Addicted to Oil:
Implications for Climate Change Policy

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Abstract

This paper applies a behavioral economics model of cigarette addiction to the issue of oil usage and climate change. Both problems involve consumption of a product that causes long-term detrimental effects and for which current reductions in usage induces an adjustment cost. The paper argues that the problem of oil addiction is much more complex than cigarette addiction and thus may be more difficult to resolve. It also suggests that oil addiction, like cigarette addiction, may generate a long period of time in which individuals express sincere desire to convert to clean energy, but do little to accomplish that outcome. Finally the paper uses the model to argue that policies to reduce the present cost of alternative non-carbon energy sources to induce voluntary adjustments in energy usage are likely to be more effective than an approach to emphasize the long term catastrophic effects of climate change coupled with policies to force changes in current energy consumption.

1. Introduction

The Intergovernmental Panel on Climate Change reported in 2007 that possible impacts of continued carbon dioxide emissions include rising sea levels causing coastal destruction, increased droughts and heavy precipitation events, damage to many global ecosystems, increased risk of extinction for up to 30% of the planet's species, rising acid levels in the oceans, reductions in crop productivity, increases in malnutrition, and

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additional deaths due to infectious diseases.[2] And these are just some of the negative effects described!

Growing fears of climate change have led to local, national and international efforts to rein in usage of carbon-based fuels; one of the most important of which is oil. Among the international efforts is the Kyoto Protocol, negotiated under the auspices of the UN Framework Convention on Climate Change, and ratified by 191 countries. The Protocol commits countries to carbon emission reductions over time; however, its implementation and effects can perhaps best be described as slow. Indeed, the largest carbon emitter in the world, the US, at about 25% of total emissions, is not even a signatory to the agreement.

UN efforts to rally international support and agreements for carbon emission reductions centered on the United Nations climate change conference in Copenhagen in December 2009. By that time, not only had the scientific community seemed to have reached a consensus that global climate change induced by human activity was occurring, but there were new players in the game, like President Obama, a strong advocate of new climate change policies. Nonetheless, the Copenhagen conference ended with little more than a promise that discussions would continue in advance of the next UN climate conference in Cancun, Mexico in December 2010, where again very little impact was made.

To many supporters of climate change actions, it is a puzzle why, despite 20-plus years of growing evidence of the dangers associated with climate change, there has been very little success in reducing the worlds' trajectory of oil usage. [Hereafter the term

2" 4th Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policymakers, Available online at http://www.ipcc.ch/ipccreports/ar4-wg2.htm

"oil" refers to all carbon-based fuel sources.] Loewenstein (2009) attributes the problem to the psychology of human decision making. Research shows, for example, that humans are evolutionarily programmed to respond to immediate threats, but are poor at adapting to very gradual changes. Quicker reactions are also likely when the threat is from other humans, rather than from nature as it is with climate change. Human reactions to threats are also less likely when the effects are imperceptible, as they are with slight variations in temperature or rainfall activity. Loewenstein also points to the human tendency for wishful thinking, that is, believing that things will simply work out. A self serving bias may explain why developing countries tend to believe that the developed countries, the main polluters of the past, must act, whereas developed countries are unwilling to strike a deal unless the rapidly growing polluters (the developing countries) are heavily involved. Finally, Lowenstein points out that individual behaviors are very difficult to change even when the effects are felt more directly, as with dieting to relieve obesity. When effects are only felt by later generations and perhaps mostly in other countries, the task may be nearly impossible. Other problems suggested in the literature include the lack of personal experience with climate change combined with the difficulty of incorporating abstract scientific info into one's decisions, [Hertwig et al (2004), Weber et al (2004) and Leiserowitz (2008)], and the effects of semantics on perceptions of the problem [Sinaceur et al (2005), Hardisty et al (2010), Kasperson et al (1988).

While these psychology-based insights are helpful, additional understanding is possible with an analogy to substance abuse and addiction. In the 2006 State of the Union address, President Bush declared that we are "addicted to oil." Journalist Thomas

Friedman followed up with a book and a documentary about the world's oil addiction.[3] The analogy to addiction is appropriate because the devastating consequences caused by the use of oil are quite similar to the individual devastations caused by substance addictions. With substance abuse, individuals choose to do something that is likely to be personally detrimental or perhaps even deadly in the future. Despite these obvious dangers, many people continue to smoke, and to use and abuse drugs. Why individuals smoke and whether they quit is the subject of many scientific investigations. An entire multidisciplinary literature encompassing psychology, behavioral economics, public policy, and medicine has developed around the problem of addiction. Consequently, the insights from addiction models may shed light on the climate change issue.

This approach in this paper is straightforward: it adapts a particular addiction model from the behavioral economics literature to develop insights about oil usage and climate change. The adapted model is then used to assess the likelihood that significant climate change policies will be implemented in the near future. The analysis also provides a framework for evaluating the methods used to motivate the implementation of climate change policies and to assess the likely effectiveness of these arguments and approaches.

2. A Cigarette Addiction Model

This section describes a cigarette addiction model, first presented by Suranovic, Goldfarb and Leonard (SGL 1999) which, in the subsequent section, will be adapted for the oil addiction phenomenon. The SGL model assumes that an individual makes an

3 Friedman, Thomas, (2008). See also Kalicki (2007) and Green (2008).

optimal decision about how many cigarettes to smoke each day by weighing three separate utility effects of smoking.

