Environmental Life Style Analysis(ELSA)

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Abstract *In this study we connect life styles and spending patterns to environmental impacts and economic implications for people living in the United States. The results show that even the most modest life styles(Buddhist monk, homeless etc) have impacts many times larger that the world average.*

Key Words: Life Cycle Analysis, Input/Output Analysis, Life Styles

Introduction

The study of environmental impacts associated with household consumption has been an area of considerable attention for the last 30 years. A few examples of this work would include the early papers focused on energy use in the U.S. [Herendeen 1976, 1981], and studies that look at energy consumption in other countries [Lenzen 1998, 2006]. More recent work has looked at the growing importance of imports [Weber 2007a, 2007b], and at the broader range of impacts associated with products [Tukker 2006]. These studies found, among other things, that large amounts of energy are embodied in products and services, that there is a close correlation between energy use and expendable income, that imports and their off-shore energy use are of growing importance, and that housing, transportation and food often dominate environmental impacts. While the current study does not disagree with any of these results, it differs from other studies in several ways. First, it focuses more on individual life styles (in the United States) rather than national statistics. This allows us to look at variations in life style within a certain income bracket, and estimate what potential improvements are realistically possible. Secondly, because this study works from an expenditure basis, it can directly compensate for certain rebound effects which are often ignored when looking at the impacts associated with products.[1] And thirdly, this study includes "subsidies" received to support a life style and the impacts associated with those subsidies. One of the largest of these so-called subsidies is from the government.

Methodology and Allocation Issues

This work was done as part of the Spring 2007 M.I.T. class "Environmentally Benign Design and Manufacturing" i.e. Mechanical Engineering 2.83 (for graduates) and 2.813 (for undergraduates). The students, listed in Table 1, (at the end of the paper) developed the spending profiles for a wide range of life styles for people in the U.S. In many cases the students interviewed the subjects about their life style choices and obtained detailed data. In a few cases, especially for the extremely rich, the life styles were estimated from information available to the public. The estimated annual disposable incomes for these people ranged from negligible to tens of millions of dollars and beyond for the very well to do.

In each of the nine expenditure categories listed in Table 1, the graduate students in the class developed detailed spreadsheets that standardized data collection, and in most cases interacted with the Carnegie-Mellon University/ Environmental Input-Output Model (CMU/EIO) to calculate impacts [Hendrickson 2006]. In a few cases, the modules functioned as stand alone models, for example, in such areas as transportation fuels use, and residential fuel use. In general the expenditure categories were the

[1] For example, if an individual buys and uses a medium sized hybrid car instead of a conventional engine SUV, she must also account for how she spends the savings (both from the purchase price and the gasoline savings). If for example she flies to Europe for various holidays, her impact may, in fact, be larger than with the SUV and no trips to Europe.

same as used by the Bureau of Labor Statistics [BLS 1998]. Because of potential over lap in some of these categories, care was taken to avoid double counting.

A special feature of this study is that the methodology employed here allocated all identifiable "subsidies" to the recipient, and included the associated impacts in their impact totals. The single largest subsidy was from government services identifiable in the input/output tables. These included components of federal, state and local government which were allocated evenly to all inhabitants in the U.S. resulting in a subsidy of $4391 in 1997.

At the same time, services with clearly identifiable recipients such as educational services, Medicare, Medicaid etc. were allocated only to those individuals who received the service. Other sources of subsidies included in this study were from parents (for children), insurance companies (for the severely impaired or disabled), ones own savings (particularly in retirement), and soup kitchens and homeless shelters (for the homeless).
Special care was taken in differentiating benefits associated with work (frequent flier airplane trips, generous travel or entertainment budgets etc. which were allocated to work and not to the personal profile) from personal expenditures.

