The Adverse Health Impacts of Industrial Wind Turbines:
A Scientific Response to "It's all in your head"

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Overview and Summary

In this paper, I review two recently completed research papers[2] that purport to provide scientific evidence regarding the adverse health effects of Industrial Wind Turbines (IWTs). Having done so, I find that they provide no scientific information. Rather, they present disinformation which may be used to improperly shape public policy.

Each paper essentially attributes increased reports of adverse health effects to some form of mass hysteria. Chapman gilds this contention with quasi-scientific "labels," such as a "mass psychogenic illness" or a "psychogenic nocebo phenomenon." With less jargon, Crichton comes to the same conclusion -- adverse health effects can be explained by psychological expectations. Both papers conclude that the adverse health effects attributed to IWTs are not actually caused by the audible and non-audible (infrasound) noise they are known to generate. Rather, the authors claim to demonstrate that the adverse health effects essentially are caused by a "vitriolic" lunatic fringe of NIMBYs who publically overload the media with fabricated claims of adverse health effects.

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[1] I present a brief overview of my academic and scientific qualifications at the end of this paper. I also attach my complete curriculum vita.

[2] Specifically, S. Chapman, A. St George, K. Waller and V. Cakic, "Spatio-temporal differences in the history of health and noise complaints about Australian wind farms: evidence for the psychogenic, 'communicated disease' hypothesis," unpublished (***hereafter*** Chapman); and F. Crichton, G. Dodd, G. Schmid, G. Gamble and K. J. Petrie, "Can Expectations Produce Symptoms From Infrasound Associated With Wind Turbines?" *Health Psychology,* Advance online publication. doi: 10.1037/a0031760 (***hereafter*** Crichton).

These research papers are fatally flawed, for reasons I discuss more fully below. In brief,

- The Crichton paper performs a very simplistic experiment using 54 "university students" who were subjected to ***10 minutes*** of infrasound; yes, **10 minutes.** Some of these students were subjected to 10 minutes of actual infrasound; the rest were subjected to 10 minutes of sham infrasound (no noise). After the 10 minute sessions, the students were divided into 2 groups: one group was told there were serious effects and symptoms induced by infrasound; the other group (a control group) was told that such effects and symptoms were minor. Not surprisingly, members of the group that were warned of more dire health-related symptoms reported ***experiencing*** more dire symptoms in greater proportions than the control group, regardless of whether they were subjected to actual infrasound or sham infrasound. This finding should not surprise anyone; absent sufficient information or experience, peoples' expectations can be manipulated, such that they experience what they are told to expect they may experience.

  What is surprising, and scientifically untenable, is that Crichton extends this simplistic 10-minute listening-room test to the reported health effects of real-world populations living in the vicinity of actual IWT installations. The people who have studied the health effects of such populations have found that the adverse health effects are for the most part slow to reveal themselves; that they are frequently cumulative; and that they are idiosyncratic to the topography of the location. They most likely begin with the disruption of sleep over time, since one of the most insidious adverse effects found is the fact that the noise from the IWTs continues to varying degrees 24 hours per day, 7 days per week. Once that occurs, many of the other documented symptoms naturally follow. Subjecting university students to **10 minutes** of experimental infrasound tells us absolutely nothing about these adverse health impacts of IWTs in the real world.

- The Chapman paper attempts to place IWTs and health complaints into an historical context. It asserts that the health complaints (which they seem to attempt to marginalize by calling them "florid allegations") have only appeared recently, despite the fact that IWTs have been around for two decades. They conclude that the recent intensity and frequency of health complaints cannot be due to IWTs. If they were, there should have been more complaints earlier. The paper attributes the complaints to more extensive and more recent documentation and analysis of populations that have claimed to have been adversely affected by IWTs, for example "a self-published book, *Wind Turbine Syndrome*, by US physician Nina Pierpont, who now runs a virulent anti wind farm website." (emphasis added)[3]

[3] Chapman., p. 6. I note that when the authors refer to those scientists (and they are scientists as qualified as the authors of their paper) that have analyzed and documented adverse health effects, they refer to them pejoratively as relying upon "florid allegations" and being "virulently anti-wind." These terms are not useful and certainly have no

The Chapman analysis is unpersuasive. It describes the evolution of public awareness of adverse health effects of almost all new industrial processes, products and/or resources that are found actually to have adverse effects. It is not unique to IWTs; it certainly is not evidence that there are no adverse health effects from IWTs. Adverse effects, when they exist, slowly become clear over time, as more information is gathered; as more people realize that the products/technologies/processes are causing adverse effects. Since the Chapman timeline is common to many products/processes that we now know are dangerous and have been banned or restricted, Chapman cannot draw the conclusions that they have.

I also note that Chapman make factual errors which further render the research without merit.

I develop these critiques more fully below. I believe it is important to respond to these papers. They essentially assert that any complaints about IWTs are based upon imaginary symptoms; they are a product of mass hysteria; they are reflections of a nocebo effect. If assertions are relied upon and found to be incorrect, they clearly will cause many people suffering and illness. Importantly, real peer-reviewed acoustical science demonstrates that Chapman and Crichton are incorrect. Chapman and Crichton are like the "scientists" who claimed (for decades) that smoking did not cause adverse health effects. Many people suffered as a result of that Junk Science. Many people will suffer if policy analysts believe that IWTs have no adverse health effects. To demonstrate what real acoustical scientists have done to assess the possible presence of IWT-induced adverse health effects, I introduce and discuss five peer-reviewed research papers that demonstrate that IWTs do have adverse impacts upon sleep and other measures of annoyance.

Some supporters of IWTs argue as follows: Perhaps IWTs do interrupt sleep and "highly annoy" some people but that does not mean they cause illness. I would quote to these folks one of the acoustical research papers I review below: "in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterized by distress and aversion, which if maintained, can lead to a deterioration of health and well-being."[4] If people cannot sleep and are living in a state of distress and aversion, they will develop a variety of diseases. I suggest that the authors try living under these conditions. Or that Crichton subjects his university students (grouped as he did) to these conditions, using real world IWT sites. Then I will find more scientific evidence in their research.

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scientific content. I would not say that Chapman *et.al.* are virulently pro wind; although they may be. However, if their science is wrong, I will make that clear.

[4] See D. Shepherd, D. McBride, D. Welch, K. Dirks, and E. Hill,, "Evaluating the impact of wind turbine noise on health-related quality of life," *Noise Health,* 13 (54), September-October 2011, pp. 333-339 at p. 337.

I. Background

Over the past ten to fifteen years, scientists and nations around the world have come to realize that reliance upon conservation and renewable energy (RE) sources may provide alternatives to fossil-based fuels and the carbon emissions generated by such fuels. With this realization has come the natural inclination to experiment with various forms of conservation and RE sources. Fuel efficient automobiles and hybrids have become more common; better insulation for homes and commercial construction has been implemented; and a variety of wind-based and solar-based electrical generation facilities have been proposed, designed and erected.