First there is the utility or satisfaction received immediately from smoking. This corresponds to the stimulating effects of nicotine and the social pleasures associated with sharing an activity with friends and acquaintances.

The second utility effect involves health. Most smokers understand that continued smoking could reduce one's lifespan and lead to lung cancer, heart disease and other chronic illnesses. However, for younger smokers these effects are not expected to occur until the distant future. Thus, while a consumer of cigarettes surely considers these potentially negative effects upon his future wellbeing, he is likely to weigh these future effects less heavily; in the language of economics he would "discount them to a present value." If the future effects are perceived to be very distant, or if the person is very present-oriented (meaning that the discount factor is large), then even if the negative future health effects are quite large, the present value of those effects will be relatively small.

The third utility effect on well-being occurs if habitual consumption of cigarettes is suddenly reduced or eliminated. Withdrawal from nicotine can be very unpleasant if smoking is substantially curtailed or quickly stopped. The presence of withdrawal costs creates the addiction in this model, with addiction defined as the inability to curtail or eliminate damaging behavior. Indeed, in the model, smokers sometimes decide to continue smoking to avoid these negative utility effects.

This model has several interesting implications for smoking behavior. First, even if individuals have complete knowledge of the dangerous effects of smoking, they may

still rationally choose to smoke. This occurs whenever the discounted value of the future costs is smaller than the present day benefits of smoking. Of course, some people may perceive that the costs of smoking exceed the benefits, and therefore may choose not to smoke. Different choices occur because different individuals perceive different costs and benefits.

A younger person is more likely than an older person to choose to smoke because the future costs, being more distant to the younger person, count for less due to discounting. This is true even if the discount rate remains invariable across ages. Sometimes it is imagined that young people discount the future at a higher rate than more mature individuals. However, it is not necessary to assume higher than normal discount rates to achieve this behavior among smokers. Indeed, most smokers begin smoking as teenagers, when the discounting applied to end of life health effects is very large, whereas very few people pick up the habit for the first time in one's twenties or thirties.

The model displays an addiction when the current smoker's present satisfaction from smoking is lower than the perceived future discounted costs. In this case a smoker wishes to quit smoking. He may even proclaim that he dislikes smoking and believes it is more harmful than good. Nonetheless, if the withdrawal cost of smoking reduction, or complete quitting, is sufficiently high, then the smoker will continue to smoke even while stating that he prefers not to.

This situation best describes an addiction: someone would like to quit but doesn't. This situation leads some observers to conclude that smokers are irrational. However, in this model, an individual's decision to continue to smoke, even while expressing

dissatisfaction and being fully cognizant of the damaging future effects, is both reasoned and rational.[4]

Lastly, the model shows how substance addictions can be broken. First of all smokers are more likely to quit as they become older. This is because aging causes the future health costs to weigh more heavily as they become nearer in time. For example, a forty-year-old contemplating an earlier death due to smoking recognizes that the early death date is much nearer in time than the same early death contemplated as a teenager. If, or when, the negative health effects, or costs of earlier death, exceed the present benefits of smoking, only then there will be a desire to quit.

How quitting occurs, meaning whether it happens suddenly or gradually, depends on the difficulty or ease of reducing cigarette consumption. One of the most common ways that many smokers quit is cold turkey. This occurs when a smoker suddenly switches from a high level of daily consumption to zero consumption immediately. Another method of quitting involves gradual reductions in consumption over a long period of time until complete cessation occurs. Which quitting pattern arises depends, in the model, on the nature of the marginal quitting costs at the addicted level of consumption. If withdrawal induces sufficient pain and suffering for small reductions in consumption, then a smoker is more likely to quit cold turkey. If instead the withdrawal costs are low for small reductions in consumption, then reductions will occur gradually over time.

4" In a technical sense, this model is not perfectly rational but is boundedly rational instead. Perfect rationality would require the smoker to consider how all of the intertemporal effects impact his decision today; this model only assumes some of those effects are considered.

3. Transforming the cigarette model to represent oil addiction

To adapt the cigarette addiction model to deal with oil addiction we need to redefine the key variables. A summary of the transformation is found in Table 1.

In place of cigarettes, we substitute the use of oil and other carbon-based fuels. Consumption of carbon-based fuels is a bit more complex since it involves a wide variety of purchases including gasoline for one's car, electricity in one's home, and home heating fuel. These purchases are made by individual households, by private businesses, and by government. Since some fuel consumption is a necessity, this problem itself may be more like an addiction to high calorie foods since zero consumption is never the objective; instead the consumer merely wants to reduce usage or change the source of one's energy consumption to non-carbon based fuels.

The long term costs associated with current oil usage are the future effects of climate change. Since oil usage adds to the carbon dioxide in the atmosphere, and since changes in those CO^2 levels take time to affect the climate, the effects of today's usage may not appear for another 20, 30 or 50 years. As mentioned earlier, those effects could have serious impacts, including the flooding of coastlines and cities due to rising sea levels, lengthier droughts, and the increased occurrence of severe weather with more powerful hurricanes and typhoons.

Applying the model, these future effects will be discounted to present values, and, given the associated uncertainty, must also be weighted by the probability that the effects will actually occur. Although the scientific community claims to have reached a consensus that climate change is real, there remain many nonbelievers. To affect

decisions in the model, these nonbelievers need not go so far as to deny that climate change is occurring, but only that it may not have the catastrophic effects sometimes asserted. In other words, consensus that climate change is occurring need not imply consensus that it will have especially damaging economic impacts.

