures as a % of Income	0.04%	0.06%	0.04%	0.04%	0.04%	0.04%	0.06%	0.07%
Aggregate Increased Expenditures ($ million)	$3,305.4	$119.1	$502.5	$701.5	$807.4	$596.9	$324.7	$253.3

Source: Chamberlain Economics, L.L.C.

TABLE 15. IMPACT BY U.S. REGION (BASELINE SCENARIO)

		U.S. Region			
	All Households	Northeast	Midwest	South	West
Per Household Increased Natural Gas Expenditures	$27	$33	$31	$22	$28
Increased Expenditures as a % of Income	0.04%	0.046%	0.052%	0.037%	0.043%
Aggregate Increased Expenditures ($ million)	$3,305.4	$742.2	$849.0	$943.7	$770.5

Source: Chamberlain Economics, L.L.C.

TABLE 16. IMPACT BY FAMILY TYPE (BASELINE SCENARIO)

			Husband and Wife with Children					
	All Households	Husband and Wife Only	Husband and Wife with Children: Oldest Child Under 6	Husband and Wife with Children: Oldest Child 6 to 17	Husband and Wife with Children: Oldest Child 18 or Older	Other Husband and Wife	One Parent, at Least One Child Under 18	Single Person and Others
Per Household Increased Natural Gas Expenditures	$27	$33	$33	$37	$40	$35	$21	$20
Increased Expenditures as a % of Income	0.04%	0.043%	0.040%	0.039%	0.041%	0.040%	0.059%	0.048%
Aggregate Increased Expenditures ($ million)	$3,305.4	$853	$184	$558	$357	$169	$148	$1,035

Source: Chamberlain Economics, L.L.C.

Figures 8, 9 and 10 present the figures from Tables 14, 15 and 16 graphically. As is clear from the figures, the distributional impact of H.R. 1380 is estimated vary widely across the nation's age groups, U.S. regions and family types. In each case, we estimate the heaviest relative burdens of the policy would be borne by households with the lowest annual incomes.

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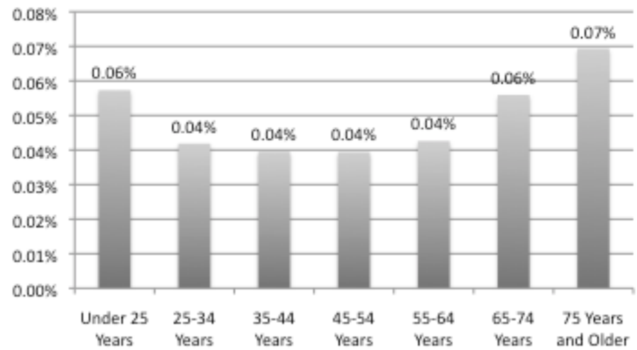
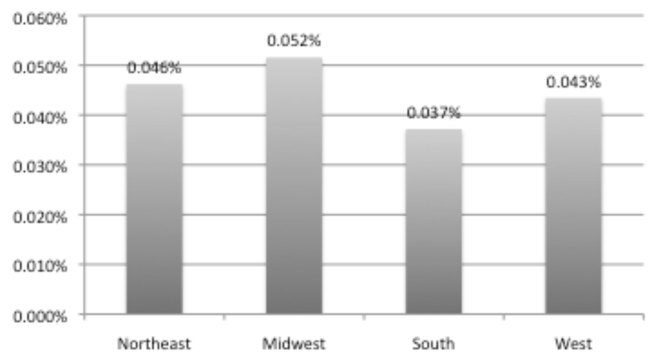
[13] The regional classifications are from the U.S. Bureau of Labor Statistics' Consumer Expenditure Survey (CEX). "Midwest" includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; "Northeast" includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; "South" includes Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; and "West" includes Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

FIGURE 8. IMPACT AS A PERCENTAGE OF INCOME BY AGE GROUP (BASELINE SCENARIO)



