Market Failure in the U.S. Petroleum Industry

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1 Market Failures

Market Failures [9] occur when markets don't allocate goods and services efficiently. They also arise when market forces fail to serve the perceived public interest. We can easily see how market failure becomes a reality in the oil/gasoline industry. There are several types of market failures (imperfect competition/market power, transaction cost, imperfect information, organizational failures and externalites). However, we will pay most attention to market failures that arise from externalities.

1.1 Externality

An externality [8] is present whenever some individual's utility or production relationship include real (not monetary) damages or benefits without particular attention to the effects on another individual's welfare. If the externality results in a loss of welfare, then it is a negative externality.

1.1.1 Should the victims of externalities be compensated? [6]

When talking about compensation to the victims of externalities, we need first to evaluate the price system. The term "price system" is used to describe any economic system that affects the distribution of goods and services. In this case each firm or individual should pay when a individual or firm causes negative externalities, such as emissions, and the individual or firm that suffers from this externality should receive some monetary compensation in return.

1.1.2 An example of an externality

Cigarette smoke is a great example of a negative externality [7]. The fact that my house could be full of cigarette smoke will not reduce or increase the welfare of my neighbor. In this case I should be charged a zero price and my neighbor should receive no compensation. Now, look at a different situation: What if the smoke coming from my house spilled over to not only to my neighbor's house but to the whole neighborhood? If all my neighbors were paid for the unpleasantness, laundry bills, damage to their house and so on they would be less angry with me. But, if I were to be taxed, how much would I have to pay? How much money would I have to pay for each of my neighbor's inconvenience? One neighbor could be more

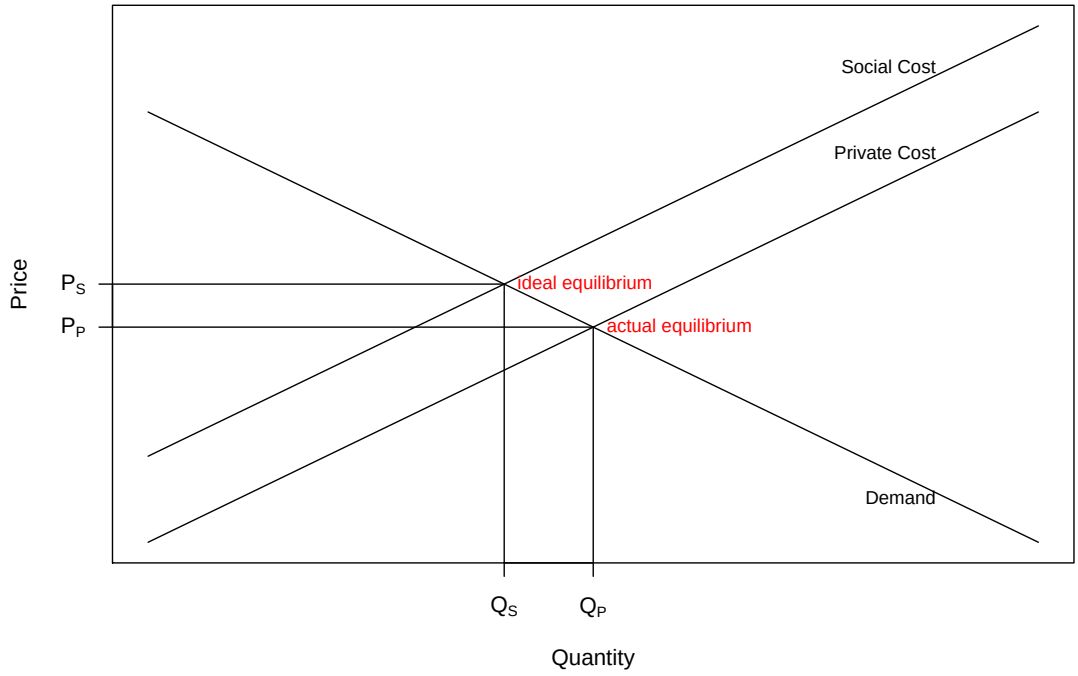


Figure 1: Social Costs of Negative Externality

inconvenienced than another and so on. How would this be measured? It becomes almost impossible to come up with a monetary compensation. However, assuming a large number of consumers and a large number of producers exist for this given externality (therefore we have a perfect competition scenario and everyone in this economy is a price taker) and using the Pareto Optimality (given a set of alternative allocations and a set of individuals, a movement from one allocation to another that can make at least one individual better off, without making any other individual worse off) we could come up with a model. Here is the identification process for for this problem: [10] X_{ij} is the amount of good i consumed by individual j, $(i = 1, \ldots, n)$ and $(j = 1, \ldots, m)$, Y_{ik} is the amount of good i produced by individual k where $(i = 1, \ldots, n)$ and $(k = 1, \ldots, h)$, R_i is the total quantity of resource i available to the community, S_k is the emission of externality (smoke) by individual k, $Z = \sum S_k$ is the total emissions in the community, $U^i(x_{1j}, \ldots, x_{nj}, Z)$ is individual j's utility function and $F^k(Y_{1k}, \ldots, Y_{nk}, S_k, Z) \leq 0$ is individual k's production function. Here the variable z in each utility and production function represents the possibility that the utility(production) of the corresponding individual (producer) is affected by the output of the externality in the community.

