36748

Agenda Item 1519 & 1520 | TESTIMONY | 2:00 PM TIME CERTAIN

CLIMATE ACTION PLAN

IF YOU WISH TO **SPEAK** TO CITY COUNCIL, **PRINT** YOUR **NAME, ADDRESS, AND EMAIL.**

NAME (print)	ADDRESS AND ZIP CODE	Email
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✓ Jim Newcomer	Transition Towns PDX, ~~Ed~~	jnewcomer@spiretech.com
✓ Robin Everett	1230 SE. 20th Ave #6 Portland OR	robin.everett@sierraclub.org
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Date 10-28-09

36748

Agenda Item 1521

TESTIMONY Climate Action Plan 2/3:00 PM TIME CERTAIN

~~CITIZEN CAMPAIGN COMMISSION APPOINTMENTS~~

IF YOU WISH TO **SPEAK** TO CITY COUNCIL, **PRINT** YOUR **NAME, ADDRESS, AND EMAIL.**

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~~BOB GAVIN~~		

Date 10-28-09

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Driving the Economy:

Automotive Travel, Economic Growth, and the Risks of Global Warming Regulations

Prepared for the Cascade Policy Institute
November 2009

QuantEcon, Inc.

Executive Summary

This study examines the role that highway vehicle miles traveled (VMT) plays in supporting national economic activity. This study is important because highway travel generally, and light vehicle travel specifically, represent a significant share of total energy consumption and fossil fuel carbon emissions.

Numerous federal and state initiatives are in place or under consideration with the aim of reducing VMT. The focus on vehicle travel is natural considering the important role that transportation plays in the use of fossil fuels. However, in designing programs to manage carbon emissions, it is important to understand the effects of these programs and the consequences for the economy if they are used to achieve a smaller carbon footprint via VMT reductions.

After first describing the role of highway vehicle travel from an energy perspective, the historical trends in VMT are compared with trends in the gross domestic product (GDP), fuel efficiency, and fuel prices. This casual empiricism reveals an intimate relationship between VMT and GDP, both over time for the US and within a large cross-section of national economies:

- Energy use and GDP growth trends are nearly indistinguishable over time.
- On average, there is a near one-for-one relationship between economic growth and growth in energy use across a sample of 177 countries.
- Growth in vehicle miles traveled and GDP also display highly similar trends over time.
- Energy use per dollar of real GDP and per vehicle mile traveled show steadily declining trends over long periods, even when no fleet efficiency regulation was in place.

The casual association of energy, travel and economic activity over time cannot be used to formulate policy. It is clear that determining the direction of causality between energy use and GDP, and VMT and GDP, is crucial to understanding how policy toward VMT should be formulated in light of its connection to carbon emissions.

The large, econometrics literature regarding energy and the economy are examined for insights regarding the direction of causality of energy-using activities such as vehicle travel and the economy. That literature strongly supports the notion that energy "causes" the economy, although bi-directional and reverse directional causality are observed in some studies as well. Specifically, the causality analysis between energy use and GDP reveals the following:

- The literature on energy-economy causality reveals a strong tendency for energy to "cause" GDP growth.
- However, there also appear to be bi-directional effects: GDP growth also, in some studies, shows a strong causal relationship vis-à- vis energy use.
- The net effect of energy use on GDP is thus a balance of the two directions of causality.

The literature directly examining the VMT-economy relationship is small. The author reviews the various threads of the literature. Studies focusing on causality effects are particularly rare. Thus, the author presents a new, econometric, causality investigation.

The VMT-economy causality investigation finds that, indeed, VMT is a large and statistically significant driver of GDP. It finds also that, historically at least, the price of energy has not been an important driver of innovation in vehicle efficiency. If fuel efficiency could be improved, there would be positive economic effects, but limited, long-run effects on VMT. Specifically, the causality analysis reveals the following:

- Although the causality between VMT and GDP is bi-directional, the primary one is for VMT to "cause" GDP growth. In the short run (2 years), an exogenous (an outside influence, such as regulation), downward shock to VMT results in a reduction of GDP of 90 percent of the size of the VMT shock. In the long run (20 years) the link is weaker, at about 46 percent.
- In contrast, endogenous (an influence from within the model, research- or discovery-based) improvements in fuel efficiency appear to have a positive effect on GDP. A 10 percent increase in fuel efficiency yields only a 1 percent GDP increase in the short run, but a 6 percent effect in the long run.
- VMT is not particularly sensitive to shocks to fuel price alone. The values calculated by the analysis predict well the effects of recent gasoline price increases on VMT.
- Increases in fuel efficiency cause positive rebounds (increases) in VMT. Although the effect is modest in the short run, after 20 years, exogenous increases in fuel-efficiency cause completely offsetting increases in VMT, and thus, energy use, everything else equal. This does not bode well for strategies such as regulated fleet fuel efficiency standards having a persistent effect on VMT or energy use. It suggests that much of the positive effect of fuel-efficiency improvements on GDP may flow from rebound effects on VMT.
- The response of fleet fuel efficiency to a shock in fuel prices is positive, but very small. This does not bode well for using fuel taxes as a mechanism to stimulate innovation in vehicle efficiency.
- Not surprisingly, increases in income tend to be associated with a decrease in fleet efficiency.

Although long-run econometric predictions have large error ranges, the results suggest that rather than employing broad, tax-based strategies in transportation (such as cap-and-trade or carbon taxes), it may be better to find ways (if they exist) to advance fuel-efficiency technology. These efficiency improvements, however, can be expected to yield less than one-for-one reductions in VMT and energy use due to the rebound effect.

With these and other results in hand, the study reviews a wide range of candidate policies for using VMT management as a channel for climate change redress. The author concludes that the evidence does not support use of non-economic manipulation of energy prices, technology subsidies or quantity regulation to improve highway VMT's energy footprint. Rather, the author recommends the following:

- Implementation of highway congestion pricing. This policy generates economic benefits by eliminating wasted travel time while, incidentally, reducing a certain amount of travel. Thus, it is uniquely, perhaps, a policy that will aid today's economy while contributing to reductions in atmospheric carbon loads even without changes in technology.

- A cost-based, revenue-neutral carbon tax can be justified theoretically if its proper level is known, set properly and revenues are returned (as, say, offsets of other taxes). For reasons explained in the report, such a tax may accelerate the penetration of fuel-efficiency technology, but not particularly rapidly.

- Subsidy of basic research may have potential as a productive avenue of policy. It is important, however, that subsidies of energy- or carbon-sparing technologies not be used for adoption of non-economic alternatives. Replacing "old" capital with new, but non-economic, energy- or carbon-efficient technology may actually aggravate adverse economic impacts and atmospheric accumulation of carbon dioxide.

- The intimacy and strength of the causal relationship between vehicle activity and the economy is such that we should approach direct, regulatory interventions with great caution. The author includes in this list regulating land use to achieve VMT outcomes, rationing schemes, and limits on vehicle use (such as alternate-day driving rules).

About the Author

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Contents

Introduction

Concerns about climate change necessarily have focused attention on the energy and carbon "footprint" of various sectors of the economy. Particular attention has been focused on the transportation sector and private vehicle travel in particular. For example, the May 15, 2009 proposal by Senators Jay Rockefeller and Frank Lautenberg requires that the next federal transportation bill "reduce national per capita motor VMT on an annual basis." With some state climate initiatives calling for reductions in carbon emissions of as much as 40 percent of today's levels in a decade, further focus on the transportation system and private highway use is inevitable.

The focus on VMT is natural, given that transportation uses approximately 30 percent of total energy – most of which is fossil fuel derived – and that light vehicles using highways represent about 60 percent of transportation energy use. It is not to demonstrate the connection between highway travel and energy use.

What has been less well articulated, however, are the economic consequences that might attend reduction of fossil fuel use by policies directed at the use of private vehicles. Much might depend upon the method used to reduce fossil fuel use in transportation. This reduction might be accomplished by reducing vehicle use, increasing the fuel efficiency of vehicle use, or both. A variety of initiatives might be considered in this regard, including levying a carbon tax on motor fuel, including private vehicle owners in a carbon trading scheme, encouraging or compelling greater fuel efficiency of new vehicles, pricing highway use, imposing physical limits on the amount of highway travel permitted, regulating land use to limit travel, etc.

The purpose of this report is to summarize the available evidence on the relationship between vehicle miles traveled on US public roads (VMT) and the vigor of the economy. In addition, the report draws on historical evidence regarding factors that influence fuel efficiency to assess the prospects of accelerating technological progress in vehicle fuel efficiency. This evidence allows us to opine on what types of policies might best achieve carbon emission goals while minimizing the impact on the economy.

Four sections and a bibliography follow this Introduction. The second section presents historical data regarding the quantity of transportation activity and its associated energy use. This review supports a narrowed focus on the relationship between highway use and the economy.

A third section examines the conceptual basis of the relationship between transportation activity and the economy. It finds that the direction of the causality is conceptually ambiguous and must be determined empirically. It also highlights the importance of measuring the potential of technical change.

The fourth section seeks to examine statistically the historical relationship between vehicle miles traveled and the economy. It explores the causal relationships among energy use, VMT, economic activity, fuel prices, and fuel efficiency.

The fifth section summarizes the implications of the analysis presented earlier for policy making. Specifically, observations are offered regarding the impact that various policies to reduce the vehicular carbon footprint might have on the economy.

The final section presents the author's recommendations regarding VMT policy.

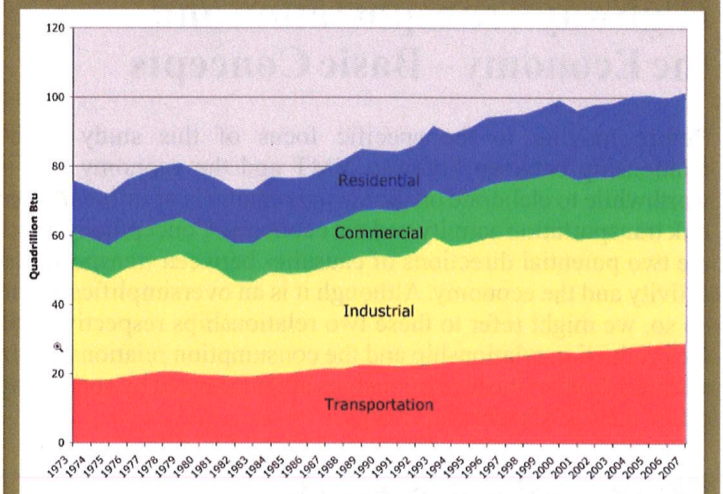
Transportation and Energy Use: An Historical Perspective

Virtually all modes of transportation are reliant currently on fossil fuel to power their movements. First, fossil fuels are the dominant source of energy in the US economy. Data from the U.S. Energy Information Administration (USEIA) indicates that petroleum represents about 40 percent of all energy consumed in the US, and total fossil fuels about 86 percent. Second, whether transportation activity involves travel by air, water, highway or rail, significant amounts of energy are required, and fossil fuel has proved to date to be the most portable energy source and one that requires the least wayside investment. Electrified rail networks exist, of course, but diesel electric locomotion dominates the rail mode.