This procedure has all of the benefits and liabilities associated with using the input/output approach. For example, we were not able to differentiate between a luxury car and a compact car, except for price and fuel mileage. However, in some categories such as food, there can be considerable differentiation. In each of the nine areas spending options were ranked according to impact intensity and plotted as Pareto plots. This allowed us to return to these life styles and explore variations in spending within a fixed total amount and calculate the impact effects. "Total incomes" were calculated per person according to the general formula:

"Total Income" =

income – taxes – subsidies paid to dependents + subsidies for this life style.

For example, in the case of a family of four with two income earners, the income was pooled, taxes and support for the children was subtracted, and the result shared between the income earners, to this was added any individual subsidies from the government etc. The disposable income, expenditures, government services and calculated Total Income are given in Figure 1at the back of the paper.

Life Styles Studied

Students studied 18 different life styles ranging from the homeless to multimillionaires. In many of the cases variants on the life style were also studied. These included both variants in income for a given life style, as well as, variants for a given life style within a fixed income. This last option allowed us to explore potential decreases or increases in impacts and translate what this would mean for the individual. In Table 2 are listed the basic life styles in order of personal expenditures including most subsidies. Not listed in the table, but included in the impact calculation, is the estimated $4,391 subsidy for every man, woman and child in the United States for government services. We took this approach based upon the underlying assumption that there is a substantial "overhead" for living in the United States, and it should be borne by the presumed beneficiaries.

Results and Discussion

This study brings attention to two aspects of life style impacts in the United States. First, by including the subsidies, we identify a floor, below which environmental impacts for people living in the United States do not drop. For example, none of the life styles studied here ever resulted in an energy requirement below 150GJ (in 1997). This includes the life style of a five year old child, a homeless person and a Buddhist monk. While 150GJ is less than half the American average in 1997 (370GJ), it is more than double the global average energy use in that year (65 GJ). Furthermore, such a level, we believe, is not obtainable for the average American on a voluntary basis. Which brings us to our second point; due to the combined effects of subsidies and rebound, the magnitude of possible reductions in energy use for people in the United States by voluntary changes in spending patterns appears rather limited. For example, within a given disposable income level we found that energy use could vary by up to a factor of 10, but that the life styles representing these extremes were widely divergent, representing what we would characterize as "irreconcilably" different approaches to life. When we explored large but tolerable changes in a given life style in the middle range of

expenditures i.e., $30k , we found that only relatively small improvements were possible, on the order of 30%. For still lower expenditures the challenge is greater. One problem was that many actions to conserve energy (or reduce other impacts), also conserve money. If this money saved is not spent wisely, a large impact can result. For this purpose we identified various environmentally friendly spending options (e.g., vegetarian diet, increase educational activities, personal trainer, psychoanalysis, law services, repair and maintenance etc.)[2], and created an environmentally friendly investment option. However, many people don't want to make these changes. A detailed look at several middle income life styles found that a 50% reduction in energy use would require dramatic changes which we believe would be unacceptable to most people. Of course, what is acceptable or not, is debatable, but the presence of the subsidy effect and the rebound effect are real.

This all suggests to us, very significant limits to voluntary actions to reduce impacts, both at a personal level and at a national level. Figures 2 and 3 show disposable income (without subsidies – this to emphasize the impact floor) versus energy and global warming potential (GWP), respectively. For incomes beyond the a certain level impacts rise monotonically. This trend is apparent in other impacts as well, such as toxic releases and air pollutants. At the same time certain societal benefits associated with higher incomes are also apparent. For example, Figure 4 shows the Economic Activity generated by a certain income level.

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[2] Generally, anything that is expensive but does not consume energy and/or material resources leads to a lower environmental profile. This includes a wide range of activities that require skilled individuals, as listed above. Of course this does not account for how those who receive these payments might alter their spending habits

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Table 1. List of Student Contributions and Areas of Contribution