Lastly, the adjustment costs that oil users face are the higher energy costs associated with currently available low- or no-carbon alternative fuels. Some argue that these adjustment costs are not that high; that the costs of alternatives is not much higher than oil, and in some cases is lower. However, if current solar and wind energy technology really could power the world more cheaply than oil, then presumably it would already be in use, or at the least, more conversions would be in process by now. Since that is not occurring rapidly, alternative energy sources must surely cost more, perhaps much more, to obtain the same amount of energy.

Table 1

Cigarette vs. Oil Addiction – Utility Effects

	Cigarettes	Oil
Present Effects	Nicotine stimulant; Social Benefits	Cheaper Transportation, Electricity and Heat/Cooling
Future Effects	Earlier Death; Cancer; Respiratory ailments	Global Climate change; Floods, severe storms, droughts, food shortages
Adjustment Costs	Withdrawal effects; habit change	Costlier Transportation, Electricity and Heat/Cooling; Habit changes

4. Distinctions Between Cigarettes and Oil

4.1 Who is the Decision Maker?

An important distinction between the two cases is in the nature of the decision maker. With cigarettes, the individual smoker makes the decision about how much to smoke each day. Similarly individuals, businesses and governments make choices about oil consumption each day. However, because oil usage by large groups of individuals has climate impacts that affect many other people around the globe, the problem itself requires collective action to solve. For this reason, public discussion about oil addiction revolves around the policies made by governments and the negotiation of international climate agreements. This point will be emphasized below, but first we'll consider several other distinctions between the two cases.

4.2 Incidence of Negative Effects

One distinction between the cases involves the external effect of the current consumption choice. In the case of cigarettes, the negative future impact is experienced mostly by the smoker himself. Smoking may have some negative effects upon family members and others via second hand smoke, but these effects are likely to be small in most cases. In contrast, the use of oil will have negative effects upon the "climate" that will in turn have impacts on many different individuals at some point in the future. Who these individuals are and how large the impact will be on each future person are largely unknown today. What does seem clear is that most of the climate impacts caused by today's oil usage will not be experienced by today's oil user. Instead, the effects will be felt by those living in the next generation.[5]

5! See Wood (1995-96).

To the extent that individuals living today are concerned about the well being of their offspring in the next generation, some of these impacts can be internalized. However, this may not be sufficient since the distribution of the negative effects of climate change is unlikely to be proportionate to a country's carbon emissions. In other words, a country's oil usage may not influence the its own offspring as much as it will the offspring of people in other regions of the world. The countries most likely to be hurt by climate change are developing countries. Maldives, Seychelles and the small islands in the Pacific may be affected due to rising sea levels. Bangladesh, the Philippines and the Caribbean islands, may be affected by stronger hurricanes and typhoons.[6] The countries most likely to contribute to climate change though, are the developed and heavily populated countries such as the US, Japan, China and India.

4.3 Probabilities of Negative Effects

Next we can compare the probabilities of negative effects between the two cases. In the cigarette model we assume that the individual knows precisely the future health and longevity effects of smoking, but in reality these effects are not known with certainty. Studies of cigarette smoking only show a higher incidence of lung cancer and heart disease; they do not indicate that every smoker is equally affected.[7] If a smoker weights

6 See for example the Economist article, "A Bad Climate for Development," Sept 17, 2009 at http://www.economist.com/node/14447171?story_id=14447171 and the World Bank 2010 World Development Report at http://www.worldbank.org/wdr2010

7"A British Medical Journal article (Doll et. al., 1994) suggests that one-third of male smokers will not die from a smoking related illness.

the future effects by the probability (less than one) that he will suffer effects, then it will increase the likelihood that he will begin or continue to smoke.

In the case of oil usage the future effects are also uncertain. The scientific consensus about climate change is largely agreement that manmade carbon emissions have contributed to an increase in the average temperature of the globe. Precisely how much the average increase will be in the future is much less certain, with estimates ranging from 2° C to 6° C by 2100.[8] Precisely how weather patterns will change and where the globe will become drier, where wetter, where hotter and where cooler, is also very uncertain. Also, whether the climate change will have notable catastrophic effects, such as larger numbers of monster hurricanes and typhoons causing untold damage, or whether the Gulf stream bringing warm water and a warmer climate to Northern Europe will cease to function, is also uncertain. Finally, the economic impacts that will be caused by changes in the climate are even more uncertain. In an addiction model, the oil consumer needs information about the probabilities of the *economic impacts* of climate change, not the temperature effects which are known with greater certainty.

The above comparison suggests that there is considerable uncertainty concerning the long term effects of both cigarette smoking and oil usage. However, assessing the effects of nicotine on individuals over their lifetime has an advantage in that millions of experiments have been conducted by virtue of the smoking histories of past generations. These histories can be used to determine the statistical likelihood of disease and early death. Despite these natural experiments, we still cannot know the outcome with certainty. In contrast, in the case of climate change, we do not have millions of episodes

8" See the IPCC Report 2007.

of planetary temperature increases that can be used to assess the effects of global climate change. It seems reasonable to conclude then that the economic impacts of climate change are much more uncertain than the personal impacts of smoking.