As with all new forms of industrial and technological innovation, it is not clear whether they will work properly; whether they will produce the levels of conservation or electrical power predicted by the engineers; whether they can be integrated into the socio-technological landscape that currently exists; and whether they produce unanticipated side effects (negative or positive) which may alter the calculus regarding the desirability of the new technology. For some new technologies, such as the use of asbestos as a fire retardant and insulation material in residential and commercial construction or the use of newly designed insecticides or herbicides (say DDT) to improve crop productivity, it may take decades to fully document and understand their unanticipated side-effect profiles. This is simply the nature of the diffusion of information about new products and technologies – there may be subtle side effects, the consequences of which are unclear for years.

The problems caused by pollution generated by the new industrial activities have often been insidious and slow to be identified. When scientists and lay people have identified dangerous pollutants and their sources, those scientists and lay people have often been marginalized by smear campaigns by the polluters, for obvious reasons. Examples abound: General Electric dumping a known carcinogen (PCBs) into the Hudson River, making the fish dangerous to eat; companies polluting water resources, which people drink for years without knowledge of the danger; toxic waste dumps, such as the Love Canal, which make residential areas uninhabitable, yet residents do not know this for years; the DOD's use of Agent Orange in Vietnam, which caused innumerable illnesses to our veterans (and the Vietnamese). For fifty years, the Tobacco Research Institute, a group of "scientists" funded by Big Tobacco, claimed first that smoking cigarettes was good for you ("soothes your throat," according to Hollywood spokespeople) and later that smoking may not be good for you but was not bad for you ("cancer was caused by other factors").

The effects of Agent Orange and the responses of the medical community to those effects are illustrative and typical for all of these pollutants. Agent Orange was one of several herbicides used by the US military to defoliate large tracts of land purportedly held by the enemy during the Vietnamese War. Over time after the War, many veterans and other non-combatants reported a variety of disease symptoms, the cause of which was unknown to them and undiagnosed by their

physicians. Not all people exposed reported symptoms; but a sufficiently large enough group did. Some of the patients were believed to be imagining the symptoms. Finally, sufficient research was performed to allow the medical community to identify Agent Orange as the cause of the disease states being reported. The Department of Veterans Affairs (VA) and other health providers came to understand what illnesses were likely to be found in people exposed and how to treat them. That research was publicized, and many veterans who suffered from disease states without knowing why, finally came forward knowing why.[5] According to the logic of Chapman and Crichton, it was the publication and media exposure that caused the increased numbers of complaints of illnesses, rather than the cumulative knowledge of the real adverse health effects of exposure to Agent Orange. In the terminology of Chapman and Crichton, these patients were suffering a "nocebo effect." Clearly, that logic is nonsense.

Yet, Chapman and Crichton have used this same logic when dismissing the complaints of adverse health impacts by people exposed to the inaudible and audible noises of IWTs. These adverse impacts and adverse health effects have been documented by careful scientific statistical studies of sample populations exposed to IWTs, studies performed over the last 20 years. I review five below. These adverse impacts have been documented by studies performed by extremely well qualified physicians examining and treating exposed populations over the last 5 years. Since IWTs have become much more numerous over the last five years, given national and international commitments to erecting them, more populations have been subjected to the effects of IWTs and more groups within these populations have complained of the same adverse health impacts. As more IWTs are erected and more groups are affected, an increasing body of research indentifying adverse impacts has been conducted and publicized. It is ***this increased publication*** of adverse effects that Chapman and Crichton blame for ***the actual experience of the adverse effects*** due to IWTs. According to Chapman and Crichton, the adversity is "in the heads" of the complainants; the effects are not real; they are imaginary symptoms caused by media campaigns.

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[5] See for examples,

- "The U.S. military sprayed millions of gallons of Agent Orange and other herbicides on trees and vegetation during the Vietnam War. Several decades later, concerns about the health effects from these chemicals continue. VA offers eligible Veterans a free Agent Orange Registry health exam for possible long-term health problems related to exposure" (http://www.publichealth.va.gov/exposures/agentorange/).
- "VA has recognized certain cancers and other health problems as presumptive diseases associated with exposure to Agent Orange or other herbicides during military service. Veterans and their survivors may be eligible for disability compensation or survivors' benefits for these diseases" (http://www.publichealth.va.gov/exposures/agentorange/diseases.asp).
- "VA has recognized that certain birth defects among Veterans' children are associated with Veterans' qualifying service in Vietnam or Korea.
    - Spina bifida (except spina bifida occulta), a defect in the developing fetus that results in incomplete closing of the spine, is associated with Veterans' exposure to Agent Orange or other herbicides during qualifying service in Vietnam or Korea" (http://www.publichealth.va.gov/exposures/agentorange/birth_defects.asp).

The technical performance and side-effect profiles of new energy-generation technologies remain unknown and must be subjected to scrutiny. We probably will not be fully informed without another decade or two of real-time experiments. The focus of this paper and the two that I am reviewing is Industrial Wind Turbines (IWTs) – a specific new renewable energy (RE) technology. The focus of the Chapman and Crichton papers are the side-effect profiles of this technology. The two papers claim to find that there is no real evidence of adverse side-effect profiles caused by IWTs. They claim, in essence, that the reported and purported adverse side-effect profiles are all in the minds of the local residents, who have in essence been brain-washed by "virulently anti-wind websites" into some "mass psychogenic" hysteria.

While it is possible that any population bombarded with enough negative assertions about a given product, resource or technology will come to believe those assertions, the papers put forward by Chapman and Crichton fail to prove that that fact pattern holds for IWTs. Indeed, I demonstrate that when properly analyzed and corrected, the Chapman paper supports a finding that IWTs are going through a normal social testing (or vetting) period and that there seem to be adverse health effects that must be addressed if Industrial Wind is allowed to develop without harming those residents living near the IWTs. The Crichton paper tells us nothing.

II. The Crichton Paper

This is a very simplistic study, which in reality says nothing about IWTs. The conclusion one can draw from this study is that expectations of a small group of university students, indeed any small group of people, can be manipulated. Whether true or not, Crichton could have manipulated group expectations about an odorless chemical that did or did not cause certain adverse or positive physical reactions. Whether true or not, Crichton could have manipulated group expectations about a particular product, public official or medical procedure. Indeed, that is what advertising and media exposure are all about.

While group expectations can be manipulated in an isolated environment like a lab and in the very short run, ***the conclusions drawn from that manipulation cannot be extrapolated*** to the real world, where responses to the relevant activity or process are subject to long-term exposure and experience under varying conditions. After an experience of short duration (a matter of minutes), one may more likely be convinced that IWTs have certain adverse attributes; or that odorless chemicals cause certain adverse or positive reactions; *etc*. However, exposure to the same set of stimuli over a longer period of time (months or years) and in an environment characterized by much more diversity and variation of stimuli very often changes expectations and perceived responses.