Figure 1 displays the trend of transportation related energy relative to total energy consumption. It is clear that transportation constitutes not only a significant share of total US energy use, but a share that has been growing as well. Although the other end uses of energy also are important to understanding the effects of fossil energy conservation on the economy, it is clear that energy use by the transportation sector will be an important issue in this debate.

FIGURE 1

Major Energy Uses[1]

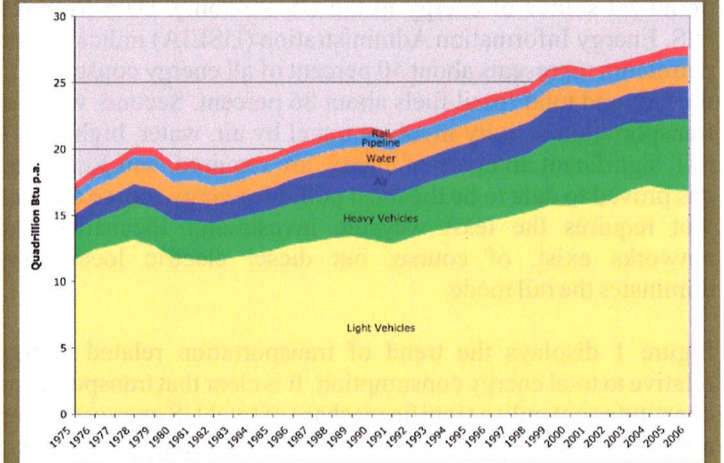


We can focus the discussion further by examining the shares of energy consumed by the various transportation modes.

Figure 2 displays the trend of energy consumed by each of the respective modes. In this regard, highway transportation is by far the largest, single use of transportation energy, using 80 percent of the transportation energy budget. Within the highway category, light vehicles (automobiles, light trucks and motorcycles) represent the majority of highway-related energy consumption. Heavy vehicles and buses, which make up the remainder of the energy used by highway modes of transportation, represent only about a third of total highway energy.

FIGURE 2

Trends in Modal Shares of Energy Consumption



Since light vehicles use less energy per mile traveled than heavy vehicles, the share of highway VMT represented by light vehicles is even greater than their share of energy consumed. Hence, policy that affects light vehicle VMT is particularly relevant to climate change issues.[2]

Highway Transportation and the Economy – Basic Concepts

Before moving to the specific focus of this study – the relationship between highway VMT and the economy – it is worthwhile to elaborate on the various channels of influence that link transportation activity and the economy. Conceptually, there are two potential directions of causality between transportation activity and the economy. Although it is an oversimplification to do so, we might refer to these two relationships respectively as the production relationship and the consumption relationship. In addition, both of these relationships are influenced by something called the rate of technical change.

The Production Relationship

The role of transportation in the production of goods and services is an obvious one. In order for a firm to produce its output, the various inputs to the production process usually have to be in proximity to one and other. That is, labor, raw materials, machinery, sources of energy, and other inputs have to be obtained from where they are naturally located and joined at the site of production. Although telecommunications innovations make it less necessary, in some settings, to be co-located with other inputs, in general, transportation costs--both directly and indirectly--figure significantly in the costs of production in most sectors of the economy.

TABLE 1

Transportation Energy Inputs, Autos/Light Trucks[3]

	Total	Share
Total for all sectors	7.570	100.00%
Truck transportation	0.419	5.54%
Air transportation	0.270	3.56%
Rail transportation	0.114	1.50%
Pipeline transportation	0.063	0.84%
Water transportation	0.046	0.61%
Ground passenger transportation	0.009	0.12%
Total transportation	0.922	12.17%
Total for all other sectors	6.648	87.83%

in terajoules

The most accessible data on the relationship between business output and transportation inputs required is obtained from so-called Input-Output representations of the economy. Table 1 shows the quantity and shares of transportation and other energy needed to produce $1 million of new automobiles and light trucks. The energy measures are in terajoules (TJ), and represent the result of tracking the inputs required to produce the autos and light trucks through the complex supply chain of direct suppliers, their suppliers, etc.

This example is arbitrary; similar calculations can be made for any sector represented in the Input-Output tables. It is simply an illustration of the importance of transportation inputs to a typical production process, and a demonstration of a channel through which transportation can cause output and, hence, economic value. Interestingly, however, if the energy use associated with making cars and light trucks were converted to equivalent gallons of gasoline, the resulting gallonage is sufficient propel an existing, average-efficiency vehicle over 100,000 miles.

The Consumption Relationship

The consumption side of the transportation/economy relationship refers to the fact that households also use energy, vehicle capital, and other resources to transport themselves. Household transportation activities are considered consumption in the National Income Accounts and input-output representations of the economy. It is not just recreational or pleasure

travel, however, that is considered consumption. Commutation from one's home to work also is considered a consumption expense, rather than an input to production. Yet it is clear that transportation of labor to the production site represents a transportation input to production akin to the transportation costs associated with bringing in materials, machinery and other non-labor inputs.

It is on the consumption side of the economic ledger that the direction of the causal relationship between economic activity and transportation activity becomes particularly ambiguous. If household transportation activity were all linked to pleasure driving, for example, one might reasonably expect causality to flow strongly from a household's income to the amount of such transportation services consumed. However, when one recognizes that a significant portion of transportation consumption involves the travel time and cost associated with moving labor inputs to the place of production, the possibility of household travel determining ("causing") economic output rather than vice versa is amplified.

The issue is further complicated by the fact that commutation to jobs does interact with other consumption decisions. Specifically, households have some flexibility to choose their place to live relative to their places of employment. Thus, a household's time and distance of travel to work is determined jointly with consumption decisions regarding residential and community amenities. Nevertheless, a household does not have full discretion over commutation costs. Indeed, the economics of location theory imply that a household balances the transportation costs of the available residential locations against the cost and amenities associated with the residence. This balancing act is what results in site values and development densities generally declining the further one gets from an urban center. Households might generally prefer to live centrally, everything else equal; but for some, the high central site values make it more cost beneficial to commute further to places of lower cost that provide the amenities desired. If incomes were higher, however, the demand for central living likely would increase, all else equal.

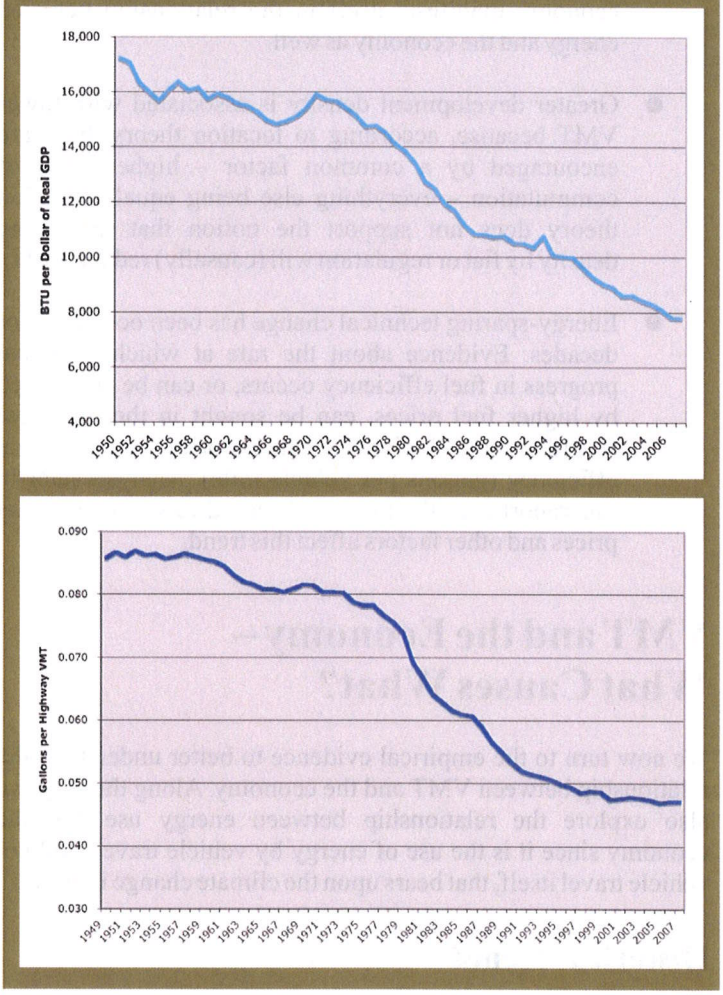
The Role of Technical Change

Another aspect of the economy that bears upon production and consumption generally, and the associated use of energy in particular, is the rate of change in what is called technical efficiency. Specifically, producers and consumers have an incentive, at all times, to reduce energy use, since it adds costs to both activities.

Indeed, the trend in energy use per dollar of Gross Domestic Product (GDP) and per VMT has been steadily downward over time. This is true even prior to government imposing energy efficiency initiatives. (See Figure 3.) In the context of the climate change issue, both of these trends reveal changing technical efficiency. The rate of technical change depends on many factors, but the most important is the discovery of technologies that are so resource sparing that it is worthwhile to abandon the old technology. Since old technology is embedded in equipment, buildings and vehicles that have long lives, the new technology must offer future resource savings sufficient to justify abandonment of old capital and acquisition of the new.

FIGURE 3

Trends in Energy Use per Dollar of GDP and Gallons per Mile



If energy is the resource to be spared, therefore, the new technology, at a minimum, must not consume more energy to implement than it is expected to save over its operating life. Such technological innovations come along at an unpredictable rate. One hopes that innovation can be accelerated through spending on research or by changes in the stakes of innovation (due, say, to an increase in the price of fossil fuel and, hence, the benefit of sparing its use). The impact that reducing VMT to save energy has on the economy, therefore, will depend on the rate at which technical change occurs.

This conceptual background yields several insights useful to this study:

- It is not clear theoretically whether vehicle travel causes economic activity or vice versa, or both to varying degrees. Thus, it is an empirical question whether, or by how much, economic activity will be affected by policies to restrict or tax vehicle use. The historical data should be examined for evidence of the direction of causality.

- Because of the intimacy of the relationship between transportation and energy use, the ambiguity regarding the direction of causality between transportation and the economy manifests itself in the relationship between energy and the economy as well.

- Greater development density is associated with lower VMT because, according to location theory, both are encouraged by a common factor – higher costs of commutation – everything else being equal. Location theory does not support the notion that increasing density by fiat or regulation will (causally) reduce VMT.