	Student	***Grad/ Undergrad***	***Life Styles, (variants)***	***Nine Impact Areas (Grads only)***
1	Allen, Anna N.	G	Soccer Mom	1.Services
2	Banzaert, Amy	G	"Oprah approximation"	2.Housing
3		G	Pro Golfer (2)	3.Insurance & Pensions
4	Cleaver, Christopher	U	Management Consultant	
5	Figueredo, Stacy	G	Retired Person	4.Utilities
6	Fredholm, Susan	G	Engineer	5.Government
7	Krones, Jonathan	U	U.S. Senator (3)	
8	Kudrowitz, Barry	G	Commercial Artist	(1.Services)
9	Lin, Cynthia	U	Teach for America (3)	
10	Morales, Alfredo	U	Corporate CEO	
11	Quinn, David	G	Buddhist Monks (2)	(2.Housing)
12	Roberts, Megan	U	Coma Patients (3)	
13	Scaringe, Robert J.	G	"Bill Gates approximation"	6.Transportation
14	Studley, Tim	U	Investment Banker	
15	Sukkasi, Sittha	G	Homeless Person	7.Apparel
16	Taplett, Amanda	G	*Project Coordinator*	*Project Coordinator*
17	Tomczak, Mika	G	5 year old	8.Food Industry
18	Vechakul, Jessica	G	Vegetarian College Student	(8.Food Industry)
19	Wolf, Malina Isabella	G	Nursing Home	9.Utilities

Table 2 Life Styles with estimated expenditures including most subsidies (add $4391 for government services) and energy use

	Life Style	**Est. Income**	**Est. Expenditure**	**Energy GJ**	**Comment**
1	Buddhist Monk I	$13k	$8.5k	154	interviewed
2	Buddhist Monk II	$26k	$20.5k	370	interviewed
3	Homeless person	$4k	$24k	160	
4	Retired person	-	$31k	390	some interviews
5	Five year old	0	$32k	160	estimated
6	Soccer Mom	-	$32k	518	some interviews
7	Teach for America	-	$35k	300-500	interviewed (3)
8	Veg. College Student	11k	$52k	260	interviewed
9	Engineer	$75k	$58k	350	composite
10	Commercial Artist	-	$50-65k	500	interviewed
11	Manage Consultant	$120k	$80k	640	some interviews
12	Nursing Home Patient	0	$90k	580	estimate
13	Investment Banker	-	$275k	780	(3 variants)
14	Coma Patient	0	$680k	3500	(3 variants)
15	U.S. Senator	$1M	$950k	4800	(3 variants)
16	Pro Golfer	$3.9M	$1.7M	6000	(2 variants)