I summarized the entire content of the Crichton paper above in my Overview and Summary. I do not repeat that here. Suffice it to say, subjecting university students to **10 minutes** of experimental infrasound tells us absolutely nothing about the adverse health impacts of IWTs in

the real world. Other assertions made by the paper to support their extrapolation to larger populations are simply incorrect on their face or in a more complete context, as I discuss in my Section on acoustical science below. Their assertions include:

- "[T]here is no empirical support for claims that infrasound generated by wind turbines could trigger adverse health effects." (p. 1)

- "Although the scientific evidence does not support a direct pathophysiological link between the generation of infrasound by wind turbines and health complaints, there is a body of lay information on the Internet and from other sources suggesting a link between infrasound exposure and health effects (e.g., Pierpont, 2009)." (p. 1)

- "Health information distributed through the media has been shown to have a powerful impact on perceptions of health and symptom reporting." (p. 1)

The first two assertions are simply wrong. There have been a variety of analyses conducted by physicians and professors of public health care policy which have documented the psycho-physiological pathways by which chronic noise exposure, whether from audible and inaudible IWT noise or other sources, can adversely affect the autonomic nervous system, the neuro-endocrine system, and the immune system.[6] I do note that Crichton, as does Chapman, use Dr. Nina Pierpont as the example of a source of unscientific "suggestive" lay information. This is utter nonsense. Dr. Pierpont is better credentialed than any of these authors; she has performed a careful analysis of data summarizing the experiences of real people living with real IWTs. She has not taken 50 graduate students; put them in a room for 10 minutes; turned on some woofer; filled their heads with some information; and found that, on average, they responded affirmatively to that information. That is easy. A graduate student submitting that effort as a class paper might get a B for originality and a D for public policy analysis. Dr. Pierpont spent months doing her careful research with her patients. She documented their symptoms and drew her conclusions from her observations. She did not arrive on the scene with a prejudged set of conclusions she wanted her data to fit.

Finally, going to their last point, while the media has published information regarding reports of adverse health effects of IWTs, there has been an equally, if not more, aggressive media

[6] For a few of many examples see:

- A. Farboud, R. Crunkhorn and A. Trinidade "'Wind turbine syndrome': fact or fiction?" *The Journal of Laryngology & Otology*, 127(3), March 2013, pp. 222-226.

- M. A. Nissenbaum, J. J. Aramini and C. D. Hanning, "Effects of industrial wind turbine noise on sleep and health," *Noise and Health*, 14(60), September-October 2012, pp. 237-243.

- R. D. Jeffery, C. Krogh and B. Horner, "Adverse health effects of industrial wind turbines," *Canadian Family Physician*, the official journal of the College of Family Physicians of Canada, May 2013.

- N. Pierpont, *Wind Turbine Syndrome, A Report on a Natural Experiment*, 2009.

campaign that is pro-wind. This pro-wind media campaign is much more highly funded than the anti-wind groups. For the same reasons proffered by Crichton, this media campaign has had "a powerful impact on perceptions of health and symptom reporting." The international wind companies and their lobbyists have been funded by enormous subsidies offered by the politicians who have become enamored with the little girl holding the flower with the IWT in the background. If the authors are correct, then these media campaigns should have the same effects as the anti-wind lay information. Do they? If not, why don't they? One obvious reason is that the perceived effects are real. Another reason is that many claims of the large IWT companies regarding noise and many operating characteristics have turned out to be grossly inaccurate, to the point of appearing to have been lies.[7]

III. The Chapman Paper

The Chapman paper focuses upon organized opposition to IWTs, which they claim occurs "predominantly in Anglophone Nations." They introduce two hypotheses:[8]

> "1. … audible noise and sub-audible infrasound generated by wind turbines can be harmful …
>
> 2. …psychogenic factors – including nocebo responses to the circulation of negative information about their putative harms – are likely to be relevant to understanding why … only small proportions claim to be adversely affected."

While both hypotheses are reasonable to examine in principle, I note that Hypothesis 2 is, at best, poorly articulated and, at worst, consciously designed to introduce bias. Specifically, there have been many studies by acousticians which have found that more than "***small proportions*** of people claim to be adversely affected," a few of which I discuss below in my Section on the acoustical science. I contend that Hypothesis (2) would be better framed as follows: (2*) psychogenic factors – including nocebo responses to the circulation of negative information about their putative harms – are likely to be relevant to understanding why ***some people*** claim to be adversely affected.

Furthermore, I can think of two more hypotheses that are reasonable to examine.

> 3. Hypotheses 1 and 2* are both true – Audible and sub-audible noises generated by IWTs can be and are harmful to some or many residents nearby a new IWT and that harm becomes simultaneously recognized and publicized over time. As actual harm becomes recognized and publicized and as other adverse effects become publicized from other areas, more people identify and complain of health-related adverse effects.

[7] Many examples have occurred in New England and New York State in the United States.

[8] Chapman, p. 3.

The simultaneous experience of and publication about adverse effects over some period of time reflects ***correlation not causation***. Both effects are caused by the adverse impacts of the IWTs. They are correlated because some effects are cumulative and become cognizable with a lag; some effects were being felt but were ignored until residents recognized the adverse changes they were experiencing but could not fully articulate;[9] and some local residents suffer from a nocebo effect.

4. Psychogenic factors – including *placebo* responses to the heavily-promoted "desirability" of renewable, pollution-free energy – cause some residents to ignore or dismiss adverse health effects that they actually experience.

However, the authors are really only interested in demonstrating that Hypothesis (2) is true. I find no discussion regarding the validity of documented findings of any harmful effects of IWT noises or hypotheses regarding whether IWT noises can be harmful. Rather, early in the paper they assert, ***improperly***,[10] that many reviews of the "literature on wind turbines and health published since 2003 have all reached the broad conclusion that the evidence for wind turbines

[9] For example, stress and stress-related symptoms are real; they can be felt; and they can cause physical disease. However, like high blood pressure, many people do not recognize they are experiencing stress until it is diagnosed or until they have learned to know what to look for. That only occurs with the publication of information. This is not a nocebo effect; this is an educational effect.

[10] These assertions (presented at their pp. 3-4) are simply wrong, incomplete and/or biased.

- While there are reviews that claim to find the evidence of adverse effects to be "very poor," there are also many reviews and scientific analyses that have found statistically significant relationships between the proximity and size of IWTs and the extent of reported adverse health effects. The authors neglect to mention this fact.
- Many of the reviews that find the evidence "very poor" have been written by academics whose major source of income (research grants, funding, consulting) is Big Wind and by political groups whose political compass has been co-opted by Big Wind. I am intimately familiar with one such review -- ***The Wind Turbine Health Impact Study: Report of Independent Expert Panel***, January 2012, Prepared for the Massachusetts Department of Environmental Protection. This review, which found the evidence to be "very poor," is Junk Science (as I develop in my presentation "The Wind Turbine Health Impact Study is Junk Science," February 2012). It misstated and mischaracterized most of the materials it reviewed; it dismissed as irrelevant important contradictory studies. It is not science; it is not even a credible review of existing science. It is a purely promotional tract.
- Many peer-reviewed research articles find that more than a small minority of local residents are annoyed and adversely impacts. The numbers increase as the size of the turbines and the measures of their noise levels increase and as the distance from the IWTs to the residents decrease. I discuss several below.
- While pre-existing attitudes will, of course, influence perceived effects of IWTs, after statistical correction for those attitudes the evidence of adverse impacts remain.
- The visibility of the turbines is often included into the explanatory regressions. Since visibility is highly correlated to proximity and line-of-sight impacts of the sound waves, ***inclusion of visibility is a statistical trick*** to reduce the measured importance of the measures of noise. To an econometrician, this statistical trick is called multi-collinearity. Results from regression analysis that include visibility should be appropriately judged with care and skepticism.
- For more detail, see my Section below on ***the Acoustical Science***.

being directly harmful to health is very poor;" that "small minorities … typically < 10% -- claim to be annoyed"; that the "majority of [responses are due to] non-physical" variables; and that "pre-existing negative attitudes to wind turbines … are more predictive of … adverse health effects" than measures of actual exposure.