- Energy-sparing technical change has been occurring for decades. Evidence about the rate at which technical progress in fuel efficiency occurs, or can be stimulated by higher fuel prices, can be sought in the historical record. Figure 3 displays the historical trend in fuel efficiency (gallons per vehicle mile). Analysis later in this report uses the historical record to study how fuel prices and other factors affect this trend.

VMT and the Economy – What Causes What?

We now turn to the empirical evidence to better understand the relationship between VMT and the economy. Along the way, we also explore the relationship between energy use and the economy since it is the use of energy by vehicle travel, and not vehicle travel itself, that bears upon the climate change issue.

Historical Trends

We first look at the historical trends in VMT, the size of the economy and energy use and prices.

Figure 4 is a plot of the long-term trends in VMT and total US gross domestic product – the most frequently used measure of aggregate economic activity. Both are trending upward at a mild exponential rate, as women entering the workforce, productivity growth, and other factors drive the economy. We see in these trends an extremely tight correspondence between trends in VMT and GDP. In economics parlance, they appear to be virtually coincident indicators. It also is impossible to discern which measure causes which; we will need much sharper analytic tools to do so. In Figure 5, we see that a similar, albeit less tight correspondence exists between trends in US GDP and total energy consumption (measured in BTU). Here, too, the trends are sufficiently coincident that one cannot easily determine whether economic activity (GDP) causes energy-consumptive activities (like vehicle travel), or vice versa. When we look at energy use across a large number of countries with widely differing levels of economic activity, we still find a nearly one-for-one relationship between GDP and energy use, as displayed in Figure 6.

FIGURE 4

Trends in VMT and US GDP

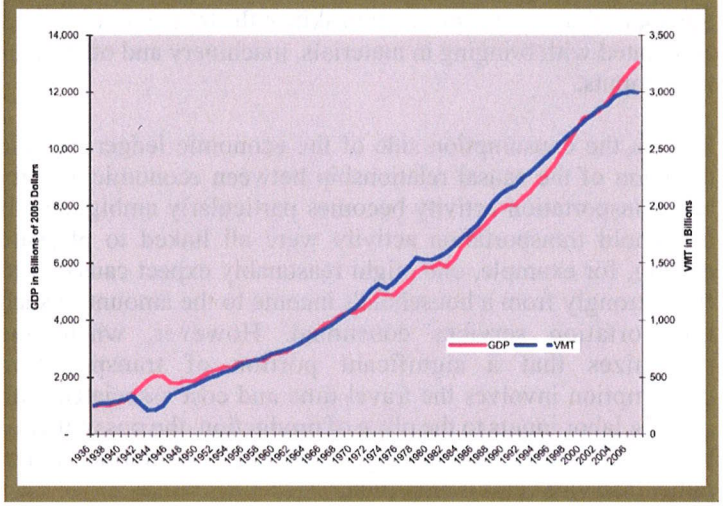
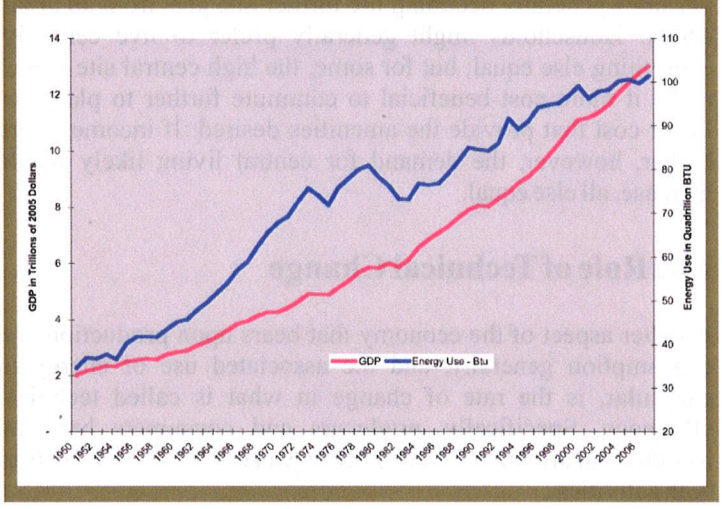


FIGURE 5

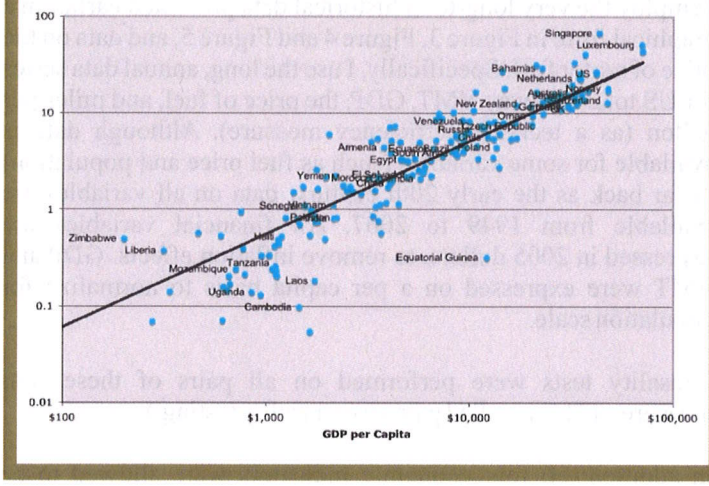
Trends in US GDP and Energy Use



Thus, the seemingly proportional relationship between GDP and energy use is not unique to the US. Figure 6 displays this relationship for 177 countries, using barrels of oil per capita as the energy use measure and GDP per capita (adjusted for relative, long-run foreign exchange relationships).[4] An econometric relationship fit through the data implies that increasing a country's income by 10 percent appears to increase its

FIGURE 6

GDP and Energy Use in Other Economies (per capita), 2005



use of energy by the same percentage. The graphical analysis highlights the dilemma we face in formulating policy to address climate change. Vehicle miles traveled, economic activity, fossil fuel and total energy use are intimately related over time. (In economics parlance, these indicators are said to be "cointegrated".) Therefore, if VMT strongly drives economic activity in a causal manner, then policies that are effective in reducing VMT also could reduce economic activity. If the direction of causality is mostly the reverse, we do not face this serious dilemma. If causality flows both ways, "bi-directional causality," then the net effect depends upon the relative strength of the two effects.

Disentangling Causality

The key issue, then, is the direction of causality between VMT and economic activity. The method economists use to determine the direction of causality relies on the assumption that, if movements in one economic variable consistently precede movements in a second variable, then the first variable's movements likely cause the movements in the second. This definition of causality (referred to as Granger causality) does not prove causality, but it does establish a case for it.[5]

This author could find no authoritative study that tests specifically for Granger causality between VMT and economic activity in the US economy. I assembled the necessary data and conducted the tests. The results will be reported below. Before doing so, however, it is worthwhile reporting the findings of related studies. In particular, many studies have examined causality between energy use and the economy, and there are a few studies that have a transportation focus.

Energy and the Economy: Causality Evidence

Most of the studies of energy/economy causality find either that energy causes GDP or finds bi-directional causality. That is, higher energy consumption causes greater economic output and income, and higher output and income cause higher energy consumption. However, these findings are not universal.

Analysts examine different countries' data, and use data series of varying sizes, etc. As with all statistical tests, causality test conclusions are not absolute, but rather are expressed in probabilistic or level of confidence terms. Depending upon the amount and source of data used, therefore, some authors' findings in this regard are stronger or weaker than others. The results of the various studies are summarized in Table 2.

A few of the studies go on to measure quantitatively the impact of a reduction in available energy on the economy as its effects play out over time. Recall that the graphical analysis in Figure 6 implies that, if energy use has a one-direction causal relationship to the economy, a ten percent reduction in energy use would translate into a 10 percent reduction in economic activity. In contrast, formal, Granger-type analysis generally implies a smaller reaction on the part of the economy for those studies that find energy causing GDP. Narayan and Smyth (2008), studying all of the G-7 countries as a group, find that a 10 percent decrease in energy use reduces economic activity by about 1.2 to 3.9 percent. This is still a large effect, of course, and implies that policy makers face tough choices as they try to reduce fossil fuel energy use to slow climate changes.

TABLE 2

Energy-GDP Causality Evidence

		Causality Finding		
Author	Country Studied	Energy causes GDP	GDP causes Energy	No Causality
Stern (1993)	US	X	X	
Stern (2000)	US	X	X	
Lee (2006)	US	X	X	
Abosedra and Baghestani (1989)	US		X	
Akarca and Long (1980)	US			X
Yu and Choi (1985)	US			X
Yu and Hwang (1984)	US			X
Cheng (1995)	US			X
Erol and Yu (1987)	Japan	X	X	
Erol and Yu (1987)	Canada	X		
Erol and Yu (1987)	Italy		X	
Erol and Yu (1987)	West Germany		X	
Erol and Yu (1987)	France			X
Erol and Yu (1987)	UK			X
Yu and Choi (1985)	UK			X
Ghali and El-Sakka (2004)	Canada	X	X	
Soytas and Sari (2003)	Italy		X	
Soytas and Sari (2003)	France	X		
Soytas and Sari (2003)	Germany	X		
Soytas and Sari (2003)	Japan	X		
Lee (2006)	Canada	X		
Lee (2006)	France		X	
Lee (2006)	Italy		X	
Lee (2006)	Japan		X	
Soytas and Sari (2006)	Canada	X	X	
Soytas and Sari (2006)	Italy	X	X	
Soytas and Sari (2006)	Japan	X	X	
Soytas and Sari (2006)	UK	X	X	
Soytas and Sari (2006)	France	X		
Soytas and Sari (2006)	US	X		
Soytas and Sari (2006)	Germany		X	
Narayan and Smyth (2008)	G-7 Panel	X		

The implications of these studies of energy for our study of VMT are suggestive, but not definitive. Transportation in general, and highway vehicle travel in particular, is a major use of energy. Highway use thus is certainly one of the major channels through which a reduction in energy could be associated with a reduction in economic activity and/or be affected by economic activity. The other channels, of course, are commercial, industrial, and residential activities and their energy use. Thus, it seems likely that the highway VMT channel of influence also will demonstrate causality of VMT to the economy, or be bi-directional, but is not definitively established by the energy studies.

VMT and the Economy: Causality and Other Studies

The professional economics literature is nearly silent on the causal relationship between transportation activity or VMT and the economy. Therefore, the author conducted a formal, causality study. Below, the results of this study are presented and discussed in the light of related literature.

A COINTEGRATION STUDY

Before describing the findings of this author's research, the work of Liddle (2007) should be referenced. Liddle performed the only analysis found in the literature that examined the historical relationship among VMT, GDP, and fuel prices for the US. His study tested for "cointegration," a statistical analysis related to Granger causality testing.