4.4 Comparison of Adjustment Costs

Consider the cost of quitting smoking. With cigarette smoking the pure opportunity cost of smoking is probably not very substantial. The value of alternatives is likely to be very near to the benefits received by smoking. However, a longtime smoker also develops a nicotine habit that likely involves a change in the neurology of the brain. When a longtime smoker reduces consumption, there are the well-known withdrawal effects that involve a loss of concentration, jitteriness, and strong urges to resume smoking. These effects may be significantly larger than the simple opportunity cost of the next best alternative.

In contrast, with oil addiction the cost of quitting is largely the opportunity cost. That cost is the cost of supplying energy using non-carbon sources, or the cost of changing habits so that one's use of energy is reduced. Consider an example: to reduce gasoline usage a household could purchase a new hybrid car at a cost of $20,000 at a minimum. Used hybrid cars are scarcer than the gas powered alternatives and thus still command a high price. An alternative would be to reduce automobile usage by using public transportation or using a bicycle instead. Unfortunately, these changes require alterations in personal habits that are often difficult to achieve, as anyone who has tried to lose weight through exercise and dieting can surely attest. For a reduction in electricity usage an individual may wish to install a solar powered hot water system or use solar

energy for some electricity provision. However, the up front cost of the equipment and installation is likely to be very expensive. The breakeven point, meaning when the savings from lower monthly electricity bills equals the investment cost, may be many years in the future, if at all. To reduce carbon emissions from home heating, one could switch to natural gas, or purchase more efficient heating equipment, involving a large fixed cost. Alternatively one can reduce heating fuel usage by investing in home insulation, at a more modest cost. Thus, no matter how an individual tries to reduce oil (or carbon) usage, it will be more costly to use the new alternative.

What seems different about oil addiction, prima facie, is that there is no withdrawal effect as with cigarettes. But on second thought, maybe there is a similarity. One thing that makes conversion to alternative energy difficult is the fact that the current consumption and production infrastructure is oil and carbon based. Already in use are oil and coal fired electricity generating plants and gasoline powered engines in a huge fleet of personal and business cars and trucks. Conversion to lower carbon fuels may require scrapping a large capital stock. What's more, the conversion itself is likely to change the cost of using the carbon-based infrastructure.

For example, consider the impact if a substantial percentage of the US population decided suddenly to sell their gas-powered autos and purchase electric vehicles instead. That change would increase the supply of used gasoline vehicles and reduce the price of gas–powered autos. Falling prices could encourage others to purchase them. Thus, if the price of the carbon based infrastructure declines as people shift to lower carbon alternatives, then the opportunity cost of switching begins to rise. In other words, as some people adjust it will make it more costly for others to do the same. This is similar

to the withdrawal effect with smoking in that smoking reduction raises the craving one has for the resumption of cigarette consumption.

Indeed to push this comparison further, perhaps one reason for the withdrawal effects with smoking is because the habitual use of nicotine has carved certain neural pathways in the smoker's brain that the smoker continually stimulates with cigarette consumption. Once smoking ceases, the pathways are no longer stimulated and the brain looks for other ways to provoke a pleasurable response; the easiest course initially being a reversion to the previous habits. In time, sustained cessation may eliminate those pathways and other alternative pleasure paths may form.[9]

It is quite similar to the capital stock for oil. The use of carbon-based fuels over the past century has stimulated development of a carbon-based infrastructure (this is like the neural pathways created via nicotine usage). When carbon fuel usage drops, there is a desire to rekindle the easy benefits generated with carbon energy production. Clearly, the least costly way to restore the benefits is by returning to the use of the existing capital stock. However, if the adjustment to alternatives could be forced and sustained for a sufficient amount of time, then the carbon-based infrastructure would depreciate (the neural networks disappear due to inactivity) and a new infrastructure could develop to replace it.[10] Possibly then, these two processes may be more similar than one might have originally imagined.

9! See for example, Watkins, Koob, and Markou, (2000) and Laviolette and van der Kooy (2004).

10! This might also imply that to effectively sustain a switch to non-carbon based fuels will require the destruction of the low cost carbon alternatives in order to prevent a relapse.

5. Ending the Oil Addiction

5.1 Gradual vs. Cold Turkey Quitting

One of the interesting insights of the cigarette addiction model is that quitting smoking, when it occurs, depends upon the nature of the withdrawal costs. If the withdrawal distress rises quickly with modest reductions in consumption then cold turkey quitting is the likely result. If instead the withdrawal distress rises slowly with modest reductions in consumption then gradual quitting is the likely result. We can apply this result to the oil addiction case by considering whether the marginal cost of reducing oil usage is relatively large or small for small reductions in usage.

A McKinsey report from 2007 considered a wide range of changes that could be made by households and businesses to reduce the emissions of carbon into the atmosphere. For each of these changes they evaluated the net present value (benefits minus costs discounted over time) to achieve a certain number of gigatons of carbon reductions in the US. For many of these changes the net present value is positive, implying that carbon can be reduced with negative marginal cost (i.e., with a net benefit) to those who implement them. Among these negative cost options are installing heating and ventilation control systems, retrofitting lighting in buildings, incorporating fuel economy packages in new cars, and planting more trees. If all of these negative cost options were implemented fully, the report suggests that almost 1.5 gigatons of carbon could be prevented from entering the atmosphere each year.[11]

One problem with implementing these changes, though, is that most of them require a large upfront capital expenditure in order to achieve a stream of benefits spread

11! See Dietz and Stern (2008) and Heal (2009).

into the future. Although the net present value is estimated to be positive, the problem is much like that of a smoker wishing to quit; he would have to incur a large upfront quitting cost to receive the benefits of increased longevity further in the future. In the case of consumer adjustments to reduce oil emissions, the McKinsey report suggests that many consumers are unwilling to implement a cost-reducing (and carbon reducing) adjustment unless the net positive effects arise within 2-3 years. That means it may be difficult to induce people to make the changes needed to reduce carbon emission. However, the addiction model suggests one other implication.