1.1.3 The Tragedy of the Commons

The Tragedy of the Commons [5] occurs when there is a common resource that can be used freely by society but each individual fails to think about how their actions might harm others. Today, this problem is very apparent with global air pollution. Most of the time the effects go from one area to the next: my community is hurt by the smoke when I burn leaves; Canada is hurt by the acid rain from American power plants. Even with regional agreements, these cross-border environmental externalities (such as the 1991 U.S Canada Agreement on Air Quality) [1], cannot control the truly global environment problems.

1.1.4 The Rio Earth Summit and The Kyoto Protocol [3]

About 20 years ago, as scientists became aware of the changes in the global climate, the world realized that was a real threat from earth's climate change. In 1992, the U.S. and 152 other nations signed the The Rio Earth Summit, which became the cornerstone of the international community's attempts to control air pollution on the planet. Then in 1997, the Kyoto Protocol was born. Its task was to create a way of cutting emissions that was fair and efficient, minimizing the economic cost of reducing emissions in the atmosphere. However, the U.S stayed out of this agreement as its senate suggested that the Kyoto Protocol would result in serious harm to the economy of the United States. Part of the reason for the refusal [2] of the United States to go along is clear: doing anything about global warming imposes costs on some very influential industries (auto, oil and coal). Some economists and businessmen say that parts of the United States may be better off as growing seasons in the northern states lengthen. At the last annual meeting in Davos, oil executives talked about the new opportunities that global warming is providing: the melting of the polar ice caps will make the oil beneath the Artic more accessible for drilling.

1.1.5 Social Costs

"...there is a need for public research to be complemented with private, which is why getting the "prices right" - that is, making households and firms pay the social costs of emissions - is so important" Joseph Stiglitz [4]

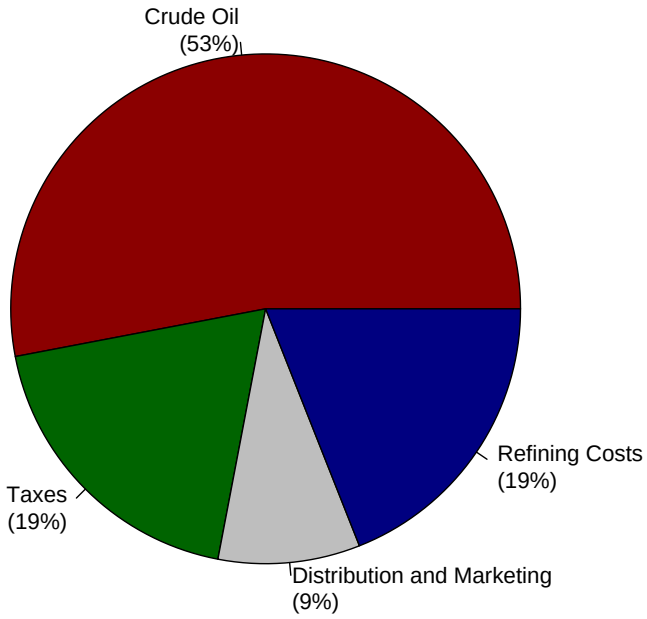
Joseph Stiglitz is the former World Bank Senior Vice President and Chief Economist, he is also the former Chairman of the Board of Economic Advisor's in the Bill Clinton presidency.

2 Pricing Gasoline

In this section, we begin by discussing the main factors contributing to gasoline price. The ultimate aim is to show that there are many effects of oil/gas consumption that are not accounted for in the price of gasoline. The next section will discuss some of the factors that are not accounted for in the price of gasoline.

2.1 Pricing Factors

Figure 2 shows a breakdown of the price of a gallon of regular unleaded gasoline presented in an Energy Information Agency report [15]. Over half the cost of a gallon of gas comes from the cost of crude oil. The Government Accountability Office (GAO) [11] also confirms this fact in a report they published on gasoline price volatility. Other costs are included in the price of gasoline such as state and local taxes, distribution and marketing and refining costs. According to the GAO [11] the structure of the gasoline market also plays a role in determining gasoline price.



Source: Energy Information Administration, Washington DC

Figure 2: What do we pay for in a gallon of gas?

2.1.1 Crude Oil Price

As mentioned before, the main determinant of gasoline price is the price of crude oil. Figure 3 shows a graph of monthly crude oil and gasoline prices. Figure 4 plots the price per gallon of gasoline against the price per barrel of crude oil. Both Figure 3 and Figure 4 show the

high correlation between gasoline and crude oil prices. In order to understand gasoline prices, we will take a closer look at crude oil prices. However, there are surprisingly few factors involved in the pricing of crude oil. Current estimates of crude oil production costs are $6.00 per barrel for non-OPEC producers and $1.50 per barrel for OPEC producers [14]. Current crude oil prices are in the $50 - $60 per barrel range. This means that it is practically free for oil producers to get oil out of the ground and is not, therefore, a main factor determining the price of oil.