In lay terms, cointegration tests for whether two or more variables are so tightly related that each is effectively determined by the others. In this case, Liddle's results "confirm a long-run, systemic relationship" among fuel price, GDP, and VMT. He found similar results when he replaced VMT with energy consumed ("fuel use") or with a measure of technical change ("fuel efficiency").

The implication of Liddle's study in his words is that "these variables cannot be easily disentangled in the short-run," limiting policy makers' options to try to influence VMT without having effects on income. Similarly, Liddle finds that attempts to influence vehicle fuel efficiency or VMT with strategies that raise the price of fuel will be "quite painful," in the sense that there would be large, negative impacts on national income and output. Liddle suggests that non-market approaches to improving vehicle efficiency (e.g., fuel efficiency improvements through technological research) might be the best path.

A DIRECT CAUSALITY STUDY

I present my own causality findings herein.[6] As mentioned above, Liddle studied VMT trends using so-called cointegration testing. Although cointegration testing is related to causality investigations, his work stopped short of providing causality findings in the form of interest to this study. However, my analysis was made easier by the prior efforts of Liddle. It also draws on the aforementioned energy-economy causality studies.

The technical details of the methodology are not presented here, but are available from the author.[7] However, the study has the following basic elements:

I employ the very long-term historical data presented earlier in a graphical form in Figure 3, Figure 4 and Figure 5, and data on the price of motor fuel. Specifically, I use the long, annual data series for US total highway VMT, GDP, the price of fuel, and miles per gallon (as a technical efficiency measure). Although data is available for some variables (such as fuel price and population) as far back as the early 20th century, data on all variables are available from 1949 to 2007. All financial variables are expressed in 2005 dollars, to remove inflation effects. GDP and VMT were expressed on a per capita basis to normalize for population scale.

Causality tests were performed on all pairs of these four measures. (This is called pairwise causality testing.)

In addition, all four economic indicators were allowed to be mutually determining (in economics parlance, "endogenous"), permitting not only causality testing, but also simulation of how each measure might be affected by a "shock" to itself or one of the other measures.[8] This latter, so-called "impulse" analysis helps us measure the size of the response to shocks, and how persistent the effects will be in the future.

The results of the analysis presented here are limited to the pairwise causality comparisons and selected elements of the impulse analyses. I turn first to the results of the pairwise causality tests:

Pairwise causality tests reveal that VMT and the economy "cause" each other. This has been referred to earlier as "bi-directional" causality, and means that highway VMT influences economic activity (measured by GDP), and GDP influences VMT. Both effects are highly significant, statistically.[9] This suggests that policy interventions that reduce VMT will have an effect on the economy. This confirms the similar findings reported by related studies of energy and the economy.

On a pairwise basis, miles per gallon and fuel prices also were found to be bi-directionally causal, although the effect of miles per gallon on fuel prices is slightly weaker statistically than test standards. The effect of fuel prices on average miles per gallon, however, was highly significant statistically.

The only other statistically-significant pairwise causal effect was a positive effect of VMT on miles per gallon. Taken together, these findings are suggestive of a response of technical efficiency to fuel price, and that the amount of travel may influence technology choice.

The second avenue of measurement is the impulse response analysis. The impulse response analysis helps to quantify the strength and persistence of effects of "shocks" to individual variables. The analysis is presented here in its "cumulative formulation," allowing the shocks and echoes of the shocks over time to cumulate.

Without impulse response analysis, or similar investigations, we do not know whether or not a statistically-significant effect also translates into a large effect. We also do not know if that effect is transient, or persists over time. In this work, the impact projections are extended over a twenty-year period (after the shock). Although the error bands around these projections are inherently large, understanding the relative scale and trajectory of the various effects is valuable, in this author's opinion.

The key findings of the impulse response analysis are presented in Figure 7, Figure 8, and Figure 9.

FIGURE 7

Response of GDP per Capita to Various Shocks

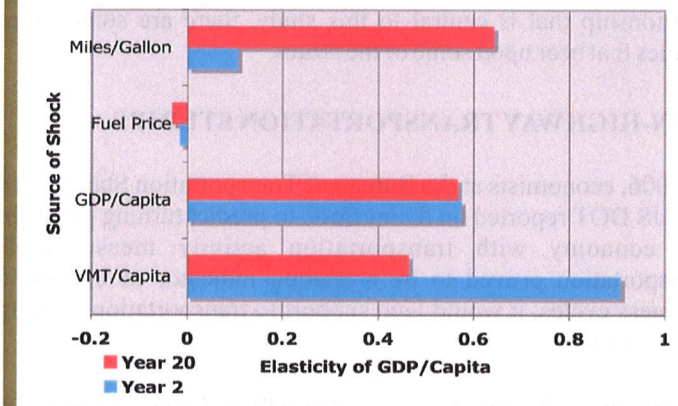
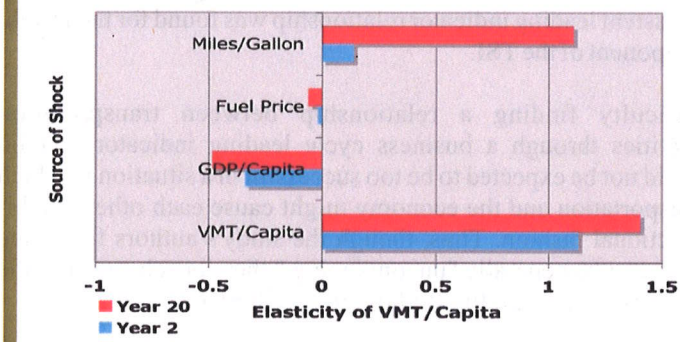


FIGURE 8

Response of VMT per Capita to Various Shocks

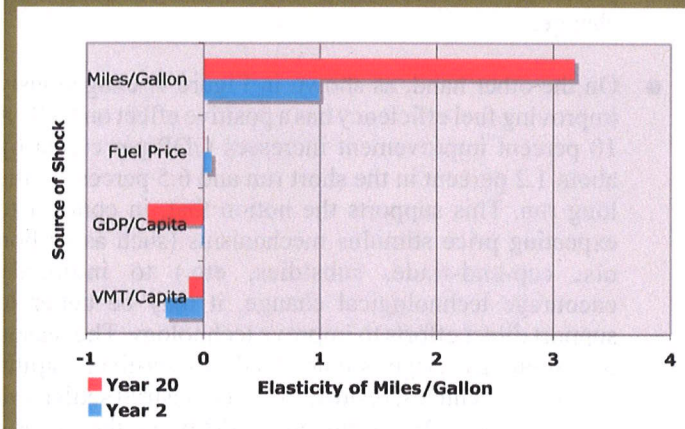


Focusing on the key findings, the implications of the impulse responses[10] are as follows:

- VMT strongly influences GDP in the same direction, consistent with the pairwise causality finding. As illustrated in Figure 7, the response ("elasticity") of GDP per capita to a shock in VMT per capita is high, both in the long and short run. Specifically, a one percent change in VMT/capita causes a 0.9 percent change in GDP in the short run (2 years) and a 0.46 percent in the long run (20 years). If accurate, this is a key finding, since it suggests there is a large penalty – even in the long run – associated with policies that use direct regulation to reduce VMT.

FIGURE 9

Response of Fuel Efficiency (MPG) to Various Shocks



- VMT is not particularly sensitive to shocks to fuel price alone. As shown in Figure 8, a shock to fuel price does reduce VMT/capita, but the elasticity is low (about 2 percent in the short run and 6 percent in the long run). This is consistent with the fact that the 117 percent increase in fuel prices between July 2004 and July 2008 are reported to have suppressed driving by about 4.2 percent.

- VMT is negatively related to shocks in GDP, as shown in Figure 8. This may be suggestive of the notion advanced earlier that VMT is less of a consumer good than it is an input to production or consumption. Higher GDP would allow owners of residential and commercial capital to afford closer locations. It is also possible that the negative relationship is a statistical artifact of the difficulty in isolating the direction of GDP-VMT causality. Either way, however, the logic supports the notion that the primary direction of positive causality is of VMT on GDP.

The analysis also reveals some interesting findings regarding technical efficiency (measured herein as miles per gallon). The potential to avoid the negative consequences of VMT reduction by making each VMT less energy consumptive and carbon emissive is one of the great hopes of policy makers. My findings in this regard are as follows:

- As Figure 9 indicates, the response of fuel efficiency to a shock in fuel prices is positive, but not very large. The elasticity of miles per gallon to

price shocks is only 7 percent in the short run and less than half a percent in the long run. This corroborates the observation by Liddle (2007) that manipulating fuel prices may not be an effective way to stimulate technical change.

- On the other hand, as shown in Figure 7, exogenously improving fuel efficiency has a positive effect on GDP. A 10 percent improvement increases GDP per capita by about 1.2 percent in the short run and 6.5 percent in the long run. This supports the notion that, in contrast to expecting price stimulus mechanisms (such as carbon tax, cap-and-trade, subsidies, etc.) to indirectly encourage technological change, it may be better to support direct efforts to improve technology. The reason is that energy usage is embedded in long-lived capital structures (vehicles, residential and industrial settlement patterns, etc.). As discussed in detail in the section Evaluating Alternative VMT Policies, below, increases in energy cost cause offsetting movements in the value of this "old" capital that tends to slow penetration of energy-saving technology.

- Exogenously improving fuel efficiency also raises the prospect that the market may respond by increasing VMT in an offsetting way, a phenomenon known as the "rebound effect." Figure 8 shows that an exogenous shock to fuel efficiency increases VMT. In the short run, the increase in VMT is relatively small. In a two-year time frame, a 10 percent increase in fuel efficiency might increase VMT by only 1 percent or so. However, in the long run (20 years) the rebound effect is completely offsetting, with a 10 percent improvement in efficiency yielding almost exactly a 10 percent increase in VMT.

  In summary, the author's econometric efforts comport with the results of related, energy-economy studies and the results of Liddle. As with Liddle's work, this author's research suggests that the market responds in ways that make tax- or regulatory interventions unlikely to be dramatically effective in reducing VMT, but very dramatic in its effect on economic vigor.

  There are, of course, qualifications to these findings that should be offered in any honest effort to study such complex economic interactions.

- First, causality studies rely, necessarily, on long, historical data series. This inherently embeds market and technological relationships that may not be fully relevant to the modern setting. However, without evidence of effects contrary to those revealed in the historical record, one must be wary of unfounded speculation.

- Second, there may be important variables missing from the efforts reported here that would alter the findings presented. There also is the possibility that the data used herein was not well measured by the agencies that generated them. Unfortunately, causality testing is very data hungry, and there are limits to the number of factors that can be considered simultaneously, and few alternative measures of vehicular activity that have long, historical records.

- Finally, there are alternative specifications of the analysis presented here that might alter the findings. The author, as discussed earlier, tested various specifications of the model presented. Generally, the findings, across reasonable variations in the specification, were qualitatively the same.