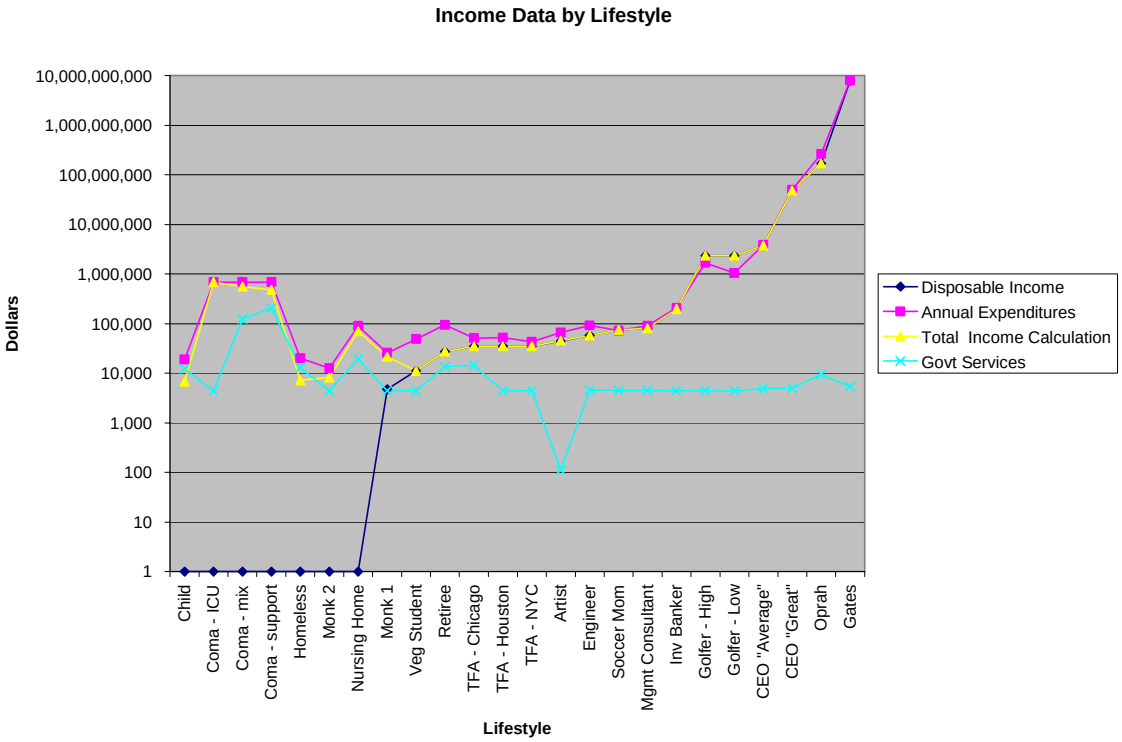

Figure 1 Disposable Income, Annual Expenditures, Government Services and Total Income calculated for 24 different Life Styles in the United States.

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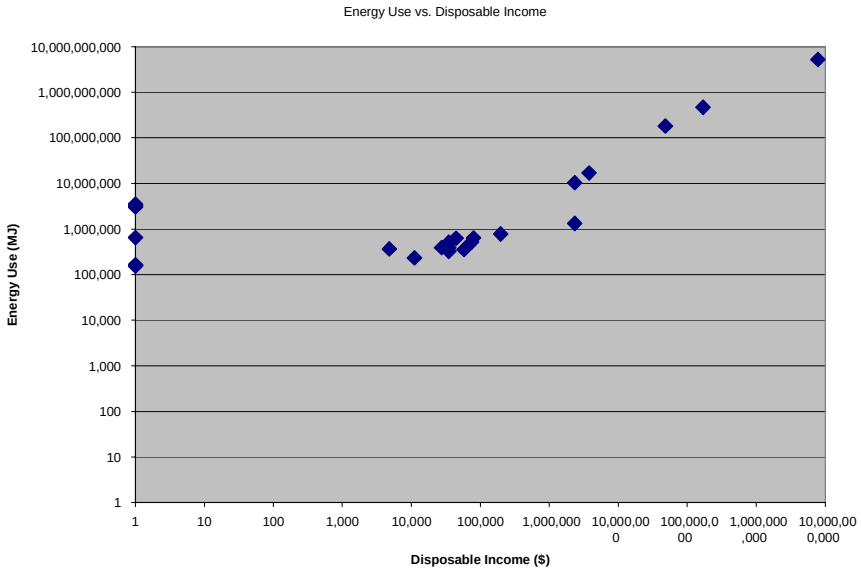

Figure 2 Energy use versus disposable income for 23 different life styles in the U.S. Note that the average energy used per capita in the U.S. for 1997 was 370 GJ.