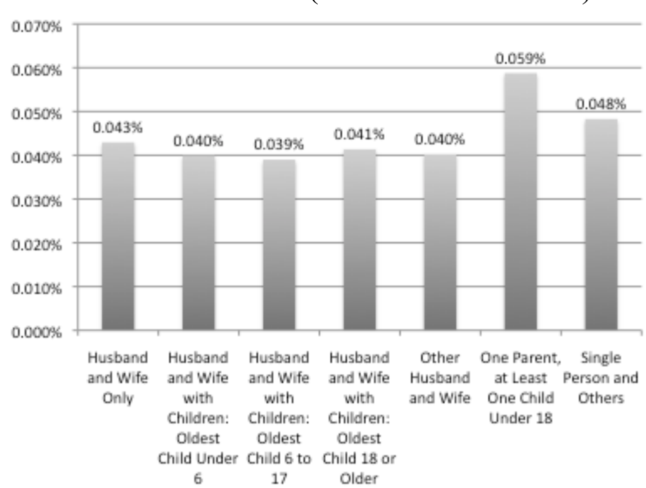
Source: Chamberlain Economics, L.L.C.

FIGURE 9. IMPACT AS A PERCENTAGE OF INCOME BY U.S. REGION (BASELINE SCENARIO)



Source: Chamberlain Economics, L.L.C.

FIGURE 10. IMPACT AS A PERCENTAGE OF INCOME BY FAMILY TYPE (BASELINE SCENARIO)



Source: Chamberlain Economics, L.L.C.

B. IMPACT ON U.S. INDUSTRIES

Natural gas is widely used as a productive input by a variety of U.S. industries. Industrial and commercial purchases account for roughly 70 percent of total U.S. natural gas demand. In this section we explore the potential impact on U.S. industries from H.R. 1380's natural gas price increases.

Table 17 presents the 40 U.S. industries most heavily dependent on natural gas as a productive input. For each industry, it shows the output required from the natural gas industry, both directly and indirectly, in order to produce one dollar of economic output in that industry. The data are from the U.S. Bureau of Economic Analysis' 2002 benchmark input-output accounts.[14]

TABLE 17. TOP 40 U.S. INDUSTRIES MOST DEPENDENT ON NATURAL GAS

Industry	Natural Gas Output Required (Directly and Indirectly) for Each Dollar of Final Demand Produced
Natural gas distribution	$1.008
Agricultural chemical manufacturing	$0.084
Basic chemical manufacturing	$0.044
Pulp, paper, and paperboard mills	$0.036
Iron and steel mills and manufacturing from purchased steel	$0.028
Metal ores mining	$0.028
Resin, rubber, and artificial fibers manufacturing	$0.027
Nonmetallic mineral product manufacturing	$0.025
Petroleum and coal products manufacturing	$0.025
Nonmetallic mineral mining and quarrying	$0.024
Nonferrous metal production and processing	$0.020
Textile mills	$0.019
Converted paper product manufacturing	$0.017
Educational services	$0.017
State and local government enterprises	$0.017
Forging and stamping	$0.016
Food manufacturing	$0.016
Crop production	$0.015
Textile product mills	$0.015
Foundries	$0.015
Support activities for agriculture and forestry	$0.014
Pipeline transportation	$0.014
Paint, coating, and adhesive manufacturing	$0.014
Other chemical product and preparation manufacturing	$0.014
Coal mining	$0.014
Plastics and rubber products manufacturing	$0.013
Boiler, tank, and shipping container manufacturing	$0.013
Apparel manufacturing	$0.013
Support activities for mining	$0.012
Leather and allied product manufacturing	$0.012
Animal production	$0.012
Beverage manufacturing	$0.012
Other fabricated metal product manufacturing	$0.011
Architectural and structural metals manufacturing	$0.010
Printing and related support activities	$0.009
Other electrical equipment and component manufacturing	$0.009
Cutlery and hand tool manufacturing	$0.009
Oil and gas extraction	$0.009
Motor vehicle body, trailer, and parts manufacturing	$0.009
Soap, cleaning compound, and toiletry manufacturing	$0.009

Source: U.S. Bureau of Economic Analysis, 2002 Benchmark Input-Output Accounts

[14] See U.S. Bureau of Economic Analysis, 2002 "Industry-by-Industry Total Requirements after Redefinitions."