Related Studies

Although they do not address the VMT-economy causal relationship that is central to this study, there are some other studies that bear upon some of the issues.

NON-HIGHWAY TRANSPORTATION STUDIES

In 2006, economists at the Bureau of Transportation Statistics of the US DOT reported on their efforts to predict turning points in the economy with transportation activity measures. If transportation proved to be a leading indicator of economic business cycles, it would lend support to transportation causing the economy.

In the study, the measure of transportation activity used is the Transportation Services Index (TSI), which comprises activity of "for hire" air, rail, water and highway transportation. Unfortunately, this means that the bulk of highway VMT – most auto and light truck travel activity – is not included in the index or the study. In any case, the study results were not conclusive. No significant leading or lagging relationship was found for the passenger component of the TSI, although a moderately consistent leading indicator relationship was found for the freight component of the TSI.

Difficulty finding a relationship between transportation activities through a business cycle leading indicator method would not be expected to be too successful in a situation in which transportation and the economy might cause each other in a bi-directional fashion. Thus, though the study's authors found the weak results generally "unconvincing," they loosely confirm the findings of the causality studies reported herein.

THE HIGHWAY CAPACITY-VMT CAUSALITY

A number of authors have studied whether new freeway capacity causes VMT or vice versa. The notion that building new highways "induces" more travel is of interest to those interested in policies that could be used to contain VMT growth. Thus, this literature is tangentially of interest to this study if limiting road building were adopted as a climate control policy.

The literature on this subject generally finds either a bi-directional causality between road capacity and VMT or that road capacity precedes (and thus "causes") VMT growth. Examples of this type of study are Cervero (2002), Cervero and Hansen (2002), Fulton, Meszler, Noland and Thomas (2000), Noland (2001), and Noland and Lem (2002). These studies are of little use to our primary mission of understanding the relationship between VMT and the economy. However, it has been demonstrated by other studies that new highway capacity positively influences regional income or employment. Keane (1996), for example, finds that a 10% increase in investment in highway infrastructure gives rise to a 4% increase in national output. Thus, finding that new highway capacity increases VMT does not eliminate the possibility that VMT causes economic growth or vice versa.

REGIONAL ECONOMIC MODELS

There have been a few attempts to incorporate the influence of regional economic activity on VMT in conventional, non-causality models but, interestingly, they usually do not set up the model to not allow a reverse effect. Choo and Mokhtarian (2007), for example, incidentally studied the VMT/economy relationship in a model of the US that was built to examine the influence of telecommunications on travel demand and supply.

Choo and Mokhtarian assumed that economic activity affected VMT, but apparently did not allow for the possibility of a reverse relationship. Similarly, they allow the pattern of land use ("suburbanization") to influence transportation activity, but apparently not the reverse. Not surprisingly, therefore, they found that economic activity and suburbanization stimulated VMT. In the case of the relationship between transportation infrastructure and the economy, they allowed the relationship to be bi-directional and found bi-directional effects.

Evaluating Alternative VMT Policies

The significant energy footprint of highway transportation makes it a logical locus for carbon emissions and climate control policy. Conceptually, the type of policy pursued should be that which, in present value terms, generates the greatest difference between the economic value of relief from negative economic impacts of continued climate change and the cost of achieving that relief. I will call this the net benefit of carbon policy toward VMT.

Unfortunately, there is great uncertainty as to the future value of alternative climate change impacts. This is both because the climate models themselves are so imprecise, and because it is so difficult to estimate the economic impact associated with any, given climate evolution. In this setting, it is probably best to evaluate alternative policies in terms of an intermediate variable, such as the comparative cost among the alternatives of a given, incremental reduction in carbon emissions. The latter, in turn, can be decomposed into the effect of the policy on emissions per VMT and the effect of the policy on total VMT.

From an economist's perspective, the cost of the policy should be measured in terms of lost economic welfare. Economic output is not identical to this economic concept, but likely is positively correlated with it. Therefore, we will treat these notions interchangeably as we discuss policy alternatives in light of the findings earlier in this report.

Policy Alternatives

There are three broad classes of policy alternatives that might be considered to reduce VMT as a means of addressing climate change issues:

Do Nothing. This alternative means that no special changes in policy are pursued. This does not necessarily mean that VMT-related carbon emissions won't be reduced, but rather that the natural evolution of fuel costs, technology, and economic growth are allowed to proceed along the paths they would take in the absence of major intervention. Implicitly, this alternative presumes that households and businesses already have incentives (including current policies already in place) to find ways to spare energy use and develop alternative technologies, given current and future expected price trajectories.

Market Price Interventions. This family of alternatives involves altering market prices in travel, energy and/or technology markets. Such alternatives include VMT charges, carbon taxes, carbon cap and trading schemes, etc. The motivation of this approach is to change behavior in a way that cost-effectively amplifies the economy's rate at which VMT-related carbon emissions will be spared relative to the Do Nothing case. By our evaluation criterion, this means necessarily that such policies result in a reduction in the cost of an increment of carbon emissions relative to the Do Nothing case. Because we are working in a present value calculus, this in turn means that such policies yield either a beneficial time shift (i.e., push emissions into the future) or generate near term savings in the present value of the cost of reducing carbon emissions, or both.

Quantity Restrictions. The third, general approach is to impose quantity restrictions on VMT itself, highway infrastructure, emissions or energy efficiency by fiat. Examples of such policies include alternate day driving restrictions, regulations, fuel or licensing rations, restrictions on road infrastructure development, fleet or manufacturer fuel efficiency regulations, regulatory land-use policy (such as greater-than-market minimum density development requirements), etc.

In very broad terms, most economists likely would agree that the Do Nothing alternative has no practical prospect of avoiding some underperformance in the economy over time. Because carbon emissions – and their impact on the economy – constitute a cost that individual, private decisions do not bear, there is a theoretical reason for believing that the Do Nothing case would lead to lower output over time if the effect on climate change is, in fact, adverse. However, it is possible that the growing scarcity of fossil fuel and its increasing relative price may guide the economy to a low GHG equilibrium.

Although a Do Nothing policy may not be as efficient economically as would be the case if all externalities were internalized perfectly and costlessly, there are risks in implementing more interventionist policies. There could be larger economic inefficiencies associated with market interventions than with the Do Nothing alternatives. Among some economists, the current ethanol initiatives at the moment are viewed as an example of these risks.

If market intervention is deemed necessary, economists tend to prefer pricing interventions to quantity restrictions. The logic is two-fold. First, economic agents are differentially disposed and have varying capabilities of responding to interventions. Price- or tax-based interventions will selectively induce those who can adapt most readily and at lowest cost to do so, which is an important consideration in minimizing economic efficiency impacts of policy.

Second, pricing policy generates revenues that can be used to mitigate adverse wealth effects for those who suffer under the higher price of a desired activity or commodity. These revenues, repatriated in a broad-based way through tax relief, thus preserve the incentive to act efficiently, but without impoverishing the producers or consumers. Regulations of quantities of activity, on the other hand, neither can selectively identify the efficient adjusters, nor generate any revenue to soften the wealth impact of the restrictions.

Evaluation of Selected Specific Policy Alternatives

Because the number and types of interventions are so large, we focus detailed comments only on the following, frequently suggested interventions.

Cap-and-Trade Schemes

These schemes are designed to create a market in hitherto unpriced GHG emissions. In a VMT-oriented cap-and-trade scheme, a cap on total, allowed vehicular carbon emissions would be established and averaged over the population of emitters (e.g., households or vehicles). Those who have means of producing emissions below the cap can sell their excess emission rights to those struggling to meet the cap. In so doing, a price for an additional unit of emissions is determined. Both high- and low-emitters now face incentives (as sellers or buyers) to economize on GHG emissions.

The problems of implementing this scheme are less theoretical than administrative. First, a proper cap has to be determined and set so that the cap is binding on at least some emitters. The recent EU experiences with cap-and-trade schemes is not encouraging, as political favoritism left few emitters with binding caps.

Second, applied to the vehicular emissions problem, cap-and-trade schemes face the challenge of very high administrative costs associated with measuring emissions and ensuring compliance of millions of households or vehicles.

Carbon Taxes

Another means of establishing a market in emissions is to levy a tax on fuel based on its carbon content. The purpose of such a tax would be to elevate fuel prices so that it now contains a signal regarding the value of the external effects of fuel use. Since it is the price signal, and not the revenue, that is of interest in the setting of carbon taxes, in a pure carbon tax policy, revenues would be used to reduce other taxes. There are some challenges in doing so without offsetting the desired, signaling effect, and in the context of distrustful taxpayers who will be dubious that the plan truly will be revenue neutral. However, the administrative mechanisms for collecting and refunding the revenues (i.e., fuel taxation systems and income taxation reporting) already exist, so that the administrative costs could be manageable.

Both short-run and long-run reductions in VMT and VMT emissions can be expected. Vehicle users can be expected to respond by reducing trip making, switching to less fuel-intensive modes (e.g., carpooling), etc. However, as the impulse response findings presented earlier suggest, the response of fleet VMT to pricing can be expected to be modest, everything else being equal.

In addition, it is not clear the extent to which carbon tax schemes will accelerate adoption of more fuel-efficient vehicles. Offsetting effects occur in the marketplace to slow the diffusion of efficient technology through the market. For example, if a carbon tax is levied, and believed to be persistent, the market value of old vehicle capital will decline by an amount equal to the present value of the expected carbon tax levy. This dulls the incentive to upgrade the old fleet. If the new vehicles are costly to build and acquire (because they are carbon-energy intensive themselves to build, the technology is expensive or monopolized, etc.), owners of functional, less-efficient vehicles will have no incentive to adopt the new technology.

Indeed, in general, for vehicle replacement to be economical, the higher-efficiency vehicle has to cost less than the market value of the old vehicle plus the present value of expected carbon tax savings relative to the old vehicle, everything else being equal. When durable capital (like vehicles or power plants) is involved, the turnover of capital tends to be slow, unless the new capital is both more efficient and cheaper to acquire. This is why, despite rapid improvements in new vehicle fleet average fuel efficiency, the average fleet fuel efficiency has changed so slowly relative to CAFE standards. This also may explain why, in the last decade, vehicles are staying in the fleet nearly twice as long.

Congestion Pricing

Congestion pricing is a policy that economists have advocated for many years for reasons other than climate change considerations. They have been advocated to better reflect the impact of additional vehicles on the speed of the traffic stream under high volume conditions. The underpricing of scarce peak roadway capacity distorts trip making, location decisions, and roadway authorities' tendencies to add new capacity.