The high capital costs needed to implement the negative cost options implies that the marginal cost of small reductions in oil usage results is very high. This means that breaking the addiction to oil, if it occurs, may look more like cold turkey quitting rather than progressing as a gradual adjustment. Since immediately before cold turkey quitting occurs, the smoker is an unhappy addict, so too might we see oil users lamenting their continued use of oil and proclaiming their intent to "quit," all the while continuing in their original oil using habits. Only when the negative effects of climate change loom large enough to overwhelm the upfront capital adjustment costs, will individuals finally break their addiction suddenly and dramatically.

5.2 The Individual Decision to Reduce Oil Usage

The model suggests that an individual can break an addiction to oil only if two conditions are met. First the present value of the future costs of climate change, accounting for its likelihood of occurrence, must outweigh the current benefits of using

oil. Second, this perceived net future benefit of preventing climate change must exceed the adjustment costs borne by an individual switching to alternative energy sources.

For an individual oil consumer, breaking the addiction seems highly unlikely for several reasons. First, the effect on the global climate caused by changes in the behavior of *one* individual will be too small to be perceptible. No one person's carbon footprint matters very much; instead, it is the summation of everyone's carbon usage that matters. Even if the aggregate effects are catastrophic, the contribution to the disaster by any one person, household or business will be miniscule. Because the costs of adjusting to lower oil use is likely to be high and since these effects are felt in the present on the individual as oil usage is reduced, these will almost surely outweigh any future benefit caused by one's own carbon reductions. Thus, there is no good economic reason for any one person to quit using oil.

But if this is true, why have some people made the costly adjustments necessary to reduce their own carbon usage? One possibility is the inclusion in one's utility function of a non-economic objective, a larger purpose. If one is taught that our individual actions when multiplied across millions of people can have the impact of preserving the planet, as we know it, then being an active participant in that effort can boost one's utility. It is much like voting in a democracy. Individually each person ought to recognize that his or her vote does not affect the final decision and therefore from a cost-benefit perspective the marginal costs of voting surely outweigh any marginal benefits that might arise. However, because we are taught from childhood about the benefits of democracy, most consider it a civic duty to vote, and most do so. So perhaps

if an environmental conscience were developed in people around the world, then more people would be inclined to make personal reductions in carbon usage.[12]

5.3 The Collective Decision to Reduce Oil Usage

The individual case is a classic prisoner's dilemma problem associated with public goods: individual incentives lead to a suboptimal outcome for everyone. This occurs because the cumulative effects of the individual actions are what cause the increase in carbon dioxide levels. The public good is the stable climate that allows for continuing prosperity based on our current methods and locations of production. Because breaking the oil addiction is individually too costly, individuals have the incentive to free ride. Thus, only by forcing participation via collective public policy action are we likely to induce a sufficient amount of individual change to resolve the oil addiction problem. For this reason, national climate change policies make sense.[13]

However the same collective choice problem appears at the international level as well. Any one country, even the largest carbon emitter, that implements strict climate policies is unlikely to have a notable effect on the world's climate if other countries don't do the same. Thus the long term benefits to a country of unilaterally implementing climate change policies is quite likely to be outweighed by the short term costs of reducing oil usage. Only by forcing participation via an international policy action are we likely to induce a sufficient amount of national changes to resolve the oil addiction

12"Additionally, in the case of smoking there has been rising social disapproval and stigmatization of the activity which lowers the current benefits of smoking and tilts the individual decision towards quitting. In a similar vein, social stigmatization of oil usage could induce more individuals to reduce their carbon footprint.

13 See Helm (2008), Wood (1995-96) and Pittel and Rübbelke (2008).

problem. For this reason, the negotiation of international climate agreements makes sense.[14]

Framed in this way, as a public policy choice instead of an individual problem, the addiction problem becomes quite a bit more complicated. Instead of an individual choosing how much oil to consume versus an alternative, now the State has to choose a policy that will induce a better social outcome. Thus it is also reasonable to ask what must happen for a nation to break its citizens' addiction to oil.

The answer depends on the mechanics of the political choice process in a country. In some countries, leaders can force through certain policies even if it is not supported by a majority of people. In representative democracies though, a public policy is implemented only after a complex dialogue involving voters, special interest groups and legislators. Often a rhetorical battle pits the stalwart supporters of a policy against the opponents.[15]

Suggested policies include regulations specifying the types of fuels that can be used in certain circumstances (eg. a requirement that gasoline contain 10% ethanol or more), a direct tax on carbon fuels, or a cap-and trade system to reduce carbon emissions. These policies will raise the cost of using oil, thus reducing the current benefits, and make alternative sources of energy relatively more attractive. The more the cost of oil is raised, the more likely the oil addiction will be broken. However, the more citizens realize that public policy initiatives will raise the cost of energy, forcing them to do

14! See Asheim et.al. (2006) and Bosetti and Buchner (2009)

15! See Attari et.al. (2009).

something they would prefer not to do, the more difficult it will be to pass climate change legislation.[16]

One new approach in the US is to bypass the political process by declaring that, as a greenhouse gas causing global climate change, carbon dioxide is an environmental pollutant and can be regulated under the Clean Air Act. This opens the door for regulatory changes that can be implemented directly by the Environmental Protection Agency, thereby bypassing the legislative process. This is a creative approach to reduce carbon emissions most likely pursued because of the expected roadblocks faced in the political process.