Excluding the natural gas distribution industry, agricultural chemical manufacturing is the nation's most heavily dependent industry on natural gas, requiring 8.4 cents of natural gas production for each dollar of output. Natural gas serves as a key ingredient in many nitrogen-based fertilizers that are widely used throughout U.S. agriculture. By some estimates natural gas accounts for 80 percent of the production cost of ammonia, a basic ingredient in nitrogen fertilizers,[15] making the industry highly vulnerable to changes in natural gas prices. Other heavily dependent U.S. industries include basic chemical manufacturing; pulp and paper mills; iron and steel mills; metal ores mining; and resins and rubber manufacturing.

Using the Chamberlain Economics Input-Output model, we simulate the impact on production costs for 134 U.S. industries from the bill.[16] Under the baseline scenario, we estimate the bill will increase natural gas expenditures for U.S. firms by $2.287 billion over five years. The model estimates how these increased natural gas costs flow from the natural gas industry through the various productive channels of the economy, ultimately resulting in higher production costs for a wide range of U.S. industries.

Table 18 presents results from the input-output simulation. For each industry, the table shows the percentage increase in production costs from H.R. 1380 under the baseline scenario, as well as the dollar increase in costs and percentage of the total economy-wide burden of the policy. As expected, the most heavily affected industry is agricultural chemicals. U.S. fertilizer producers would face the largest production cost increases of any industry, a 0.29 percent increase for an aggregate cost of $54 million over the life of the bill.

Basic chemicals manufacturing is the second most heavily affected industry, and would face a 0.153 percent cost increase or $169 million, the largest dollar cost increase of any U.S. industry. They are followed by pulp and paper manufacturing, which would face a 0.127 percent cost increase or $93.6 million over five years. As is clear from the table, nearly every U.S. industry would be affected in some way by rising natural gas prices from the bill. However, the policy's impact would be highly concentrated in just a few U.S. industries, with agricultural fertilizers and basic chemical manufacturing bearing the heaviest burden from H.R. 1380.

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[15] Wilson, Stephen R. (June 21, 2011). "Letter: Bill Proposes Unneeded Subsidy," *Baton Rouge Advocate*. Available at http://theadvocate.com/news/opinion/217238-63/letter-bill-proposes-unneeded-subsidy.html.

[16] See Section IV for a discussion of the underlying input-output model methodology.

TABLE 18. IMPACT OF H.R. 1380 ON PRODUCTION COSTS FOR VARIOUS U.S. INDUSTRIES (BASELINE SCENARIO)