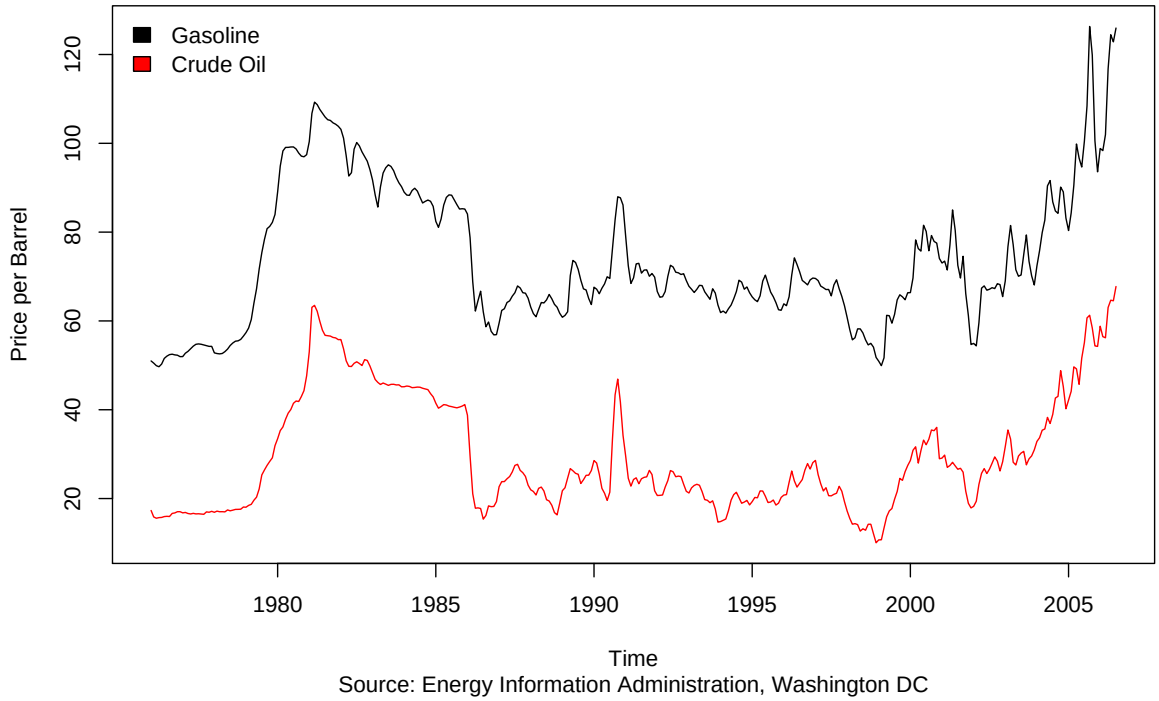


Figure 3: Monthly Gasoline and Crude Oil prices 1976-2006

MacAvoy [13] has a succinct explanation of how the market prices oil. In summary, he says that the supply of oil is determined by the volume of both previously developed and newly discovered reserves and by the rate of extraction, both determined by prices offered for the oil. Oil demand is determined by the efficiency and rate of use of gas and oil burning machinery. Again, efficiency and rate of use are influenced by the price of oil. The market is in equilibrium when increases or decreases in production and demand together result in no additional price movement.

There are many issues affecting oil supply and demand. No discussion of supply and demand within the oil industry is complete without mentioning the Organization of the Petroleum Exporting Countries (OPEC). OPEC attempts to stabilize the price of oil by controlling production. Reasons they give for this are to secure an efficient, economic