They conclude their discussion of the alternative hypotheses by addressing the single hypothesis of interest to them as follows:

> "A mass psychogenic illness model may be applicable to this phenomenon. Mass Psychogenic Illness (MPI) is described as a constellation of somatic symptoms, suggestive of an environmental cause or trigger (but with symptoms without typical features of the contaminant, varying between individuals, and not related to proximity or strength of exposure) which occurs between two or more people who share beliefs related to those symptoms and experience epidemic spread of symptoms between socially connected individuals."

Translating this hypothesis into plain English, the authors claim that the adverse health effects of IWTs may not be the result of the real and measurable audible and inaudible low-frequency noises they emit. Rather, the health problems are more likely psychosomatic; the claims of adverse health are more likely to be in the heads of the claimants. It is a form of mass hysteria, fed by the media, which has latched onto what they assert to be non-scientific "labeling, … [which] attempts to popularize ***portentous quasi scientific names*** for health problems caused by wind turbines: Wind Turbine Syndrome, Vibro Acoustic Disease and Visceral Vibratory Vestibular Disturbance." (emphasis added) It is ironic that Chapman dismisses or marginalizes the names used by scientists to describe the set of symptoms suffered by sub-populations adversely impacted by IWTs as "quasi-scientific" labels, while using a similar "quasi-scientific" label – "Mass Psychogenic Illness (MPI)"—and filling the paragraph quoted above with quasi-scientific jargon.

To examine whether an MPI is the best description of the patterns of reports of IWT-caused adverse health effects, Chapman pose the following 4 questions:

1. Are there some or many IWT installations subject to a history of no health-related complaints?
2. Is the number of complainants per IWT installation small or large?
3. Are there some or many IWT installations at which the number of complaints or complainants did not occur until some period of time ***after*** the IWTs began operation?
4. Did most complaints date "after the advent of anti-wind farm groups" … (from around 2009)? And were "wind farms" subject to organized opposition more likely to have histories of complaints than those not exposed to such opposition?

In other words, did complaints really only begin after the "advent of the anti-wind farm movement" and at IWTs subject to more organized opposition? Were there few complaints before the anti-wind farm movement?

The authors address these questions to 49 IWT installations in Australia, the first of which began operation in 1993 at 10 Mile Lagoon near Esperance, Western Australia (which has only 50 residents living nearby). They assert that health concerns were marginal in the early years, ***with only one report*** in September 2004. ***One must question the objectivity of that 2004 report***, since it describes (and marginalizes) the complaints and complainants by stating "some objectors have ***done themselves few favours*** by playing up ***dubious claims*** about reflecting sunlight [i.e. flicker], mental health effects and stress to cattle."[11] (emphasis added) ***Why would the objectors do themselves few favors*** by reporting actual health problems, unless the related regulatory bodies did not want to hear about problems? Why call the complaints dubious? ***Using Chapman's own jargon ("labeling"), this sounds like a nocebo effect evidenced by a relevant regulatory body of Australia, expecting to find that IWTs cause no adverse effects.***

The authors base their empirical finding upon a survey of the ***49 IWT-operating companies***, ***not the residents living nearby*** who actually experienced the effects. Information on the commencement of turbine operation, the number of turbines operating, average turbine size and the megawatt (MW) capacity of each IWT was gathered from public sources such as wind farm websites. The authors then make ***a very telling naïve statement regarding their survey data*** (a statement that seems to be contradicted by the statement in the preceding paragraph):

> "Wind farm operators have clear interest in any reactions of nearby residents to the farms they operate. In the planning, construction and power generation phases of wind farm operation they monitor local community support and complaints submitted to them, in news media and via notifications from local government. … In September 2012 all wind farm owners in Australia were asked to provide information on:
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> - the actual or estimated number of residents within a 5km radius of each wind farm they operated. Google Maps and census data were also used to obtain this data.
> - whether the company had received or was aware of any health and/or noise complaints, including sleeping problems, that were being attributed to the operation of their wind farms.
> - the number of individuals who had made such complaints (direct complaints to the companies, those voiced in local media, to local government or state or national enquiries).
> - the date at which the first complaint occurred after.
> - whether there had been any anti-wind farm activity in the local area such as public meetings addressed by opponents, demonstrations or advertising in local media.

[11] Chapman, p. 5.

Any documentation of complaints such as internet links or news clips about public [*sic*] was requested."[12]

This statement reveals profound naivety and a complete absence of statistical and analytic training and experience. First, any survey researcher understands that survey participants being asked to self-report negative information about their performance or operation will tend to self-edit that information in their favor.[13] To rely upon the operating utilities themselves for information regarding ***complaints*** about their operation is a ***critical and likely fatal survey error***. The fact that it is a critical and likely fatal error here is made abundantly clear by the statement quoted above from the 2004 survey, which was a formal survey, not the backward-looking request for complaints that Chapman has implemented: to wit, the 2004 survey stated "some objectors have ***done themselves few favours*** by playing up ***dubious claims*** about reflecting sunlight [i.e. flicker], mental health effects and stress to cattle." ***Dubious claims***! In other words, in 2004, 11 years after the first IWT installation, complaints and complainants were clearly viewed unfavorably, a fact that would not be lost on the potential complainants or on the utilities recording the complaints. This suggests to me, an MIT-trained PhD econometrician and statistician, the data reported by these utilities to Chapman grossly understate the true number of people with complaints regarding adverse health effects. Indeed, I have no idea whether their data is useful at all. Given the fact that Chapman does not even address this issue leads me to question his statistical training and the statistical training of his team. Second, even if the utilities sought to record, correctly and accurately, complaints (that they apparently believed to be bogus) about adverse health effects, the utilities are assumed to have maintained accurately those reports for 10-20 years. In general, power companies are not good tenders of information. I would conjecture, based upon 40 years of research and consulting to and about power companies around the world, the self-reported negative information used by Chapman, especially the information from many years ago, would be totally unreliable.

Third, the authors assert "Wind farm operators have clear interest in any reactions of nearby residents to the farms they operate." I have not found this to be true at all. In the US, IWT installation operators and the regulatory bodies that monitor their performance have been demonstrated to lie repeatedly about technical performance and adverse health effects. In my home state of Massachusetts, regulators and residents have been told regularly that installed IWT

[12] Chapman, pp. 7-8. The authors assert that they attempted to corroborate documentation by reviewing submissions to a 2011-2012 Senate enquiry; to several other government draft plans; and daily media monitoring records.

[13] Certainly, utilities, regulatory agencies and the IWT equipment manufacturers in the US have overstated the operational success of IWTs and have understated the adverse human health impacts and impacts upon livestock and native fauna. The reason, of course, is financial. Utilities are being pushed by politicians to install IWTs; extravagant subsides are being paid to utilities, operators and manufacturers; extravagant lobbying checks are being written to politicians. And the media has been complicit with a placebo effect – showing the little girl, chasing the butterfly with the IWT in the background. Who could be against little girls chasing butterflies?

capacity meets noise standards, only to admit later that their claims were untrue after third-party-financed research and state-funded research demonstrated the absence of veracity.[14]

Relying upon this highly untrustworthy data base, the authors find the following "results," upon which I comment as I report them.