6. Model Predictions for Debate Framing

So, what could be done to raise the chances that climate change policies will be enacted? Since the political choice process is a given, the only way to change the outcome is to change enough people's minds. If a sufficiently large percentage of a nation's voters support climate policy changes, then it can be enacted. Changing people's minds may require changing their individual cost and benefit perceptions. Thus, as Lowenstein (2009) suggests, how you frame the debate may have a significant effect upon the outcome.[17]

16! Pelletier (2010) highlights the societal assumptions made that prevent collective action on climate change.

17! See Doulton and Brown (2009) for a discussion of how the link between climate change and development has been framed in UK newspapers.

6.1 Exaggerate the Long-Term Costs

One tendency for supporters of behavior and policy changes is to exaggerate the negative long term consequences of the activity. For example, in the case of cigarette smoking, anti-smoking campaigns through the years have shown the public the diseased lungs of deceased smokers, hospital patients who need oxygen tanks due to smoking related emphysema, and warnings on cigarette packages forecasting early death and disease. One effect of these campaigns has been that many smokers believe the risk of lung cancer and other diseases is much higher than it actually is. In other words the anti-smoking campaigns have created an exaggerated perception for some of the negative impacts of smoking.[18]

We can expect a similar tendency with respect to the climate change debate. In most cases the exaggerated perception arises not because untruthful effects are forecast, but rather because the most catastrophic effects are the ones most often mentioned while the more modest costs and even benefits are rarely discussed. For example, rather than pointing out that climate change may force adjustments in land usage due to changes in the geographic distribution of rainfall and that in some areas the climate may improve for crop production, climate policy supporters are more likely to emphasize the possibility of mass extinctions, or, numerous category five hurricanes. While these outcomes are surely possible, citizens may get an exaggerated view of the dangers of climate change if they only hear about the most cataclysmic outcomes.

One recent example of a tendency to exaggerate is a UNEP website report of a paper published in 2005 showing a map predicting that there would be 50 million climate

18" See Viscusi (1992).

refugees displaced from their homes by 2010.[19] Back in 2005 one might have concluded that these major impacts of climate change are imminent. However, by 2010 no major migration had occurred and the population had actually increased in those regions rather than decreasing as predicted. The UNEP later dropped the reference to the paper on its website. It may be prudent then, for supporters of climate change policies to avoid exaggeration since incidents like this can reduce the credibility of the message and result in a backlash in support of these policies.[20]

6.2 Underemphasize the Adjustment Costs

An alternative approach to encourage a national electorate to support climate change policies is to underestimate the expected adjustment costs. If voters believe that a carbon tax, or a cap-and-trade program will not greatly affect the cost of energy, then it is more likely to garnish their support for the change. If it doesn't cost much to make the adjustment to non-carbon fuels, many people would be willing to do so. This strategy could backfire and reduce credibility too if policies are implemented and only later do energy consumers learn that the costs are higher than projected.

Highlighting the McKinsey report conclusion suggesting that many adjustments to reduce carbon emissions could be accomplished with negative marginal cost is one way to argue that much could be accomplished with no pain at all. That report also shows that the US could reduce carbon emission by up to 3.1 gigatons per year using techniques that would each cost less than $50 per ton of carbon emission reductions. However, reporting

19 See "Climate Refugees Not Found," Wall Street Journal, April 21, 2011.

20 See Biber (2009)

this conclusion while deemphasizing or ignoring the large upfront capital expenditures necessary to achieve many of the long run carbon reductions amounts to an accurate, albeit misleading, assessment of the costs of adjustment.

Another example of a possibly hopeful scenario involves the evaluation of the expected cost to consumers of the US cap-and-trade legislation that passed the US House (but not the Senate) in 2009. The EPA projected that one effect of this legislation would be an increase in the price of gasoline by a mere 24 cents by 2030. Because gasoline prices are closely monitored by consumers and the cost of gasoline is an important component of a household energy use, by indicating a relatively small increase 20 years into the future, this could certainly serve to raise support for the bill. Some other studies concluded that the price of gasoline could rise by as much as $1.38 by 2035 due to the legislation.[21] Which analysis is correct may be difficult to determine, but surely supporters of the climate change bill would seek to report smaller adjustment costs whereas opponents of the bill would seek to report larger adjustment costs. Since simulation models have high degrees of plausible parameter variation, it is possible for different studies to report significantly different outcomes.

It is interesting to note that in the case of cigarette addiction, numerous resources were devoted to reducing the cost of quitting by providing nicotine supplements and other types of support. However, anti-smoking advocates did not tend to emphasize that the cost of quitting was low, probably for fear that it would induce more teens to begin

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21 **Beach, William, Karen Campbell, David Kreutzer, Ben Lieberman *and* Nicolas Loris (2009), "The Economic Consequences of Waxman-Markey: An Analysis of the American Clean Energy and Security Act of 2009," Center for Data Analysis, The Heritage Foundation.**

smoking. The oil addiction case is probably different since there is more to be gained by getting high carbon users to reduce emissions than to prevent young energy users from adopting high carbon use patterns.