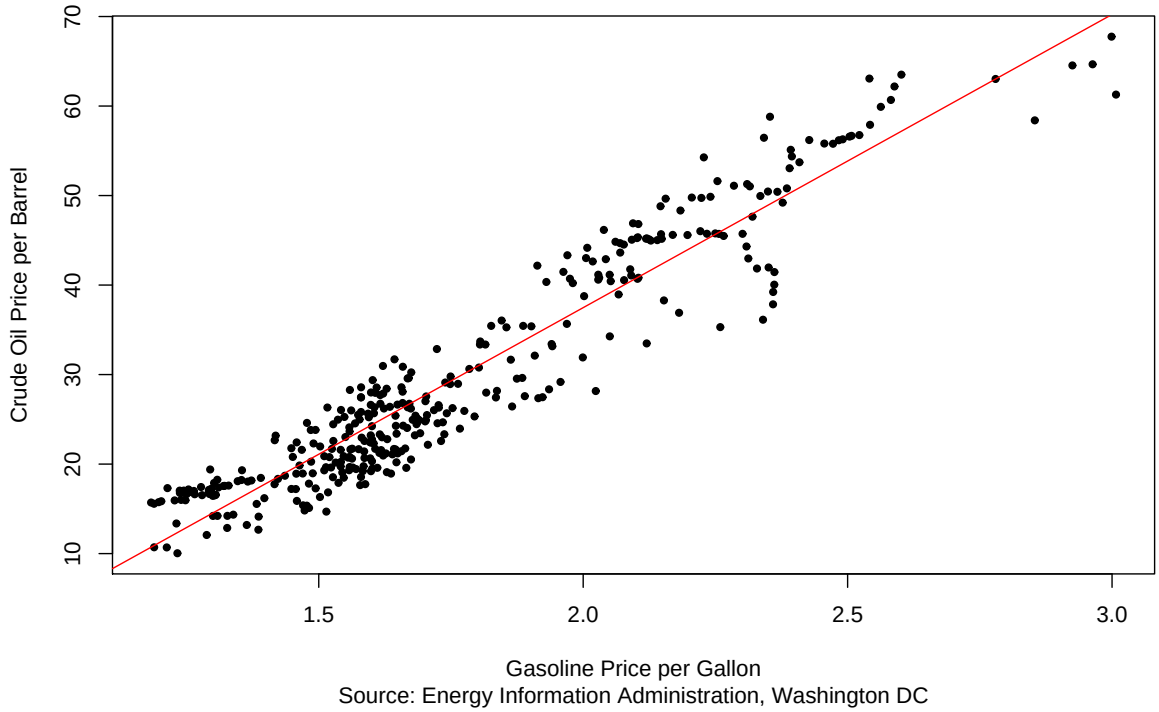


Figure 4: Relationship between Gasoline and Crude Oil prices

and regular supply of oil to consumers and provide a steady income and fair return for producers[1]. Unfortunately, OPEC does not always come through with their stated purpose. OPEC's effectiveness at controlling prices has fluctuated over time. One of the privileges OPEC enjoys is to withhold oil supply when they think it will be advantageous. For example, in the 1970's OPEC instituted an oil embargo by restricting supply to the point that there were long lines in the United States at gas stations. Today, OPEC is not as powerful as it once was, due to development in the Gulf of Mexico and other areas in world and problems enforcing its quotas within the organization.

The energy crisis caused by OPEC in 1979 is a good example of how politics can affect the price of oil. According to Williams [16], price controls were instituted by the United States government to lessen the impact of the 1973-74 price increase. These controls reduced the price of domestic oil for consumers. The effect was that consumers paid 50% more for imported oil than for domestic oil or, in other words, domestic companies recieved less than the world market price. In response to the price controls, domestic oil producers curtailed exploration and production. When the price controls were lifted in 1981, the price of oil sky rocketed. This can be seen in Figure 5 which shows monthly oil supply and price from 1976 through 2006. Each variable was standardized to fit on the same graph and all

[1]OPEC's mission statement http://www.opec.org

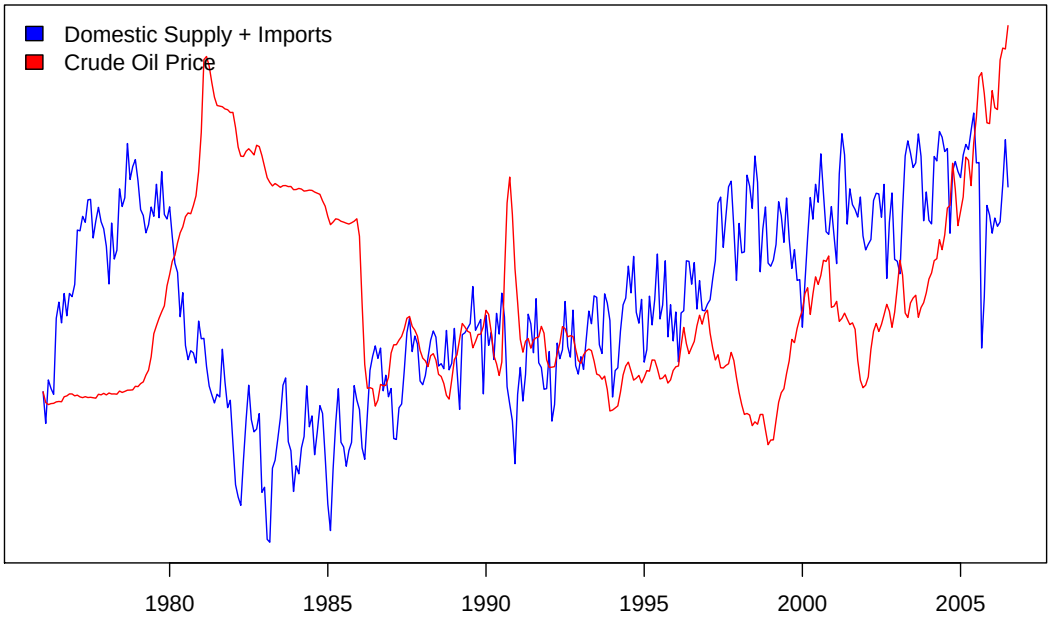


Figure 5: Supply, Demand and Prices for Crude Oil

prices have been adjusted for inflation. The price decreased steadily until late 1986 when it fell dramatically. Notice also that when price increases, supply decreases and vice versa. During the period of high prices in the early 1980's, inovations in home insulation and automobile fuel economy reduced the demand for oil causing a reduction in price. This can be seen in Figure 6 where high gasoline prices in the early 1980's seem to have caused an increase in average fuel economy for cars sold in the United States.

Current trends in oil prices reflect increasing conflict in the Middle East and diminishing domestic oil production. There have been temporary upward spikes corresponding to the first Gulf War. More recently, the second Gulf War and hurricanes have caused glitches in supply and subsequent price spikes. The most significant cause of price increases in the last few years has been increased demand from developing Asian countries such as China and India. Global oil demand can have dramatic effects on domestic oil prices.