Industry	Percentage Increase in Production Costs	Increased Production Costs (2009 Dollars)	Percentage of Total Economy-Wide Cost Increases
Agricultural chemicals	0.290%	$54,083,614	2.4%
Basic chemicals	0.153%	$169,073,627	7.4%
Pulp, paper, and paperboard	0.127%	$93,550,195	4.1%
Primary ferrous metal products	0.099%	$80,491,864	3.5%
Metal ores mining	0.099%	$6,944,258	0.3%
Resins, rubber, and artificial fibers	0.096%	$58,930,269	2.6%
Nonmetallic mineral products	0.087%	$93,255,425	4.1%
Petroleum and coal products	0.087%	$158,773,835	6.9%
Nonmetallic mineral mining and quarrying	0.085%	$18,961,953	0.8%
Primary nonferrous metal products	0.071%	$48,600,045	2.1%
Yarn, fabrics, and other textile mill products	0.067%	$31,557,056	1.4%
Converted paper products	0.060%	$49,667,897	2.2%
State and local government enterprises	0.058%	$41,039,662	1.8%
Forgings and stampings	0.057%	$13,392,337	0.6%
Educational services	0.056%	$11,661,765	0.5%
Food products	0.055%	$117,037,719	5.1%
Crop products	0.053%	$47,851,814	2.1%
Foundry products	0.053%	$15,461,427	0.7%
Nonapparel textile products	0.052%	$7,993,664	0.3%
Support activities for agriculture and forestry	0.051%	$7,114,324	0.3%
Pipeline transportation	0.049%	$11,157,642	0.5%
Coal mining	0.048%	$11,137,705	0.5%
Paints, coatings, and adhesives	0.048%	$13,162,107	0.6%
Other chemical products	0.048%	$17,224,433	0.8%
Plastics and rubber products	0.047%	$81,252,360	3.6%
Boilers, tanks, and shipping containers	0.046%	$10,508,230	0.5%
Mining support services	0.044%	$1,645,034	0.1%
Apparel	0.043%	$5,018,648	0.2%
Leather and allied products	0.041%	$2,251,727	0.1%
Animal products	0.041%	$44,998,032	2.0%
Beverage products	0.040%	$6,015,539	0.3%
Other fabricated metal products	0.037%	$52,230,743	2.3%
Architectural and structural metal products	0.035%	$22,634,461	1.0%
Printed products	0.033%	$35,535,398	1.6%
Other electrical equipment and components	0.033%	$10,415,021	0.5%
Oil and gas extraction	0.032%	$69,678,542	3.0%
Cutlery and handtools	0.031%	$2,651,683	0.1%
Motor vehicle bodies, trailers, and parts	0.031%	$72,246,044	3.2%
Natural gas distribution	0.031%	$16,825,127	0.7%
Soaps, cleaning compounds, and toiletries	0.030%	$6,021,001	0.3%
Household appliances	0.030%	$1,309,556	0.1%
Wood products	0.029%	$30,488,841	1.3%
Motor vehicles	0.029%	$1,087,092	0.0%
Agriculture, construction, and mining machinery	0.029%	$2,746,048	0.1%
Ordnance and accessories	0.028%	$646,399	0.0%
General state and local government services	0.027%	$13,939,878	0.6%
All other industries (87 industries)	<0.019%	$618,511,097	27.0%
Total	n.a.	$2,286,781,139	100.0%

Note: Complete table of 134 industry impacts on production costs is available upon request.
Source: Chamberlain Economics, L.L.C. Input-Output Model.

An important limitation the above figures are that they may not represent a complete accounting of the potential impact of H.R. 1380 on industries. In this study we model only the additional costs from rising natural gas prices due to the bill's tax credits for NGVs. As noted above, the bill may also provide some offsetting benefits for industries in the form of reduced tax liabilities or potentially reduced fleet operation costs. While these effects may be important for some industries, they are beyond the scope of this study and we do not estimate their value or distribution across U.S. firms.

V. CONCLUSION

An important difference between the market for crude oil and the U.S. market for natural gas is their geographic scope. While the global market for crude oil is large and flexible, the U.S. market for natural gas is regional and characterized by short-term bottlenecks in production. As a result, while domestic tax policies have little effect on crude oil prices, they can significantly impact U.S. natural gas prices.

Federal tax credits for NGVs are well intentioned, aiming to lower U.S. transportation carbon emissions and reduce imports of crude oil from politically volatile Middle-Eastern regimes. However, by encouraging U.S. consumers to shift from gasoline and diesel fuels to natural gas, a significant consequence of the policy will be higher U.S. natural gas prices faced by households and companies.

We estimate the impact of H.R. 1380 on U.S. natural gas prices under four scenarios of the policy's effectiveness. In each, the impact on prices is directly related to the success of the policy at promoting sales of new NGVs. The more successful the policy, the larger is the impact on prices and total natural gas expenditures.