1. Many wind farms have no history of complaints. They find "63% had never been subject to health or noise complaints."

   The conclusion to be drawn from this finding is that their data are totally unreliable and vastly underreport adverse health effects. Not one single complaint! Given the careful acoustical analyses that have been performed and published elsewhere (a small subset which I discuss below), the probability of obtaining this result with reliable data is 0. There are simply too many studied and published cases in which some people, even if a small number, report adverse health effects. ***It is impossible that not one person had a complaint in 63% of the sites.*** It is possible that records of complaints that were submitted were lost; or that complainants were intimidated into not reporting complaints; or that the persons experiencing the adverse effects did not know realize that the IWTs might have been the cause.

2. Of those IWT sites for which at least one complaint was reported, the overall number of complaints was very small. "Nationally, a total of 120 individuals in Australia appear to have ever formally or publically complained about wind farm noise or health problems," … "out of an estimated 32,677 nearby residents" (within 5 km of the IWTs).

   That is 0.37%, or 3.7 out of 1000, of all nearby residents. The conclusion to be drawn from this finding is, again, that the authors' survey data are worthless.[15] Such a small percentage of complainants is well below the range found in the standard accepted studies of which I am aware.

3. Few wind farms have a history of complaints consistent with the claim that turbines cause acute adverse effects. Acute adverse effects are those which appear almost immediately upon exposure to the IWTs. For an example, Chapman cite the "Bruce MacPherson Study" by Ambrose and Rand,[16] two well-respected and published acousticians, who found that "The onset of adverse health effects [***to them***] was swift, within twenty minutes, and persisted for some time after leaving the study area." Symptoms are said to

[14] The IWT installations at Falmouth MA and Princeton MA are two examples.

[15] Of course, an alternative explanation could be that the IWTs were all sufficiently set-back from almost all residences. Chapman claims to have included all residents with a 5 km radius of the IWT; or within a radius of about 16,400 feet. If all the residences around all these IWTs were near the circumferences of such a circle, it is possible that there would be many fewer complaints than are found when populations are distributed more randomly within the circle. Chapman has presented no information about that such a location holds for most IWTs.

[16] S. Ambrose and R. Rand, "The Bruce McPherson infrasound and low frequency noise study," 2011, available from: http://docs.wind-watch.org/BruceMcPhersonInfrasoundandLowFrequencyNoiseStudy.pdf.

disappear when those affected move away temporarily, only to return as soon as they come back.[17]

While I have reviewed survey results and published reports that have found acute effects as defined above for some survey respondents, I am aware of no survey addressing the extent to which survey populations present this effect. Chapman derives this conclusion by the finding that most of the small number of documented complaints occur well after the relevant IWT had begun operation. They conclude therefore that the effect could not have been acute, or it would have been reported immediately.

While it may be true that adverse effects reported well after the start of the operation of the IWT would not have been acute relative to the start of the IWT operation, there is no way to discern whether the delayed adverse effect was in reality a response that had become acute after long exposure to the irritant. With drug allergies, one can take a given pharmaceutical for some period of time with no adverse effect. At some later date, perhaps even for a different treatment requiring the same pharmaceutical, the patient can have built up a retained level of toxicity and have "an acute allergic response," after which he/she cannot take the medication without anaphylaxis. Further, the claimants may not have realized that their adverse effects were caused by the IWTs until further information was made available to them that such adverse effects could be caused by the IWTs.

I have no idea whether any, some, or many of the delayed adverse effects (there were only 120 complaints) could have become acute symptomology over time. Neither does Chapman. The data and the experiment do not allow for valid testing of that hypothesis. Furthermore, the extremely poor quality of the database used by the authors makes reliable testing any hypothesis impossible.

4. Most complaints date from 2009 or later, a finding which is sufficient for the authors to conclude that mass hysteria or using their quasi-scientific label, Mass Psychogenic Illness (MPI), is the cause of the complaints. Given the small number of any complaints provided by the IWTs, it is difficult to characterize this purported effect as "mass." In support of their interpretation, the authors also assert:

   Researchers only began to study adverse health effects of IWT noises in 2003,[18] a decade after the installation of the first IWT in Australia. Those studies were published over 2003-2007. In ***the decade prior*** to these first reports, there were only ***3 complaints in all of Australia.***[19] I report this finding with emphasis because it ***is implausible*** to anyone

[17] Cited by Chapman, *et.al*., at pp. 6-7.

[18] They only seem to count as relevant "Anglophone" reports by Amanda Harry in Britain and David Iser in Australia, as cited throughout the Chapman paper. There were certainly other reports published in English that appeared before these reports, as I discuss below.

[19] Chapman, p. 10.

who has reviewed and studied the reports of adverse health effects of IWTs conducted by serious acousticians. ***3 complaints in 10 years!*** Based upon peer-reviewed, professionally-conducted acoustical survey analyses (see below), this finding demonstrates the following:

- Chapman and his team reveal inadequate technical training in the design of surveys and survey instruments. They fail to address the many biases likely found in their data base. Companies operating IWTs are inappropriate sources of information regarding complaints about their services. Any statistician and most lay persons understand that companies and individuals will edit self-reported information about their performance. The data relied upon by Chapman are self-edited and self-reported; in many cases the data are very old and likely inaccurate; and in some cases it is likely the data was never collected and saved and merely "produced" at Chapman's request. Chapman's quote from the 2004 Report certainly demonstrates that his survey respondents viewed complaints and complainants with disdain. This fact alone makes it clear that the proper survey population should be local residents, not the IWT operators.

- Even if the IWTs scrupulously gathered and saved data summarizing complaints of adverse effects for 20 years, that data will likely understate the number of actual events of adverse effects to the extent that the surveyed respondents did not understand that the adverse symptoms they were suffering were caused by the IWTs. If they were being told there were no adverse effects and they believed that wind from IWTs is a natural benign phenomenon, many respondents suffering from adverse effects may have ignored the adverse effects, believing there was something wrong with them.

They identify the watershed event seeding the hypothesized nocebo effect as the publication of Nina Pierpont's Book, *Wind Turbine Syndrome,* in 2009 and her "virulent anti wind farm website."[20] They present a time-series of web-based searches for adverse health effects of IWTs. It begins in 2004 and continues through the early 2013. It reveals the start of public interest in the health effects of IWT noises in 2007. This interest, as revealed through web-searches, remains fairly constant through the end of their series. Interest in the term Wind Turbine Syndrome begins in mid-2008; continues at approximately the same rate throughout the time series; but reveals a substantial spike at the end of 2012. They cite their survey evidence as supporting the MPI by the fact that "nearly 70% of wind farms began operating prior to 2009 while the majority of complaints (82%) were recorded after this date."

[20] Chapman, p. 6.