2.1.2 Other Factors Contributing to Gas Price

Crude oil needs to pass through a complicated refining process before being usable as gasoline. According to the EIA [15] refining costs make up 19% of the cost of a gallon of gas. Refining capacity can affect the price of gasoline, dramatically sometimes. The most obvious occurance was in the aftermath of hurricane Katrina when the refining facilities

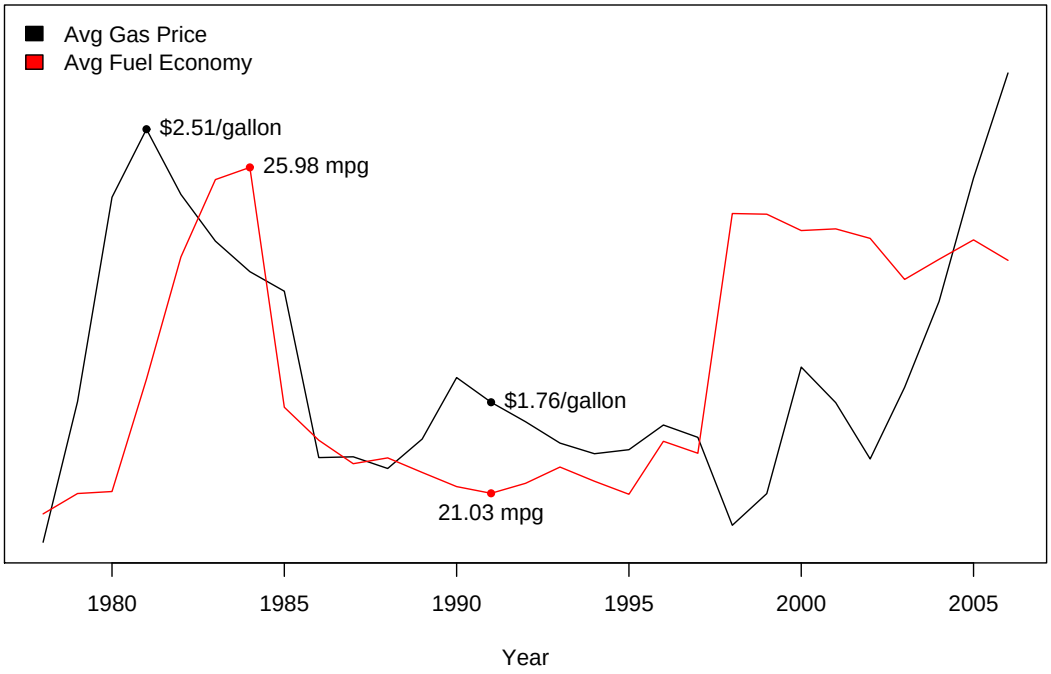


Figure 6: Gasoline Price vs Average Vehicle Fuel Economy

in New Orleans were damaged. Another difficulty is that refining capacity in the United States has not increased in the last 25 years [11]. This may contribute to higher prices as demand is projected to increase by 20% by 2020 [11].

Finally, the structure of the gasoline market has an affect on the price paid by consumers. There was a wave of mergers within the gasoline industry that resulted in an increase of one to seven cents per gallon [11]. About 85% of these mergers occurred in the exploration and production segment of the market, 13% of the mergers were in the marketing and refining segment and 2% in the transportation segment.

3 Variables Absent in Petroleum Pricing

We will now transition into presenting variables which are not accounted for, but should be present, in petroleum pricing. By identifying factors inherent in the petroleum markets that are not incorporated in the price, we will illustrate the blatant market failure occurring in this industry.

3.1 Environmental and Health Impact

Market failure in Environmental Economics occurs when the supply function does not embody all costs of producing and consuming goods. This is also defined as when the price of a good or service falls short of reflecting the true cost to society of the activity [17]. When you begin to consider the environmental impact of the extraction, refining, transportation, and consumption of crude oil it becomes clear these activities are drastically under-accounted for, and possibly not even considered, in the current-day pricing model for petroleum in the United States. We will identify a few core areas where the detrimental environmental impact should be accounted for in an optimal pricing model. While a complete list of the negative side effects would be much more comprehensive, we hope the ideas presented below are sufficient to prove serious market failure in the petroleum industry.

3.1.1 Greenhouse Gas Emissions

Instead of debating whether the emissions of greenhouse gases are harmful and create anthropogenic warming of the globe; we will rely on the scientific consensus, led by the Intergovernmental Panel on Climate Change, that climate change is a reality and humans are largely responsible for this phenomenon [18]. We also believe that climate change is one of the most significant challenges facing humanity and its environmental impact is of paramount significance to the future energy, natural resource, and overall economic concerns of the planet.

Recently, one of the world's foremost economists, and former chief economist at the World Bank, Sir Nicholas Stern expressed sizable concern over the economic consequences of climate change. After finishing a year-long investigation, Stern concluded global warming could create a 5-20% drop in total world wealth before the end of this century [19]. He forecasted huge disruptions to food production as a result of drought; fresh water supply to nearly a billion people melting away as glaciers disappear; hundreds of millions displaced from their homes due to sea level rise; and potentially large increases in the rate and ferocity of hurricanes. Globally, the monetary impact could approach $4 trillion by the end of the century. As a result, Stern concluded that "economically speaking, mitigation taking strong action to reduce emissions, is a very good deal". This may be a worst case scenario but demonstrates some of the possible consequences of low gasoline prices and its externalities.