Under the baseline scenario, we find the bill would raise U.S. natural gas prices by 2.06 percent, for a total cost to the economy of $3.305 billion over five years. Results from the high and low scenarios suggest the bill may raise prices by as much as 2.98 percent or $4.78 billion, or as low as 1.14 percent or $1.83 billion. In all cases, roughly 70 percent of cost of the policy is borne by U.S. companies in the form of higher production costs, with the remaining 30 percent borne by households in the form of higher utility costs.

Distributionally, we find the costs of H.R. 1380 would be regressively distributed across income groups, with the heaviest relative burdens falling on low-income households, households over age 75, households in the U.S. Midwest, and single parents with at least one child under age 18. In terms of U.S. industries, the most heavily affected would be agricultural fertilizer producers, basic chemical manufacturers, pulp and paper mills, and metal ores mining. Under the baseline scenario the bill would increase production costs for U.S. companies by roughly $2.29 billion over the life of the bill.

Using the stick of federal tax policy to guide transportation decisions rather than the carrot of ordinary market prices results in significant hidden costs to the economy in the form of artificially high U.S. natural gas prices. Federal tax policy remains a blunt instrument for promoting alternative-fueled vehicles, and lawmakers debating H.R. 1380 should be wary of these hidden costs of federal tax subsidies for natural gas vehicles.

VI. Appendix: Methodology and Data Sources

This section provides background on the input-output model used to simulate the industry-level effects of H.R. 1380, as well as the econometric estimates of the impact of previous federal tax credits for NGVs.

A. Distributional Impact on Production Costs

The analysis of H.R. 1380's impact on production costs to U.S. industries is based on a Leontief input-output model developed by Chamberlain Economics, L.L.C. for use in modeling the impact of tax and climate policies on U.S. households. The model simulates the production relationships among 134 U.S. industries and consumer prices, both with and without NGV tax credits, based on the following equations:[17]

(1) Production Costs without H.R. 1380 (Industry Level): $P_i = (I - A')^{-1} \cdot V$

(2) Production Costs with H.R. 1380 (Industry Level): $\hat{P}_i = (I - A' \cdot T)^{-1} \cdot V$

V is an *n x 1* vector of each industry's value added, $(I - A' \cdot T)^{-1}$ is the Leontief inverse matrix, T is an *n x n* matrix with (1 + industry effective natural gas cost increase from the policy t) along the diagonal and zeros elsewhere. Under the baseline scenario the bill increases the cost of natural gas used as a productive input by 3.6 percent. This is the value used for t corresponding to the natural gas industry in the T matrix.

The model is based on the 2002 benchmark input-output accounts from the U.S. Bureau of Economic Analysis. To allow industry costs increases to be distributed to households, the model also incorporates 2009 expenditure and other data from the U.S. Bureau of Labor Statistics' Consumer Expenditure Survey (CEX). For additional detail on the mathematical structure of the model, see Chamberlain (2009).

B. Econometric Estimates

The data for the econometric estimates in Section III are based on three sources. The number of NGVs in use is from annual U.S. Energy Information Administration figures from Form EIA-886, "Annual Survey of Alternative Fueled Vehicles." Monthly prices for new gasoline-powered vehicles are from the U.S. Bureau of Labor Statistics' "Consumer Price Index" (All Urban Consumers, U.S. City Average). Quarterly data on real U.S. investment in transportation equipment is from the U.S. Bureau of Economic Analysis, NIPA Table 5.3.3. All quarterly and annual data are cubic spline interpolated to be consistent with monthly auto price data, providing a total of 216 monthly observations.

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[17] For the complete methodology, see Andrew Chamberlain, "Who Pays for Climate Policy? New Estimates of the Household Burden and Economic Impact of a U.S. Cap-and-Trade System," *Tax Foundation Working Paper No. 6*. (March 2009).

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