As I have discussed the Chapman paper above, I have noted a variety of reasons why it is fatally flawed and unreliable for policy analysis and policy conclusions. I contend that if their survey data were more reliable, the numbers of complaints would have been higher throughout the time series, 1993-2013. However, even if their survey data were reliable, or at least less unreliable, ***the response pattern they report does not allow them to differentiate between Hypotheses (1) and (2).*** Their analysis is still inconclusive for the following reason. Their data reveal the preponderance of reports of adverse health effects in the last several years of the time series, after publication of several research papers and books documented what was being found in populations subjected to the audible and inaudible noises of IWTs. While this pattern is consistent with Hypothesis (2), it is also consistent with Hypothesis (1).

Indeed, the observed temporal pattern of complaints is consistent with the rate of diffusion of information regarding positive and negative impacts of new technologies. In modern industrial society, as new technologies are introduced and diffusion throughout society occurs, the rate of introduction is usually slow. There are some first adopters, who want to try the new technology. If the technology is aggressively promoted, the number of first adopters will be greater, everything else equal. Over time, there is a slow uptake in the number of adopters, users if the product is desirable or complainants if the product has an unanticipated adverse side-effect profile. After some period of time, knowledge of the new technology has spread, through word of mouth and through publication by users and researchers. There will come a point in time at which the market uptake increases considerably and many users come to realize the positive attributes of the technology and adopt it (if there is a positive response). Or many users or consumers come to realize the negative side-effect profile of the new technology and do not adopt it, or complain if some group (governmental or business or both) is forcing them to experience the negative side-effect profiles. Once this rate of adoption becomes substantial, if the adoption experience is positive, there will be individuals expressing their positive experience (to friends and to survey researchers) with the technology and at the same time the public press describing what is being reported by these adopters. If the experience is negative, once this rate of adoption becomes substantial, there will be individuals expressing their negative experience (to friends and to survey researchers) with the technology and at the same time to the public press describing what is being reported by these complainants.

This diffusion of users or complainants about a new technology can take decades to evolve. A few new technologies/products/procedures which were initially believed to be benign; consumer-friendly; or productive and safe; or at least not dangerous, but were found to be deadly over time include the following:

- Smoking cigarettes.
- Using asbestos as a fire retardant and insulating material in commercial and residential construction, including grammar schools.

- Using certain herbicides and pesticides, like DDT.
- Erecting residential buildings near abandoned toxic waste sites.
- Discharging pollutants into waterways that served as drinking water and/or environments that were fished; for example GE dumping PCBs into the Hudson River.
- Radon gas exposure in New England homes.
- Automobile-induced air pollution and urban smog.
- Impact of Agent Orange exposure upon American Vietnam veterans.
- The complexity of symptoms of Lyme disease.

Diffusion rates of complaints about the adverse side-effect profiles of these products, procedures, practices or infections took years to exhibit sufficient uptake to draw the attention of researchers. Researchers confirmed the adverse effects. Other users, ***who had not drawn, or had subliminally drawn, the connection between adverse effects they were experiencing and the products/procedures/infections they were using or had been exposed to***, finally could confirm that effect. Even then, as complaints were increasing exponentially, researchers in the employ of or receiving financial support from the producers of some of the products at issue produced countervailing "science" claiming that the dangers being reported were not really induced by their products. For example, decades of research by the Tobacco Research Institute, a research institute staffed by many well-trained scientists but funded by Big Tobacco produced statistical studies that they purported demonstrated that cigarettes were either good for smokers or at least not dangerous to smokers.[21] It was Junk Science; purported science with a promotional agenda. The same pattern is found with the other products listed above. The producers of the dangerous products frequently claimed that it was mass hysteria, induced by the publication of research that demonstrated that the product/technologies/procedures had adverse side effects. They were wrong; they knew they were wrong; they lied.

While I have focused upon the diffusion and uptake of information of negative side-effect profiles, the same diffusion patterns exist for new products that are received positively. For example, email made its appearance in the early 1990s. I consulted to the US Postal Service as it tried to develop responses to email that would allow it to compete. It took years for email to become the dominant form of social communication it is now. However, it is, and that is how uptake and diffusion of new technologies occur.

[21] In the mid-1990s, I was one of a group of expert witnesses for the Commonwealth of Massachusetts which calculated the money damages to Massachusetts Medicaid Agencies caused by smoking-induced diseases, the cost of the treatment for which was borne by Medicaid in Massachusetts and all other states. Big Tobacco agreed to settle this litigation with a settlement amount of $212 billion, a very large amount of money. Throughout the trial, they claimed that other things caused the observed adverse health effects, including genetics, risk-taking behavior and the life style of those who smoked and got sick.

Chapman has merely taken a standard model of the diffusion of information and grafted it onto their extremely poor survey data. That model of diffusion supports Hypothesis (1) that there are adverse health effects as well as Hypothesis (2) that the reported health effects are imagined. It does not differentiate between them.

IV. The Acoustical Science

I find that acousticians provide the most reliable science and quantitative analyses measuring the impacts of noise upon those persons experiencing the impacts. The studies generally gather survey information from the people who are being impacted, either through a time-series or cross sectional survey. Note that this survey methodology will provide much more reliable information than asking the IWTs for a 20 year-history of complaints lodged against them, as Chapman has done. The acousticians hypothesize a dose-response model, relating doses of noise to responses in the surveyed sample of respondents. A time series survey allows for measurement before and after the installation of the IWT; as such they provide a very precise measure of the change in health status induced by the IWT, which may be the only real change introduced into the survey experiment. Cross-sectional analysis allows for assessing the responses and impacts of survey respondents at a given point in time, where the survey respondents differ from one another in, among other things, personal attributes, attitudes toward IWTs, and most importantly, ***proximity to the noise dosage (the IWTs)***. Dose-response will differ by these attributes and those differences allow for identifying the single impact of the noise and its proximity upon the survey respondents. Both time-series and cross-sectional survey information and analyses are standard quantitative methods. A time-series cross-sectional study is an even better hybrid of the two approaches. However, such a survey is more difficult and expensive to implement and performed less frequently.

In my References, there are five IWT dose-response statistical analyses presented, which I discuss here.[22] These are cited frequently; for example, the Wind Turbine Health Impact Study

[22] Specifically the following:

- E. Pedersen and K. Persson Waye, "Perception and annoyance due to wind turbine noise – a dose–response relationship," *Journal of the Acoustical Society of America*, 116(6), December 2004, pp. 3460–3470.
- E. Pedersen and K. Persson Waye, "Wind turbine noise, annoyance and self-reported health and well-being in different living environments," *Occupational and Environmental Medicine*, 64, 2007, pp. 480-486.
- E. Pedersen and P. Larsman, "The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines," *Journal of Environmental Psychology,* 28, 2008, pp. 379-389. Note that this article was only briefly mentioned in the Study.
- E. Pedersen, F. van den Berg, R. Bakker and J. Bouma, "Response to noise from modern wind farms in The Netherlands," *Journal of the Acoustical Society of America,* 126(2), August 2009, pp. 634–643.
- D. Shepherd, D. McBride, D. Welch, K.N. Dirks and E. Hill, "Evaluating the impact of wind turbine noise on health-related quality of life," *Noise Health,* 13 (54), September-October, 2011, pp. 333–339.

conducted for Massachusetts relies heavily upon these five studies. Based upon that reliance, the study panel concluded, incorrectly, that there is no real evidence that IWT noises produce adverse health impacts. These conclusions are completely contradicted by the actual studies, as I demonstrate below, which leads one to conclude that the Independent Expert Panel was either completely inept rather than expert, or more likely it was acting as a proponent of Big Wind while supporting the well-known commitment of the Massachusetts state government to wind power – a placebo effect.