The two most prominent greenhouse gases creating anthropogenic warming are also ubiquitous by-products of petroleum consumption. Both carbon dioxide (CO_2) and methane, which has a greenhouse effect 20 times more potent than CO_2, are released as a result of gasoline consumption. Given the United States' tremendous reliance on oil for energy (873.6 million gallons/day in 2005, 25% of the world total) [20], there is an equally prodigious amount of greenhouse gases created as a result. The U.S. Energy Information Administration (EIA) reports that residential and commercial activities in 2003 produced 157.2 million metrics tons of carbon dioxide, and 1.20 million metric tons of methane [20]. When only considering CO_2, that is still over 314 billion pounds of greenhouse gases entering the atmosphere yearly as a result of petroleum consumption. Given the overwhelming evidence of this activity's contribution to global warming, there should be some amount of this accounted for in the price of oil to reflect an accurate cost to society and the environment.

Currently, it is erroneously overlooked in the pricing model of the U.S.

3.1.2 Impact Beyond Global Warming

Apart from the emissions of greenhouse gases, petroleum production and consumption are associated with other harmful externalities worth considering. Pollution to air, water, and land all occur as a result of the market activities of petroleum. While it is difficult to assign exact amounts to the cost of these damages, we can be certain they exist and know they are not accounted for in the pricing of petroleum. We will go on to identify just a few examples where the negative externalities are not absorbed by direct market participants, but by society and the environment as a whole.

Smog, whose primary component is ozone, is a malignant side effect from the burning of petroleum. The Environmental Protection Agency (EPA) [21] identifies smog as a serious air quality problem and attributes it to numerous negative health effects such as chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma by reducing lung function and repeated smog exposure can permanently scar lung tissue. The increasing consumption of petroleum each year no doubt contributes to the health problems mentioned; however, the costs are levied on the health care and quality of life of all residents rather than incurring them based on the level of market involvement and ultimate creation of smog pollution.

Another less discussed, but equally harmful, side effect of petroleum based activities is the pollution of global water sources. Petroleum products get into water mainly through accidental spills from ships, pipelines, tanker trucks, and leaky underground storage tanks. While the cleanup costs of such disasters are paid for by the parties involved, the environmental damages are rarely included in pricing the final petroleum products. Furthermore, the increasing CO_2 concentrations mentioned earlier are known to be raising water acidity well beyond desirable levels. Richard Seely [22] from the National Oceanic & Atmospheric Administration (NOAA) points to evidence that ocean acidity has already increased 30 percent since the start of the Industrial Revolution, identifying a dramatic impact on the earth's ecosystem. The effect is greatly altering the amount of coral reef by inhibiting its ability to form and survive in a drastically different environment. Also at risk are 25 percent of the earth's marine creatures which spend some amount of their lives on the reefs. Additionally, many of the affected organisms are significant food sources for commercial fish, such as salmon.

Finally, we would like to briefly point out the environmental effect petroleum extraction has on the earth itself. While acquisition costs are accounted for in terms of the capital and labor used, they usually ignore the effect this behavior has on the land and water occupied. Nations and corporations are often able to exploit the landscape and natural resources of their own countries, and others, without addressing the long-term implications of their behavior. If the true cost to society is to be accurately considered the environmental impact left by oil producers should be measured and taxed appropriately.

3.2 Other Acquisition Costs and Long-Term Well-Being

We will now consider other aspects of the petroleum market, besides health and the environment, which should play a part in the pricing of this resource. We will start by examining

the costs of recent wars which, many argue, were at least partially fought to ensure the continued supply of oil to the U.S. Next, the long-term implications of low petroleum prices and some effects of under-priced oil on our economic and national security will be examined.

3.2.1 War

Never before in history has a country been as actively involved in acquiring oil as the United States has been the past 20 years. The government has consistently remained influential in regional events with our oil trading partners and has spent an abundant amount of fiscal and human resources in doing so. While oil is supplied to the U.S. from many regions including Canada, South America, and Russia this section will only identify costs associated with events in the Middle East.

The 1991 Persian Gulf War included many complicated variables between countries in that region; however, the United States' central reasons for involvement were to re-establish stability and ensure continued unfettered supply of oil to the States. The U.S. Department of Defense estimated the cost of the gulf war at $61 billion. Besides the monetary toll, there was an estimated 30,000+ Iraqi civilians killed as a result of collateral damage [23]. Additionally, the U.S. continues to remain financially and militarily engaged in the region for a multitude of reasons, one of which is presumptively oil.

The tax payers of today and tomorrow continue to fully finance the effort despite the fact that some costs should rightfully be placed on the petroleum market. If even a small portion of the $200 million/day used in financing the current conflict were attributed to the true cost of petroleum, the U.S. market would surely see some rise in gasoline prices. As for now, the government is complacent with financing the conflict through running a deficit and not recovering any of the costs through higher federal gasoline taxes which have remained constant at 18.3 cents/gallon since 1997 [20].