6.3 Other Framing Techniques

One other framing technique used in the climate debate is to emphasize the positive spillover effects from reducing our addiction to oil. Perhaps the most often cited is the economic growth and expansion that will occur in the alternative energy sectors. Production and installation of windmills, solar panels, electric vehicles and other low carbon energy sources will create thousands of jobs in these sectors. That will stimulate a sectoral economic expansion that is especially welcome coming out of the global financial crisis of 2008. Of course, those who emphasize these effects usually avoid mentioning the cost. That cost is the higher price of energy provision using alternative methods, which may in turn reduce aggregate output and overall welfare.

Thomas Friedman takes the positive spillover effect one step further when he argues that the Chinese are quickly developing new capabilities in solar and wind technology and if the US doesn't act fast, the alternative energy sector may be dominated by the Chinese in the future. In other words, the positive spillovers involving new jobs and new industries may accrue to someone else if we don't move quickly to break our own oil addiction.

Finally, one other technique that may be used by climate policy supporters is the suppression of information that contradicts the scientific analysis supporting global climate change. Although many have claimed that the science of climate change is

mostly settled, there remain a sizeable number of climate change skeptics. The skeptics sometimes argue that climate change induced by humans, is a scam; that it is the most recent excuse used by those who desire more intervention by the State.[22] The skeptic's case was strengthened recently with the so-called Climate-gate controversy regarding released emails exchanged by climate change researchers. These emails suggested that some scientists were making concerted efforts to suppress information that might contradict their climate claims. The leaked emails raised concerns about the legitimacy of the research and increased doubt that the climate change issue is sufficiently worrisome to justify government intervention, let alone an international agreement. Indeed between 2006 and 2009 the percentage of people who thought the seriousness of global warming was exaggerated rose from 30% to 41%. Incidents like this reduce the perceived present value of the future costs, rightly or wrongly, and therefore reduce the likelihood that people will be willing to give up their addiction to oil. Unfortunately, it is very difficult for the general public to discern whether such statements made by experts are factual or whether they represent the exaggerations of enthusiastic advocates of climate change policies. Any perception of a lack of credibility is likely to raise the uncertainty of future climate change effects and may actually serve to prevent action on climate change. Hence, it is prudent to present all information about the impacts of oil usage on climate change as objectively as possible, even if sometimes that information tilts individual decisions away from action. It is better to achieve informed consent by citizens rather than lose reputation and credibility when inaccuracies or exaggerations are revealed.

22" See for example the remarks by Vaclav Klaus, President of the Czech Republic, at the UN in 2007. http://www.globalwarmingheartland.org/article.cfm?artId=22021.

7.0 Conclusion

By building the analogy between cigarette addiction and oil addiction, we have reached some interesting conclusions. The problems share some important similarities that make the analogy stronger. Both problems involve a consumption choice that provides short-term benefits but with costs that may not occur until long in the future. Both problems display a withdrawal or adjustment cost if current consumption is reduced substantially. However, there are important differences between the two cases as well.

The most notable difference is the collective nature of the oil addiction case. Because each individual oil consumer will have little impact on the total greenhouse gas emissions, the individual has little incentive to change behavior and may free ride on the efforts of others. One way to solve the public good problem is to use government policy to affect the choices made by all individuals and businesses. However, even at the national level countries may find it advantageous to free ride, thus stimulating the negotiation of international climate change treaties.

The differences between the cases mean that breaking the addiction to oil may be much more difficult than breaking an individual's addiction to cigarettes. In the cigarette case the antismoking campaign began earnestly in the 1960s with the release of the US Surgeon General's report detailing the risks of smoking. Since that time the smoking rate has declined from 44% to 21% of the US adult population. Nonetheless, despite the well-known warnings, teen smoking increased by 50% between the 1960s and the 1990s. Around the world 1.3 billion people consume cigarettes everyday. This means that even with good knowledge about the future impacts from smoking and even when it is known

that the effects will be self-contained and felt on one's own future self, cigarette smoking continues at fairly high rates.

In the case of climate change, the dangers of rising global temperatures began to be widely reported in the 1990s, but the notion of anthropogenic climate change did not reach the level of a full-blown consensus view perhaps until the IPCC report in 2007. Given the larger difficulties of the oil addiction problem, the analogy suggests that the prospects for concerted international action are perhaps weak at best in the near term. Persuading an individual to reduce oil usage appears to be much more difficult than persuading a smoker to quit smoking. Persuading a collective of voters to agree to major policy changes is even more difficult. Finally, persuading a collective of countries to come together to reach an effective climate change agreement would seem to be incredibly difficult relative to the individual cigarette case.

This is not to say that an international climate change agreement will not be reached in the next few years. Political leaders are often eager to reach accords that they can herald as indicators of their success. However, given the inherent difficulties in getting widespread citizen support to break our addiction to oil, an international agreement may either, a) put off large changes in energy usage until some distant time in the future so that adjustment cost will be minimal initially, or, b) will lose voter support once the larger adjustment costs begin to be realized. In the latter case, we may expect countries to renege on the treaty promises for fear of political reprisals at home. Thus, even if all the major carbon-emitting countries sign an international climate accord, it will not necessarily indicate that the addiction to oil will soon be broken. An international accord may be little more than a false promise since the addiction is broken only when

the promises of the agreement are fulfilled and the detrimental effects of climate change are averted. Just think, how many times have you heard a cigarette smoker proclaim he is quitting and even take the first steps to quit, only to be back smoking shortly thereafter?