A side effect of congestion pricing would be reduction in VMT – especially in the peak period – but likely also in daily traffic. The results of a regional implementation experiment in the Puget Sound Region suggests that pricing for congestion alone would reduce VMT by about six to seven percent, and generate economic benefits of $28 billion over a thirty-year period in present value terms.

Although congestion pricing should be implemented on its own merits, and because it actually generates positive economic benefits by sparing another, valuable resource (travelers' time), its potency for affecting VMT is high but its economic footprint may be positive, rather than negative. Whereas carbon taxes, set at a level that emulates the social cost of carbon emissions would be on the order of a fraction of a cent to a cent or so per VMT, peak period congestion levies may easily be in the 25 to 65 cents per VMT on congested facilities. Thus, congestion pricing may be a case where doing something to generate economic benefits may indirectly be a good first step in managing carbon emissions.

VMT Charges

A flat, per mile VMT charge also would influence VMT and thereby the associated carbon emissions. However, with the exception of a charge of a few cents per VMT to represent roadway wear and tear charges, levying a high, flat VMT charge simply to retard VMT lacks economic justification. Unlike congestion-linked pricing, it has no essential economic justification. Rather, it likely would impair economic well-being and create a pattern of responses that is justified neither by congestion nor carbon emissions economics.

Quantity Regulation of VMT

Reducing VMT by directly regulating the quantity of VMT has little empirical or theoretical support. The impulse response analysis described earlier suggests that the negative, exogenous "shock" to VMT represented by these policies will have a negative impact on the economy nearly in direct proportion to the VMT reduction achieved in the short run. In the long run, the effect will be about half the size, but still large and persistent.

The reason for this likely is because quantity restrictions are notoriously inefficient, non-selective, and inequitable. The one-size-fits-all premise of such policies affords no opportunity for the lowest-cost adjusters to do the adjusting, enlarging the adverse economic impacts. It creates what economists call "dead weight" losses and no means of remediating them since no revenue is generated.

Approaches to direct regulation that have been tried or suggested include alternative day driving restrictions (as practiced in Greece to control air pollution), ceasing road building, transportation system management (TSM) programs that regulate the quantity of parking at or access to employment by single occupant vehicles, etc. There has been virtually no comprehensive analysis of the effects of such policies. Economists have long been skeptical that such policies produce benefits in excess of their cost, however. (See, for example, Palmer, Oates and Portney, 1995).

Regulating Density

Regulating "density" or "compactness" of development is another popular approach – sometimes referred to as "smart growth" – to dealing with the effects of highway travel on climate change. This policy has its genesis in purported findings of an inverse relationship between regional VMT and development density. It has become popular to assume that regulating land use to take a more compact or denser form will, causally, result in lower VMT.

As discussed earlier, there is no theoretical reason to expect causality to run in this direction. Placing residential development closer to commercial and industrial employment by fiat, for example, does not necessarily yield lower VMT. Numerous studies have demonstrated that income and demography are more strongly associated with VMT than is the pattern of settlement, or that associations are correlative rather than causal. See, for example, Boarnet and Nesamani (2003), Crane (2000), Handy, Cao, and Mokhtarian (2005), and Schimek (1996). This author recently completed, for a private client, an exhaustive review of approximately 200 refereed publications to review the factual basis of the smart growth model. That paper, forthcoming in 2009, concludes that there is no evidence to support implied causality flowing from density to VMT.

Location theory tells us that cities form dense centers with progressively lower densities at greater distances from the center because of the interplay of three factors: (a) agglomeration economies created by close proximity, (b) diseconomies of development associated with densities, and (c) the fact that there are positive costs to transport. Density can be stimulated, therefore, by greater agglomeration economies, reductions in the diseconomies (higher costs) of dense development, or an increase in the cost per mile of transport.

Location theory does not imply, therefore, that compelling greater densities will yield lower transport costs. On the contrary, if one compels through regulation higher densities than the market would otherwise produce, the associated diseconomies of building higher, more densely or on marginal sites will cause some activities to decentralize. This is not to say that observed, market densities are entirely efficient, given the lack of proper pricing of roadways during congested periods. Land use regulation, however, cannot offset that pricing distortion because it does not affect the marginal incentive to decentralize (or centralize). Indeed, if such policy elevates central-area land values, which would increase the benefits of decentralization (everything else being equal).

Portland, Oregon may be a good example of this phenomenon. Decades of enforcement of minimum density planning has resulted in a CBD that has been losing jobs and activities to the surrounding areas since the 1990s. For example, between 1998 and 2005 (the latest year for which data is available), employment in the Portland CBD Zip Codes

declined by 0.83 percent per annum, in contrast to positive growth in greater metro area employment of 0.70 percent per annum.

As a practical means of addressing climate issues, the durability of in situ residential, commercial and industrial structures and infrastructure means that, like the automobile fleet, turnover of residential, commercial and industrial capital and the pattern of settlement it represents will be slow. Consequently, land use planning and development regulation is a costly and slow way to influence vehicle activity.

Subsidization of Alternative Technologies

Another approach to VMT reduction is to subsidize the development and/or use of alternatives to today's modes of travel. Providing tax credits to buyers of hybrid vehicles, subsidies to transit providers, subsidies to new vehicle propulsion technology, CAFE standards, etc., are all methods that are used to promote fuel-sparing technologies.

Some believe that by subsidizing a technology to which today's marketplace is unreceptive will help "transform " the market by encouraging product development and consumer acceptance. Cases in point are subsidies provided to buyers of hybrid vehicles or FlexCar®-like car sharing systems. Other technology subsidies, such as those to mass transit subsidies, are better thought of as attempts to redress an auto-transit imbalance resulting from underpricing of peak road capacity.

A final class of subsidies is those provided to researchers and carmakers to encourage development of new, energy sparing vehicle transport methods. In my view, and that of at least some technology experts, is that subsidies can often have the opposite of the desired effect. Subsidies may keep alive otherwise moribund companies, technologies, and policies. Meanwhile, mostly unsubsidized innovation occurs at breakneck speed by the sheer dint of rent seeking by entrepreneurs and their financiers.

There is a theoretical logic to subsidizing basic research – i.e., that research that does not in and of itself generate patentable or marketable innovations, but underpins the latter. There also is logic to subsidizing transit in the face of non-economic pricing of roads. However, even in these cases, there is the risk associated with assigning policy makers the job of picking winners, and/or the subsidies being captured by special interest groups such as project developers or operating labor.

Conclusions and Recommendations

This study has revealed the centrality of highway vehicle miles traveled as both a climate change issue and an economic force. The footprint of highway transportation in the carbon economy and the real economy is large. Evidence that energy – and thus VMT indirectly – causally stimulates economic activity is joined by more direct evidence offered by this author and others.

This causal connection frustrates climate policy, which is seeking a low-impact way of containing carbon emissions associated with highway travel. The connection between VMT and economic activity appears so intimate and potent that heavy-handed policies to reign in VMT for carbon's sake pose grave economic risks. This policy will be frustrated further – if the results presented herein are reliable – because it appears rather difficult to stimulate turnover of low-efficiency capital in favor of high energy efficiency, low carbon emissive technology.

We are best advised to address the climate change considerations associated with VMT through application of measures that engage the market – especially those that have theoretical prospects for generating net economic benefits. Specifically, I recommend the following policies.

We should fix those broken or missing elements of the marketplace that are impairing economic activity today, while at the same time inadvertently amplifying vehicle use. The application of congestion-based road pricing seems the obvious first step in this regard. It also may be the only option that can be implemented quickly and that actually generates net economic benefits, instead of injury, to the economy over both the short- and long-runs.

Although much less effective, a revenue-neutral carbon tax may be theoretically justified. It could be implemented at lower cost than more convoluted, arbitrary and corruptible schemes (such as cap and trade or carbon offset approaches). However, the carbon tax rate should be based on the specific impact of a given behavior, and not set arbitrarily high simply to retard VMT. The effectiveness of fuel price increments in stimulating adoption of carbon-sparing technology is not strong and the risk of injury to the economy is high.

Subsidizing basic research may make sense, but I am dubious of the ability of policy makers to pick technology initiatives to back. There is a significant risk that such subsidies will be misused to sustain non-starter or moribund technologies.

The intimacy of the relationship between vehicle activity and the economy is such that we should approach direct intervention solutions with great caution. I would include in this list regulating land use to achieve VMT outcomes, rationing schemes, directly regulating vehicle activity or fuel efficiency, and the promotion of any technology, fuel, or industry that the venture capital market – by its rejection of support – fails to find worthy. In my view (having served as an investment advisor for a large, public fund), if rent-seeking venture capital, private equity and other money managers cannot find new vehicle-propulsion technologies to back, they may not yet exist.

Endnotes

1. USEIA, Annual Energy Review.

2. The data used in this report comes from sources that attempt to measure vehicle activity on all roads. However, it should be noted that only state and federal highways are instrumented with measurement devices that provide refined vehicle counts and then only at selected locations. In practice, the terms roadways and highways, therefore, are used interchangeably.

3. Source: Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA) model [Internet], Available from: <http://www.eiolca.net/> [Accessed 1 Aug, 2008]

4. Dr. Stephen Brown of the Federal Reserve Bank of Dallas kindly provided the data for this graphic. GDP is adjusted for Purchasing Power Parity (PPP).

5. The most common situation when Granger causality falsely implies causality is when a third factor, related causally to both other factors, is at work. This third factor causes the movements in the first and second factors to occur at slightly different times, creating the illusion of precedence of the first factor over the second.

6. To give proper deference to the fact that causality analysis is not a completely formulaic procedure, I refer to my efforts here as an investigation.

7. A few details are offered here for those interested in the method employed. The data is converted to natural logarithms and first-differences employed to avoid data stationarity issues. Tests for stationarity, cointegration, lag length, causality, Cholesky ordering, and causality were performed using eViews© 5.0. Cumulative impulse measurement was performed in eViews for a four variable system, alternately with two or four lags.

8. This was accomplished in the context of a so-called Vector Auto Regression (VAR) model.

9. Technically, the causality statistics reject the "null" hypothesis of no causal relationship.

10. These figures present calculations made from cumulative response studies. In these studies a "shock" is equal to one standard deviation of the shock variable, as measured from its data history. Thus, a shock always is a positive change in the shock variable. Since different variables have different standard deviations – thus making it hard to appraise the scale of the impulse response – the author converted the various measures to elasticities. An elasticity in this application expresses the ratio of the percent change in the affected variable to the percent change in the shock variable. Note that an impulse response is provided for the case when a shock occurs in the variable being studied; for example, there is a response of GDP/capita to a shock in GDP/capita. This is a natural consequence of the interdependent relationship of all of the variables studied and the fact that a shock occurs in a period (year) prior to measurement of the response.

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Testimony before City Council on Climate Action Plan
By Jeanne Roy, Oct 28, 2009

Buildings and Energy

Objective: Reduce the total energy use of all buildings built before 2010 by 25%.