3.2.2 Long-term Economic Security

Current day affordability of petroleum provides little financial incentive for consumers to demand alternatives and producers to research and provide them. The resulting lack of innovation could have unfavorable consequences as the competition over the resources intensifies to include the emerging industrial economies of Asia and expanding populations around the world.

Americans expressed their concern over the problem in a 2006 CNN/USA Today/Gallup poll [24]: Seventy-one percent felt that the current federal administration is not doing enough to solve the nation's energy problems. The poll also indicated that roughly three out of four Americans (77 percent) fear the future supply of oil will not be able to keep up with global demand. Their concern seems to be justified by statistics from the U.S. Energy Information Administration [20] which indicate that 60 percent of the 20.8 million barrels of oil consumed in the U.S. daily are imported from foreign countries. Also, the EIAs 2004 estimate of proved domestic reserves was just 21.4 billion barrels, not even three years worth of domestic consumption given current levels.

The U.S. petroleum pricing model includes very few long-term economic considerations. Rather than focusing solely on short-term profits and economic growth it would be appropriate to include the longer-term consequences of an oil shortage. Also, raising prices

would stimulate the development of alternative energy sources and provide monetary encouragement for change in a country far too complacent with accepting the non-renewable norm.

4 Correcting Market Failure in the Petroleum Industry

Higher petroleum prices in the U.S. are needed to accurately account for all the costs associated with its production and consumption. While there are multiple ways to reach a higher price, we present the recommendation of levying a tax to correct the market failure.

4.1 Implementing a Pigouvian Tax

A Pigouvian tax, also spelled Pigovian tax, is a tax levied to correct the negative externalities of a market behavior [25]. The tax can be charged at either the point of production or consumption and shifts the market towards a socially optimal equilibrium (Point A in Figure 7). As seen in Figure 7, a tax increases the price of a good to the point where marginal revenue (MR) equals marginal social cost (MSC) and thus corrects the market failure. The tax ensures that negative externalities associated with a market behavior are appropriately accounted for in pricing. In the preceding sections of the paper we identified numerous externalities and costs connected with the petroleum market which would ideally be accounted for in the cost of gasoline via a Pigouvian tax.

Our suggestion is that the Pigouvian tax be charged at the final point of purchase for petroleum. Identifying an optimal tax amount is an arduous and lengthy task which we leave to another discussion, but our recommendation is that some extra amount of taxation should be included. Besides the fact that a Pigouvian tax would more justly allocate the costs of petroleum market activity, it would also generate a tremendous amount of revenue for the federal government. Assuming an additional fifty cents is charged per gallon of gasoline, this would create over $300 million in tax revenue per day using the 2005 estimates of U.S. consumption for transportation [20]. The money could be used to fund alternative energy programs, protect the environment, provide for national security costs, cut taxes elsewhere, or pay down the looming fiscal deficit. Simply put, correcting this market failure has tremendous advantages for American society and its federal government.

We would briefly like to address the argument that raising petroleum taxes would have a larger negative impact on the economy than the benefits provided. Currently, numerous industrialized nations have much higher gasoline taxes than the United States. As Figure 8 shows, the costs for crude oil, refining, marketing, and profits were relatively constant across these countries while the differences in final retail price were created by each governments' taxing policies [26]. The taxes, which can be used help fund socially favorable programs, are apparent in the final end cost to consumers. Furthermore, 2004 rankings from the U.N.'s Human Development Index (HDI) [27] are included in parenthesis to the challenge the notion that higher taxes lead to inferior prosperity in a nation. The index, which weighs a country's progress based on health, education, and GDP per capita, ranks all the below countries in the top 21 of 177 countries surveyed despite widely varying petroleum tax rates.