A. E. Pedersen and K. Persson Waye, "Perception and annoyance due to wind turbine noise - a dose–response relationship," *Journal of the Acoustical Society of America,* 116(6), December 2004, pp. 3460–3470.

This paper summarizes a cross-sectional study conducted in Sweden. Residents exposed to varying A-weighted sound pressure levels (SPL) from wind turbines were surveyed in five areas totaling 22 km^2 comprising 16 wind turbines and 627 households. The survey was conducted in May and June 2000, well before the publications that Chapman claim induced mass hysteria (MPI) in Australia. The study was conducted in Sweden, but the paper was published in English. Therefore, I do not see why this study should be treated any differently than the British study (by Amanda Harry) and the American study (by Nina Pierpont) when assessing published research possibly causing the mass hysteria hypothesized by Chapman in Australia.[23] Furthermore, if MPI is a reasonable explanation for reporting adverse health impacts, this study should find very few, since Chapman found only 3 from 1993-2003.

While the purpose of the study was to measure a dose-response relationship between IWTs and adverse health impacts, that purpose was appropriately masked in the questionnaire, which addressed a variety of perceived advantages and/or disadvantages to living in the rural country side where there also happened to be one or several proximate IWTs.[24] When asked about the IWTs, respondents were asked to describe their level of perception and annoyance related to the

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I note that I excerpt considerable portions of the articles without using quotation marks, since the articles speak well for themselves and there is no need for me to rephrase what has been well-said. In some places, I do use quotes, when the excerpting is exact and the point important.

[23] Chapman identifies three studies as being primarily relevant to "Anglophone" areas; two over 2004-2007 (Harry and Iser) and the 2009 publication of Nina Pierpont's book as the catalysts to his purported MPI. However, only one of those studies was published in Australia.

[24] The purpose of the survey was not framed as feelings towards IWTs. The survey was designed and implemented as if it were assessing rural living generally. The questionnaire consisted of questions on living conditions, reaction to possible sources of annoyance in the living environment, sensitivity to environmental factors, health and wellbeing. The inclusion of responses to IWTs was embedded in the survey, as if IWTs were just one more aspect of rural living about which the respondents might have some feelings. Perception of and annoyance with wind turbine noise were assessed together with other environmental stressors. "The survey method is well established and has been used in several previous studies exploring annoyance due to community noise" (*e.g.*, E. Ohrstrom, "Longitudinal surveys on effects of changes in road traffic noise-annoyance, activity disturbances, and psycho-social well-being," *Journal of the Acoustical Society of America*, 145, 2004, pp. 719-729), p. 3467

wind turbine sounds they could hear, using verbal descriptors of sound and perceptual characteristics. Respondents were asked questions about their normal sleep habits: quality of sleep, whether sleep was disturbed by any noise source, and whether they normally slept with the window open. The turbines were relatively small by today's standards – about 160 feet tall.[25]

"A statistically significant dose–response relationship was found, ***showing higher proportion of people reporting perception and annoyance than expected from the present dose–response relationships for transportation noise."***[26] As shown in Figure 1 below, this dose-response relationship is expressed as the proportion of nearby residents "highly annoyed" by the dose of noise (measured in dBA, A-weighted decibels[27]). The percentage of the population highly annoyed was positive at much lower dBA (32.5) than other forms of transportation noise (aircraft, road traffic and railways; which begin at 42 dBA). The percentage of the population highly annoyed increased much more rapidly than other forms of transportation, reaching 35-40% at 40-42 dBA, that is, before the other forms of noise (even aircraft at airports) even register annoyance. One can conclude that, for some reason, the proportions of respondents annoyed by wind turbine noise are higher than for other community noise sources at the same A-weighted SPL and that the proportion annoyed increases more rapidly. No respondent self-reported being annoyed at sound categories below 32.5 dBA, but at sound category 37.5–40.0 dBA, "***20% of the 40 respondents living within this exposure were very annoyed and above 40 dBA, 36% of the 25 respondents***."[28]

"When adding the subjective factor of attitude to visual impact as an independent variable, the influence of the noise exposure decreased, but was still statistically significant."[29] Almost all

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[25] "The towers were between 47 and 50 m in height." p. 3462.

[26] P. 3460. Dose-response relationships between doses of alternative transportation noise and the response of annoyance were well studied before IWTs became a relevant technology. Three well-known examples include H. Miedema and H. Vos ("Exposure-response relationships for transportation noise," *Journal of the Acoustical Society of America*, 104, 1998, pp. 3432-3445 and "Demographic and attitudinal factors that modify annoyance from transportation noise," *Journal of the Acoustical Society of America*, 105, 1999, pp. 3336-3344) and H. Miedema and C. Oudshoorn ("Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals," *Environmental Health Perspectives*, 109, 2001, pp. 409-416). The source of Figure 1 below is Figure 3 in Pedersen and Waye (2004). The link between continual annoyance and the adverse health effects has become clearer over the past 15 years.

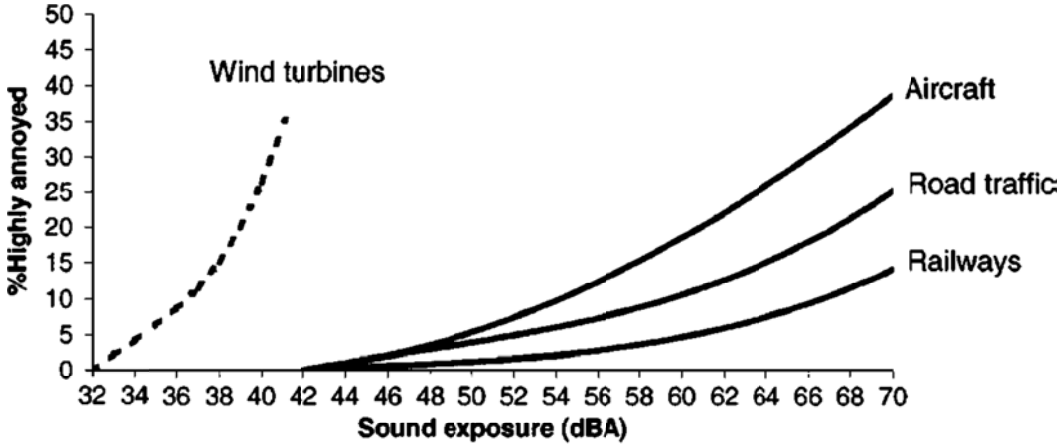
[27] The authors note that it is possible that A-weighted SPL (sound pressure levels in decibels) do not fully capture the noises that cause annoyance. They note different sound properties (likely low frequency infrasound, measured in Hertz, rather decibels) not fully described by the equivalent A-weighted level, are of importance for perception and annoyance for wind turbine noise. Support for such a hypothesis was given in a previous experimental study where reported perception and annoyance for five recorded wind turbine noises were different, although the equivalent A-weighted SPL were the same (K. Persson Waye and E. Ohrstrom, "Psycho acoustic characters of relevance for annoyance of wind turbine noise," *Journal of Sound and Vibration*, 250, 2002, pp. 65-73).