Oil users in developing countries may recognize and accept that they and their progeny are likely to be negatively affected by climate change. This could increase their willingness to accept climate change abatement policies. However, eliminating the addiction to oil would still be very costly for them. Developing countries like China and India need economic growth and job creation to maintain stability among their large populations. If climate change policies reduce the rate of growth and the speed of new job creation, then social instability may arise and the adjustment costs may be too large to bear. Thus, while the incidence of climate change on their own countries may raise their desire to break the oil addiction, the larger adjustment cost is likely to reduce that desire.

This problem fuels the desire by developing countries to receive transfers from the richer countries to pay for the costs of switching. At the Climate Change Conference in Cancun, negotiators proposed a $100 billion fund to be used by developing countries to help them break their addiction to oil. These transfers could indeed raise the incentives for developing countries to participate but at the same time will reduce the support by developed country taxpayers who have to fund these transfers. Thus, the greater the size of these transfers the less likely a developed country will be able to attract its own citizens' support for climate change policies.[23]

The final insight from the smoking analogy is the possibility that we will see an extended period of time in which the world appears to be an unhappy oil addict. Because

23! See Panaytou, Sachs and Peterson Zwane (2002), Haug (2011) and Dellink et. al. (2009).

the marginal cost of withdrawing from oil usage is likely to be quite high, the problem is similar to the situation in which unhappy smoking addicts quit smoking cold turkey. If the same scenario plays out in the case of oil addiction then many people and policy makers in many countries may spend a considerable number of years lamenting the impending climate disaster, while simultaneously being unwilling to do anything substantive to prevent it.

So what can be done to avert a climate catastrophe?

Although awareness of the long-term negative consequences of oil usage is a necessary precondition to induce changes in current behavior, excessive emphasis on these costs is unlikely to have much influence on current behavior. Because these costs lie far in the future, even an exaggerated perception of the effects may do little to reduce oil usage today. Information about future harm would have to overwhelm not only the high discounting factor but also the high level of uncertainty about the real economic incidence of the climate effects. The likely ineffectiveness is similar to the case of teen smokers who are undeterred by graphic warning labels on cigarette cartons and pictures of diseased lungs.

Perhaps a better solution is to directly affect the present day decision to either use oil at current rates, or to change habits and convert to alternative sources of energy. There are two basic ways to achieve a switch: either substantially raise the cost of using oil, or substantially lower the cost of alternatives. The first approach requires government policies that will tax and discourage the use of carbon-based energy. These

policies may also face tremendous resistance from reluctant citizens. Furthermore, to be effective, this approach requires the coordination of policies by governments around the world and, as recent efforts attest, this has proven to be very difficult to achieve.

The second approach requires efforts to reduce the cost of non-carbon or low-carbon based alternatives to less than the current price of carbon-based energy. This would make alternatives competitive with traditional energy sources and would encourage voluntary adjustments. If it doesn't cost much to switch to alternatives, many people would probably be more than willing to do so, even if only as a precautionary action to avert a potential future calamity. If it costs less to use alternative non-carbon based fuels, then energy users would surely switch, assuming of course that the fixed costs of the adjustment are not too large.

Of course, making alternatives cheaper than oil is not easy to accomplish and may not even be technically feasible in the near future. Nonetheless, R&D expenditures by private firms or subsidies from governments to solar, wind, geothermal, and battery power research may reduce the cost per unit of energy produced. Convincing voters to support subsidies may be difficult especially if they do not yield the technological breakthroughs that can lower the costs sufficiently once the subsidies are removed. Also, subsidies might be ineffective if they are allocated more on the basis of political influence rather than based on the probability that a firm will engineer a successful cost-saving innovation.[24] For this reason, R&D spending channeled through the private market and venture capital system might yield better results in the long-term.

24! The failure of the US solar panel firm, Solyndra, after receiving $1/2 billion of subsidized loans perhaps offers a recent example of this potential problem.

Finally, one last approach supported by the addiction model, would be subsidies to households and firms to cover the fixed costs of implementing cost-saving and environmentally friendlier technologies. As mentioned earlier, many changes to reduce carbon emissions can be made that will reduce the long term cost of energy for consumers. However, many are resistant to implementing these changes because the high fixed costs come early while the savings are spread out over future periods. Subsidies by government, by the private sector, or by foundations would be another method that could motivate current behavioral changes in energy usage.

The objective to reduce oil usage to ward off the serious consequences of climate change will be difficult to accomplish. There are many approaches being taken, each of which has some influence over the choices made by individuals around the world. However, because the resources that can be devoted to this effort are scarce, it would be best to allocate resources towards those approaches likely to have the largest impact per dollar spent. The addiction analogy presented here strongly suggests that efforts to convince people of the seriousness of climate change or to force changes in behavior via domestic government policies and international climate change agreements is unlikely to have much leverage over people's energy choices. Much more effective will be policies that reduce the current cost of clean energy technologies and induce more households and businesses to voluntarily choose to use cleaner energy technologies.

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