Action 2. Add a requirement that a commercial building owner disclose energy usage to a potential buyer or tenant. First, this requirement will ensure that building owners track energy consumption. This in itself might spur some improvement. Second, this requirement would create an incentive for owners to reduce energy consumption to attract tenants who pay the energy bills.

Objective: Achieve zero net greenhouse gas emissions in all new buildings and homes.

Add an incentive for builders to construct small homes. Homes that provide more space than occupants really need impact global warming in two ways. First, they require more energy to heat. Second, they require more building materials and furnishings that contain embodied energy. New EPA data shows that goods and materials are responsible for 42% of greenhouse gas emissions compared to 33% for buildings.

Consumption and Solid Waste

Objective: Reduce total solid waste generated by 25%

The primary driver of increased waste is construction of large homes and the resulting home furnishings. Therefore if the city can establish an incentive for smaller homes, it will have an impact on waste generation as well as energy.

Actions 1 and 2. I do not believe that government outreach and education will alter consumer purchasing practices. Metro has tried education campaigns a number of times with no observable result.

Instead the city should implement the following measures:

- Establish a zero waste policy. Those involved in solid waste management need to begin thinking about how to achieve zero waste in the long-term just as the building professions have been addressing zero energy. Seattle, San Francisco, and Austin are among the US cities that have both established zero waste policies.
- Establish a surcharge on non-recyclable packaging, starting with plastic bags.

Objective: Recover 90% of all waste generated

Action 1. The most important act you can take is commercial and residential food waste collection. Your staff has estimated that each additional 10,000 tons of food waste composted eliminates 10,000 tons of CO_2. However, this won't happen unless we develop local composting capability. Therefore I ask you to adopt four more actions:

- Hire a commercial composting expert to establish a local composting facility or facilities.
- Inventory public sties that can be used for small-scale, on-site composting as part of a multi-site approach.
- Provide grants and technical assistance for on-site composting at institutions such as colleges, schools, and medical facilities.
- Require building owners and commercial haulers to send yard debris to composting facilities.

Action 3. Change the wording to say "Prompt Metro and DEQ to incorporate technologies such as digestors and plasmafication into the current solid waste hierarchy using a systems approach." The city should not be recreating the wheel. Metro and DEQ already have solid waste hierarchies, but they are not refined enough to include some of the newer technologies. Also, a systems approach should be used so that producing energy is not preferred over replenishing the soil through composting.

Action 6. I urge you to eliminate this action. Separation of recyclable materials at the source results in more marketable materials. If apartment dwellers are underperforming, the city could require them to separate recyclables from trash, a suggestion in action 8.

Action 7. Clarify that this includes expansion of take-back legislation to include other electronics, batteries, and CFLs. It should also include expansion of the bottle bill.

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36748

Subject: Verbal testimony to the Portland City Council on the Climate Change Action Plan October 28, 2009

Thomas Jefferson accurately foresaw individual liberty becoming secondary to government powers when he said: "The natural progress of things is for liberty to yield and government to gain ground."

That is so true in Portland where "The City that Works" refers to forcibly taking more of its citizens hard earned income only to dictate how the populous should live. There are obviously two Portlands here; one for the elitists and their toys, and one for the rest of us. Double standard examples include flights to China and the Netherlands by bureaucrats where each round trip airplane seat has a carbon footprint a kin to driving a car the distance of 5000 miles; and where the concept of building a web of less than financially self-sustainable streetcars ignores the carbon footprint of producing the steel rails and digging up the streets to put them in while hiding those specific project costs from the public view.

This is a place where driving is frowned upon only to have City police supervisors drive the equivalent of hummers, where huge fire trucks respond to medical emergencies and where city code inspectors travel around in single occupancy cars instead of using public transit or bicycles. Motorists are discriminately over taxed while irresponsible deadbeat bicyclists are free to act like spoiled little children with special privileges and immunities. Elected officials live in single family homes with generous yards, but expect the majority of the people to be packed in like sardines and warehoused in tenement style high density heat island development. This plan calls for almost everything to be new or rebuilt, making the costly replacement of infrastructure, structures and products not unlike excessive consumption.

Overall, this Climate Action Plan is yet another social engineering power play whereby local governments are endeavoring to dictate the lifestyle, housing and transportation choices of the people - even what people eat, Adopting the plan as proposed throws out the democratic principals this country was founded upon and turns Portland and Multnomah County into a socialist state where public officials become totalitarian dictators utilizing fear, one-sided and even bias tax policy to control life's day to day activities. The plan also places handcuffs on the economy, some of which are already in place, by only promoting specific types of jobs while ignoring how many existing jobs will be eliminated. The biggest threat to the eco systems and sustainability of the planet is the over population of the human race. Having an extra child in the family has 20 times the carbon footprint compared to driving an efficient car. Yet this action plan aims to accommodate an increase in population growth rather than discouraging it.

THE BOTTOM LINE is this Climate Action Plan as proposed is designed to give an appearance of solidity to a pure wind when in actuality the intended purpose is to enact heavy handed socialistic controls over the people severely limiting basic rights and freedom of choice. There is an old proverb that says "when an elephant dances, the grass gets trampled". Instead of trampling the historically fought for freedoms this country was founded upon with a politically motivated action plan that resembles an oversized oppressive elephant, any manipulative social engineering policies directed at and to be imposed on the people are best placed in the shredder!

In the packet I passed out, you will find more specific comments and submissions. Please read it.

COMMENTS ON THE CITY OF PORTLAND AND MULTNOMAH COUNTY

CLIMATE ACTION PLAN 2009

Overall, the City of Portland and Multnomah County Draft Climate Action Plan is a social engineering scheme whereby local government is endeavoring to dictate the lifestyle, housing and transportation choices of the people. Adopting the plan as proposed throws out the democracy this country was founded on and turns Portland and Multnomah County into a socialist state where public officials become totalitarian dictators utilizing fear to control life's day to day activities. The plan also places handcuffs on the economy by only promoting specific types of jobs while ignoring how existing jobs will be eliminated. The biggest threat to the environment and sustainability is the over population of the human race. Yet the action plan aims to accommodate an increase in population growth rather than discouraging it. The following comments and submissions are grouped by topic.

1) BUILDINGS AND ENERGY

Since many architects agree the greenest buildings that exist today are the ones that are already built; PRIORITIZE historic preservation and revitalizing existing buildings over new construction and development. Additionally, tearing down reusable buildings is unnecessary consumption.

To encourage the reduction of multi-destination travel, provide incentives for neighborhood "one-stop" shopping centers such as Fred Meyer and WalMart.

Energy efficiency for buildings should be market based, not government mandated.

As an incentive to reduce the reliance on using electric and gas clothes dryers, ESTABLISH a 5% energy tax credit on utility bills for households that don't have them and only drip dry their clothes.

2) LAND USE AND MOBILITY

To reduce cross town travel by school children, REQUIRE Portland school districts to maintain a minimum of one K-8 public school in each and every Portland neighborhood. Neighborhood schools build community.

To bring services closer to where people live, DECENTRALIZE the concept of a downtown district and establish more government services in town centers, especially on the Eastside. Establish incentives for businesses to locate in town centers rather than downtown. Equalize public venues and attractions city wide.

With stringent national fuel consumption and tailpipe standards on the horizon, and FOR BALANCE AND EQUITY in paying transportation taxes; REQUIRE that bicyclists pay their own way by establishing "cost of service" bicycle taxes and fees whereby bicyclists (only) are directly responsible to pay for bicycle infrastructure. Taxing motorists (and/or taxpayers in general) to pay for specialized bicycle infrastructure while "deadbeat" bicyclists freeload is tax discrimination.

ESTABLISH "cost of service" parking fees for bicycles in districts where parking meters exist for motorists, or eliminate pay to park all together. An equitable balance of transportation taxes requires that bicyclists must pay their own way for what they use.

Make the existing Portland Streetcar lines financially self-sustainable by increasing fares and eliminating subsidies from motorist paid parking meter revenues.

REVERSE the unsustainable trajectory of local taxpayer funded subsidies to transit by establishing step by step goals to make all public transit services 60% financially self-sustainable by the year 2020, and 100% financially self-sustainable by the year 2035. Methods MUST include increasing fares, eliminating fareless square and charging for freight on transit such as transporting bicycles. This would also eliminate subsidies to transit from the payroll tax.

Since TriMet's two-axle transit busses do some of the heaviest damage to streets and roads, a portion of transit fares MUST also go to maintaining those streets and roads.

Since producing the steel rails for streetcars and digging up the streets to put them in is less than eco friendly and harmful to the environment - it takes decades to recover effects; and since the up front financial costs for constructing a streetcar system is financially unsustainable and not recoverable through the fare box; SCRAP and ELIMINATE all (politically motivated) streetcar planning from the action plan. The concept of building a web of streetcars must be DISCONTINUED and REPLACED with an electric trolley bus system plan that in its most basic form only requires overhead wires be installed over the streets. Unlike streetcars operating in mixed traffic that stop and obstruct motor vehicle lanes when boarding passengers (thus creating congestion and causing motorists to consume more fuel); electric trolley busses can pull over to the curb when boarding passengers and let other vehicles pass thereby reducing stop and go traffic and increasing fuel efficiency for motorists. Incorporating a streetcar plan in this document is a manipulative ploy by streetcar advocates to deceive and mislead the public into accepting the debt ridden concept. Specific transit planning must be a separate discussion with mode choice coming NOT first, but last, and only after an in-depth comprehensive study of ALL modes of transit for each route.

Since idling engines in stopped traffic waste fuel (2.3 billion gallons a year nationally); curb extensions where busses stop for passengers and obstruct other traffic need to be totally eliminated with NO additional ones constructed. Add bus pullouts where possible.

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To equalize service, SCRAP the "to and from" downtown transit model and REPLACE it with a more direct employment center/town center "hub to hub" transit model.

To establish justice, IMPLEMENT a policy whereby no reductions in motorist roadway capacity (which also increases congestion) would be allowed to accommodate other modes of transport. Motorists should be financially compensated with tax rebates if reductions in motor vehicle capacity occur.

It is OUT OF CONTROL SOCIALISM AND NARROW MINDED TAX DISCRIMINATION to implement pricing mechanisms on driving such as congestion pricing, tolling and/or pay to park dollars, and then redirect those funds to pay for non-automobile transportation modes. Instead, a reverse balanced policy that levels the playing field needs to be established whereby the taxes collected from one mode of transport, specifically motorists, can NOT be used, siphoned off, raided or poached to fund and/or subsidize another mode of travel. Tax codes must be free of the socialist mindset. Additionally it must be noted that one in ten jobs in the US, many of them private sector jobs, are tied to the auto industry. Therefore, reducing driving eliminates jobs that can not and will not be fully replaced by transit and/or bicycling alternatives. Freedom of transport mode and mobility choice, including driving, MUST remain a cornerstone priority in a democratic society. Driving MUST remain affordable to the working class.