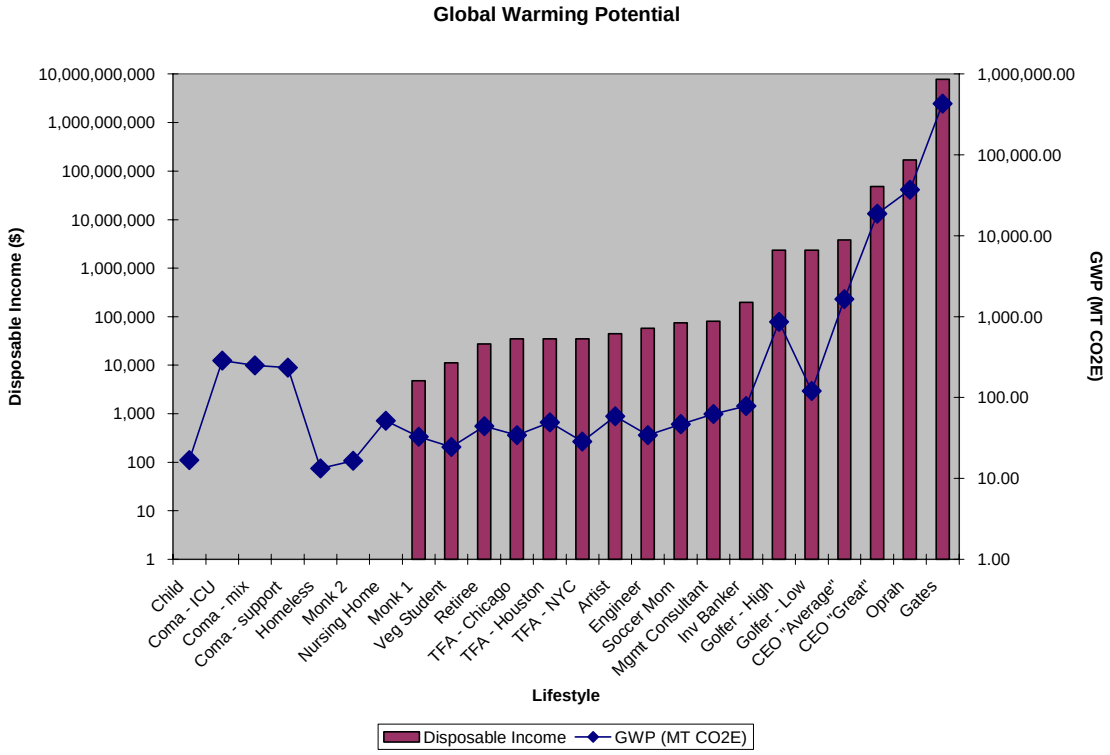

Figure 3 Global warming potential per person and disposable income for 23 different Life Styles in the United States. Note that the average GWP for the U.S. in 1997 was approximately 24 tCO2E per capita.

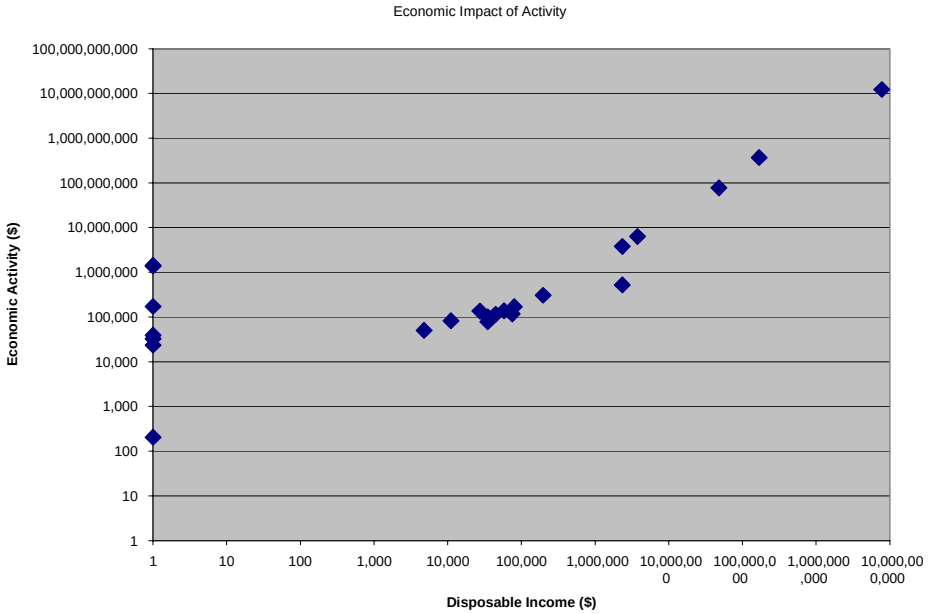

Figure 4 Economic activity generated by each life style versus disposable income for 23 life styles in the U.S. 1997 data