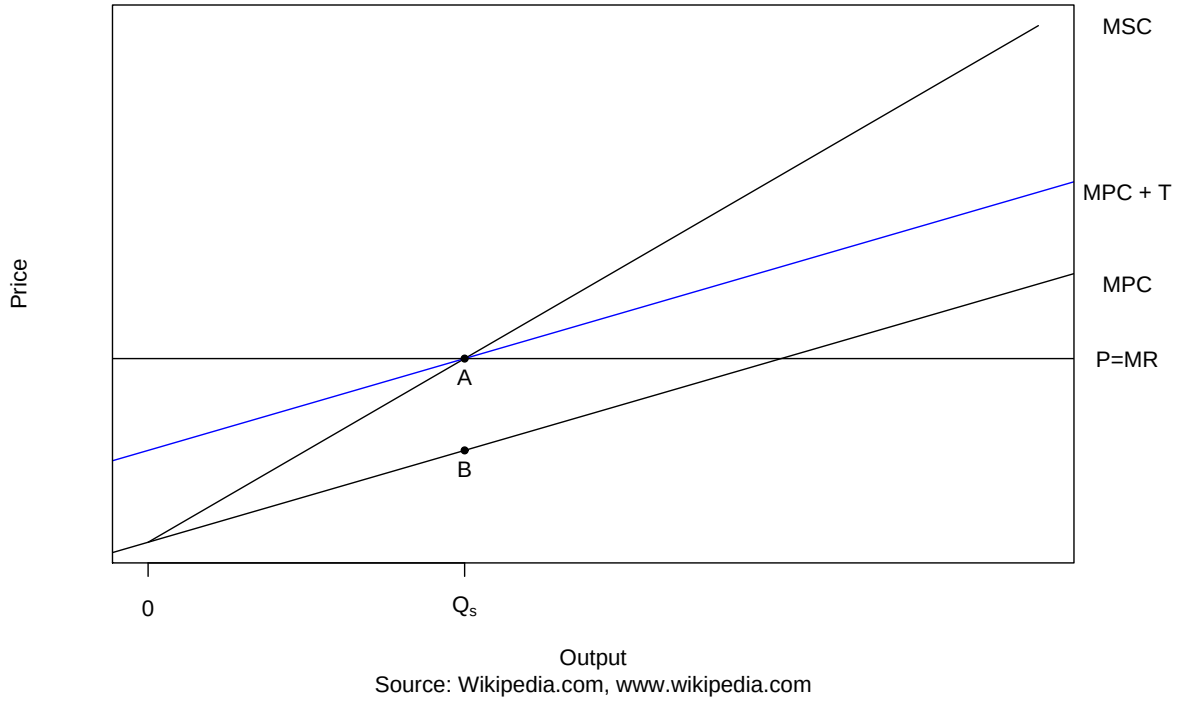


Figure 7: Correcting Market Failure by Levying a Pigouvian Tax

Implementing the suggested tax of \$0.50/gallon would not bring the U.S. even close to the price level of many of these thriving nations. Moreover, research on "green" taxes from areas such as Norway, Sweden, and the Netherlands suggest that countries with higher Pigouvian taxes actually experience higher GDP growth and superior standards of living than their peers due to improvements in the efficiency of the tax structure [28]. At a minimum, this research shows that levying Pigouvian taxes does not relegate a country to inferior economic success and suggests that it may, in fact, stimulate development.

5 Conclusion

In conclusion, we would like to quote the late British economic historian, John Clapham, in stating that "economic advance is not the same thing as human progress". This is particularly relevant when viewing the short-term economic progress of the U.S., which is being chosen over long-term considerations in the pricing of petroleum. Resource preservation, ecological preservation, and ultimately human preservation all depend on making decisions that lead to sustainable consumption harmonious with economic success. As science discovers increasingly more of the harmful effects of climate change and global population growth rewrites the definition of sustainable resource use, we need to accurately reflect this

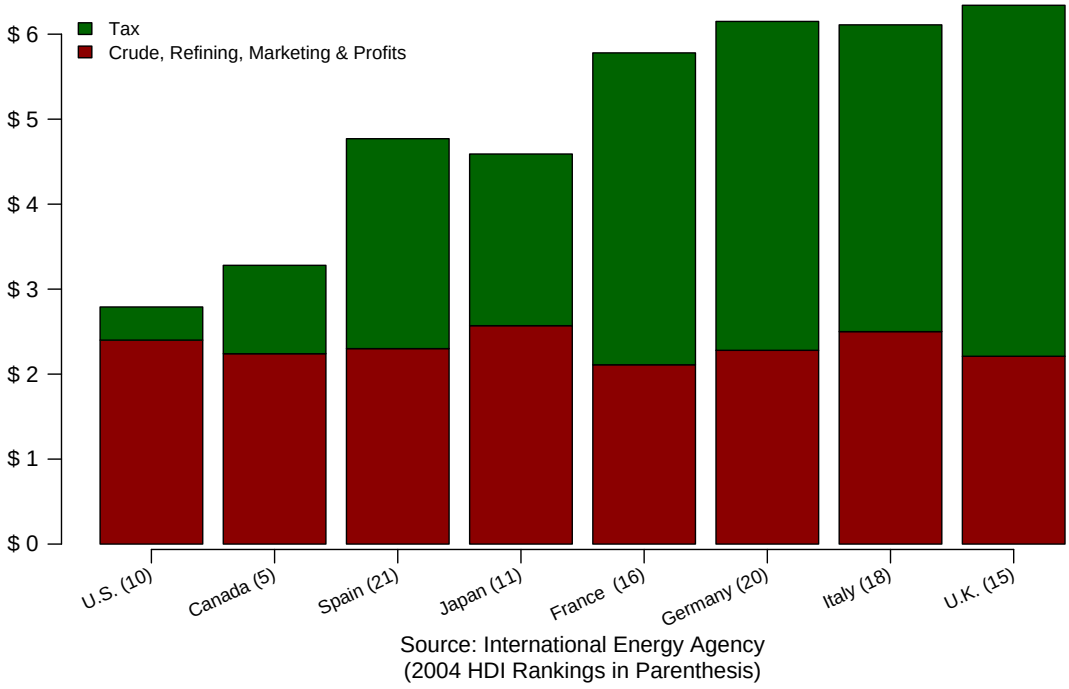


Figure 8: Retail Petroleum Prices - October 2006

knowledge in the price of gasoline. Raising petroleum prices now, to better account for its known costs, will be a great step toward correcting market failure and a tremendous milestone for human progress.

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