ELIMINATE targets for transport mode share. This too is social engineering.

ADD a road user tax to the price of electricity at all electric vehicle charging stations

The Federal Government (and not local or state governments) should be the only government entity to set vehicle tailpipe emission and fuel mileage standards for privately owned vehicles. Adopting another state's standards, specifically California's where Oregon voters have no say, strips away Oregonian's constitutionally protected voting rights. Moreover, one national standard is less costly for consumers. However the city, county and TriMet can themselves purchase vehicles that are more aggressive than the Federal standards by establishing a requirement for local government entities that MUST include diesel powered transit busses and mid-sized to heavy trucks meet fuel efficiency standards that are no less than one-half that of a fuel efficient automobile, thereby obtaining a near 20 miles per gallon or better for each vehicle.

The 10% renewable motor vehicle fuel standards need to be rejected because it shortens the life of and destroys engines as has already been demonstrated within the City of Portland's own fleet of maintenance vehicles. Having to replace an engine prior to its projected lifespan is not only costly, but it is also excessive consumption. Additionally, the city's ethanol requirement for gasoline needs to be eliminated because it increases fuel consumption to the point that some vehicles use more gasoline alone than would be consumed without the ethanol additive mixed in. Additionally, it takes more energy to produce and transport ethanol than is derived from the product itself, especially when feed stocks must be transported long distances and/or from other states.

Expansion of the UGB is neither the direct responsibility of Portland's or Multnomah County. Statements regarding it (that also impact other counties) need to be removed.

3) CONSUMPTION AND SOLID WASTE

In that garbage cans and receptacles are not always filled to capacity when solid waste is picked up, REQUIRE garbage haulers to charge by weight instead of can or container size.

To encourage the reuse of building materials, ENTIRELY ELIMINATE building demolition permits and replace them with required deconstruction permits thereby reducing consumption and making more materials reusable instead of just recyclable or demolition waste.

Unlike a few decades ago when the garbage man drove down the street once a week and picked up the trash from residences on both sides, currently haulers trucks must make six passes on each street, one each direction for solid waste, one each direction for recyclables, and one each direction for garden debris. Trucks need to be redesigned so that only one pass in each direction is needed thereby reducing the miles driven and fuel consumption by haulers. Additionally, this will also save wear and tear and replacing the asphalt less often on city streets and roads.

REQUIRE fuel efficiency standards of at least 20 mpg for the trucks of government contracted franchised haulers.

4) URBAN FORESTRY

To promote more foliage and permeable in urban areas, IMPLEMENT significant property tax credits for all homeowners that have carbon storing vegetation, shrubbery, trees and grass lawns on their property.

IMPLEMENT FREE or significantly reduced water rates, and eliminate sewer charges during the spring and summer hot season for homeowners that have foliage, vegetation, shrubbery, trees and grass lawns on their property.

To reduce the negative impact of high density heat island development at street level, IMPLEMENT zoning changes that require ALL new development to set aside a minimum 10% of the land or property for foliage, vegetation, shrubbery, trees and grass lawns which could either be landscaped or natural areas. No longer would it be possible to construct a structure from sidewalk to sidewalk and covering 100% of the property.

To create more permeable area opportunities, REDUCE standard sidewalk widths to not greater than 8 feet wide so more foliage, vegetation, shrubbery, trees and grass lawns can be included with newly developed properties.

5) FOOD AND AGRICULTURE

Instead of giving development tax breaks to boutique and high priced specialty grocery stores; PROVIDE incentives for large "discount" grocery stores to locate in all Portland neighborhoods - stores like WinCo that buy in bulk and thereby can reduce costs and the miles driven to transport food products.

The government MUST NOT attempt to dictate what foods people individually choose to eat, either by taxation or otherwise. Such actions are again social engineering and also a kin to the government preaching religion.

6) COMMUNITY ENGAGEMENT

REQUIRE a public vote on ALL tax and fee increases (except for bicycle taxes and transit fares - modes which MUST become financially self-sustainable).

ESTABLISH a policy whereby the tax code can NOT be used for social engineering purposes.

Citizen activists are not elected. For greater public involvement, participation and diversity; and to avoid rounding up the usual subjects to create another stacked deck committee, LIMIT individuals to serving on only one city or county citizen committee.

7) CLIMATE CHANGE PREPARATION

The writers of this plan, a stacked deck faction of the usual politically motivated subjects, want people to believe that humans are responsible for climate change as opposed to it being a natural occurrence as demonstrated by the formation of the Columbia Gorge millenniums ago. Yet, for this plan to have any credibility; rather dictating schemes to accommodate regional population growth, the plan would need to address and find incentives that inspire a reduction in population growth - including a possible cap on the number of people that can live within the UGB (Portland and Multnomah County).

8) LOCAL GOVERNMENT OPERATIONS

While the government MUST NOT attempt to socially engineer, dictate and/or impose lifestyle, housing, transportation and food choices to the people; if for no other reason than to protect taxpayers from typical government over consumption, the government can and should impose mandates on its own daily business practices as follows:

To protect American jobs, MANDATE that government entities only purchase American brand-American manufactured products, including vehicle fleets.

Make changes at the government level whereby all city/county inspectors and city/county employees of all types that need to travel within the Metro area are REQUIRED to use public transit or ride a bicycle while performing their daily job duties.

REQUIRE that all elected officials take public transit or ride a bicycle to ALL meetings and appointments within the UGB. Additionally, government officials need to be restricted and eliminate the majority of out of area travel like driving or being driven (such as to Salem to meet with legislators), air travel (such as to other cities, Washington DC and off shore) and instead telecommute.

Set a hard mileage daily LIMIT on ALL city and county owned, leased and rented motor vehicles (except emergency vehicles) that is no greater than the passenger miles per day per person goals. IF THIS CAN NOT BE ACCOMPLISHED, DON'T EVEN CONSIDER IMPOSING GOALS ON DRIVING FOR THE PUBLIC.

Immediately REPLACE ALL the Portland Police Supervisor's huge Chevy Suburbans (built on the same platforms as Hummers) with Ford Escape Hybrids. REQUIRE that police vehicles, and the police fleet as a whole, including ALL trucks and inmate transport vehicles, meet national fuel efficiency and tailpipe standards.

INSTEAD of responding to medical emergencies with big fire trucks and engines, the Portland Fire Bureau needs to CHANGE its practices and respond to medical emergencies using a fleet of fully equipped American brand-American manufactured fuel efficient mini cars, motorcycles or motor scooters that can be housed at all fire stations.

REQUIRE A REDUCTION in the huge monstrous average size of city and county maintenance vehicles (such as dump trucks, tractors, street and sewer cleaning vehicles, etc), Set mileage standards for all newly purchased maintenance vehicles, including for heavy trucks, so they meet a standard of not less than 20 mpg each. Purchase electric maintenance vehicles

ESTABLISH a no exception policy whereby employees and officials are not allowed to take government vehicles home at night if they live outside their respective jurisdictions.

MANDATE that TriMet (a government entity) REDUCE the size of SOV supervisory vehicles by replacing all full sized sedans and SUVs with American brand-American manufactured fuel efficient small and mini vehicles.

REQUIRE TriMet to change its transit vehicle paint scheme to one that more simplified thereby using less materials to apply.

THE BOTTOM LINE is the Climate Action Plan as proposed is designed to give an appearance of solidity to a pure wind when in actuality the intended purpose is to enact heavy handed socialistic controls over the people severely limiting basic rights and freedom of choice. There is an old proverb that says "when an elephant dances, the grass gets trampled". Instead of trampling the historically fought for freedoms this country was founded upon with a politically motivated action plan that resembles an oversized oppressive elephant, any manipulative social engineering policies directed at and to be imposed on the people are best placed in the shredder!

Respectively Submitted,
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URBAN
Greenspaces
INSTITUTE

36748

October 28, 2009

Sam Adams, Mayor
Commissioners
City Hall
1220 SW Fourth Avenue
Portland, OR 97204

Mayor Adams and Commissioners,

I am offering the following comments on the Portland-Multnomah County *Climate Action Plan* (*CAP*) both as a member of the Sustainable Development Commission and on behalf of the Urban Greenspaces Institute.

As is noted in the Climate Action Plan Development section of the *CAP*, your staff received many comments related to Adaptation, especially with respect to the role of natural systems. We are extremely pleased to see that the final *Climate Action Plan* has responded to those comments and now includes substantive changes with regard to Adaptation and the importance of green infrastructure to both mitigate and adapt to Climate Change. .

The current draft, we believe, strikes the correct balance between mitigation measures that are critical to reducing greenhouse gas emissions and adaptation strategies needed to respond to the severe social and environmental problems we will face with Climate Change, including impacts to air and water quality, diminished and degraded fish and wildlife habitat, decreased biodiversity, and increased risk of flooding, landslides and fires.

We are pleased that the *Climate Action Plan* focuses attention on the need to protect and enhance air quality and natural systems including healthy watersheds and ecosystems. The vision for 2050 calls for a robust urban forest and ecoroofs that cover the community and enhanced green infrastructure that is shared equitably. It recognizes the importance of protecting and restoring our green infrastructure and providing access to parks, trails, and natural areas.

The one area that we feel still needs attention, however, is the essential role land use planning can plan in both mitigating and adapting to

Post Office Box 6903, Portland, Oregon 97228 *Phone:* 503.319.7155 *Fax:* 503.725.3166 **www.urbangreenspaces.org**

Climate Change. The section of *Urban Form and Mobility* was titled *Land Use and Mobility* in the earlier draft. We're not sure what the rationale was for changing the title to *Urban Form and Mobility*, but we feel strongly that land use planning can and should play a significant role in responding to Climate Change. For example, the *CAP* states that "sustaining the values and functions of our tree canopy, rivers, and streams and wetlands is an essential strategy that can simultaneously reduce emissions, sequester carbon and strengthen our ability to adapt to a changing climate. Healthy watersheds, forests and ecosystems are an integral part of this plan."

Yet, there is no mention of the role that land use regulations play in protecting floodplains, stream corridors, natural hazard lands, and fish and wildlife habitat. We are not suggesting that the *CAP* should be modified at this point to address this significant issue. We do, however, want to point out that accomplishing the 2030 Objectives and Vision for 2050 will require the use of city and county land use programs to enhance protection and restoration of natural systems. Bob Sallinger, Conservation Director at the Audubon Society of Portland, asked me to convey the same concerns to you. We'd like to discuss this issue with staff to determine how best to proceed to fold land use regulatory programs into strategies to address both mitigation and adaptation to Climate Change.

Respectfully,

Mike Houck,
Executive Director