[28] P. 3464.

[29] P. 3465.

respondents (93%) could see one or more wind turbines from their dwelling or garden, so visibility was not the determining factor.

Figure 1
Dose-Response Relationships – % Population Highly Annoyed (y-axis)
Given Level of Noise (dBA)



Sound exposure is for wind turbines calculated A-weighted L_{eq} for a hypothetical time period and for transportation DNL.

The authors speculate that the high prevalence of noise annoyance could be due to the intrusive characteristics of the aerodynamic sound. The verbal descriptors of sound characteristics related to the aerodynamic sounds of swishing, whistling, pulsating/throbbing, and resounding were reported to be most annoying. "***Most respondents who were annoyed by wind turbine noise stated that they were annoyed often, i.e., every day or almost every day***. The high occurrence of noise annoyance indicates that the noise intrudes on people's daily life. The survey was performed during May and June when people could be expected to spend time outdoors, and the results therefore reflect the period that is expected to be most sensitive for annoyance due to wind turbine noise. … Some of the respondents also stated that they were disturbed in their sleep by wind turbine noise, and the proportions seemed to increase with higher SPL."[30]

It should be noted that a rather high proportion, 50%, of respondents self-reported as being rather or very sensitive to noise. Other field studies in Sweden on annoyance due to road traffic

[30] P. 3468. Recently, acousticians have hypothesized that low-frequency infrasound is more annoying indoors rather than outdoors. I do not address that issue here.

noise ***in urban areas*** have found a lower proportion of noise-sensitive persons. The difference likely reflects some preference of living environment, indicating that ***noise sensitive individuals prefer a more rural surrounding*** or that people living in areas with low background noise levels might develop a higher sensitivity to noise. The difference might suggest erecting IWTs in noisy urban areas with much higher ambient background noise.

One can conclude the following from this paper:

- There was a substantial proportion of the population that was annoyed or highly annoyed by IWT sounds. Annoyance was reported by those being impacted, rather than by some backward search through company files for complaints purportedly lodged and kept for decades (*i.e.*, the Chapman data). These responses were surveyed in 2000, well before Chapman's hypothesized introduction of the few research papers which somehow created the mass global hysteria (MPI) that reached the shores of Australia.
- To those that are annoyed, the annoyance occurs every day, every hour the turbines are running. This annoyance is not some simple irritation; it is annoyance that affects mood, well being and health.
- Approximately 25% of the surveyed respondents experienced sleep interruption. As we shall see in the next several papers I review, this effect is common to all surveys. Sleep deprivation is a documented cause of a variety of physical and psychological diseases. Many disease states begin with poor or interrupted sleep. Most modern technologies which create noise and annoyance are noisy during ***the day but the noise ceases at night***, giving those living nearby the night time to sleep, relax and recover from the adverse physical and psychological responses to noise. IWTs are unique in that they are noisy day and night. Those adversely affected do not have a quiet night to sleep and recover. Indeed, some studies find that the noise is worse at night, since the ambient noise is reduced and the relative noises of the IWTs are that much greater. The adverse effects of sleep deprivation and annoyance are cumulative. The annoyance cannot be simulated by 10 minutes of sitting in a laboratory listening to actual and sham infrasound and drawing conclusions. Judged against true acoustical research, the Crichton survey design, implementation and results lack any scientific merit.

B. E. Pedersen and K. Persson Waye, "Wind turbine noise, annoyance and self-reported health and well-being in different living environments," *Occupational and Environmental Medicine*, 64, 2007, pp. 480-486.

The paper extends the survey research and policy modeling reported in their (2004) paper discussed above. The objectives were the same. As above, the authors implemented a cross-sectional survey in Sweden. 1,309 questionnaires were sent out; the response rate was 57.6%; that is, there were 754 respondents. The design of the survey and survey instrument was almost identical to that used in the (2004) paper.

The survey population (hence the number of respondents) were grouped into 7 groups.[31] The ***average*** distance for each group to the nearest IWT ranged from a low of 1,984 feet to a high of 3,326 feet. These are fairly long set-backs compared to some siting practices. The average A-weighted noise level (SPL) for all but one group ranged from 31.4 – 35, which is fairly quiet, as noted in Figure 1 above. One group had an average noise level > 35 (38.2 dBA, with a standard deviation of 4.7).

The analytic results, conclusions and main messages from the paper are the following.[32]

- "The odds of perceiving wind turbine noise increased with increasing SPL [sound pressure levels – measured in dBA], … [and] [t]he odds of being annoyed by wind turbine noise also increased with increasing SPLs." … "Dose-response relationships at noise levels as low as these have not earlier been derived."
- "[N]oise annoyance was associated with sleep quality and negative emotions." Of those respondents who were annoyed by wind turbine noise, 36% reported that their sleep was disturbed by a noise source. This is compared with 9% among those not noise-annoyed. Respondents who were annoyed by wind turbine noise felt more tired and tense in the morning. They also felt resigned (29%), violated (23%), strained (19%) and tired (19%) when thinking about wind turbines to a statistically significantly higher degree compared with those who were not annoyed. These feelings were not related to self-reported health status.
- "Perception and annoyance were associated with terrain and urbanization." "Living in a rural environment, in comparison with a suburban area, increases the risk of perceiving and being annoyed by sound from nearby wind turbines." "Annoyance was associated with both objective and subjective factors of wind turbine visibility, and was further associated with lowered sleep quality and negative emotions" which "could lead to hindrance of human restoration." This, together with reduced restoration possibilities may adversely affect health."
- "There is a need to take the unique environment into account when planning a new wind farm so that adverse health effects are avoided."

The results of this study, as well as the previous one by these authors, demonstrate that greater annoyance, lower sleep quality, lower levels of "human restoration" from sleep, and negative emotions are related to increasing IWT noise. The period of study precedes the global mass hysteria hypothesized by Chapman and reveals the degree of nuance found in a real-world study of IWT audible and inaudible noises, relative to the 10-minute exposure used by Crichton.

[31] P. 482, Table 1.

[32] Pp. 480, 484 and 485. I have woven a variety of quotes together from these pages.

C. E. Pedersen and P. Larsman, "The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines," *Journal of Environmental Psychology,* 28, 2008, pp. 379-389.

This paper combines the survey data sets from the two Pedersen and Waye articles (2004, 2007) discussed above. The authors develop a more nuanced multi-equation model which tests for the measured impact of noise (audible and inaudible) upon respondents' propensity toward being annoyed and the simultaneous relationship between annoyance and attitudes toward the visibility of the turbines.

Citing a 1995 research effort, the paper's first sentence notes that "***[c]ommunity noise is an increasing environmental problem known to cause adverse health effects***." This is in 1995, only 2 years after the first Australian IWT cited by Chapman and 13 years before the global mass hysteria (MPI) proposed by Chapman to have been caused in large part by Nina Pierpont. Pedersen and Larsman continue, citing the previous two Pedersen and Waye articles, "Wind turbines are new sources of community noise and their impact on people living nearby are as yet only partly known. … Dose–response relationships between A-weighted sound pressure levels (SPLs) and noise annoyance with wind turbine noise were verified in these studies, even though the noise levels from wind turbines were low, typically being below 40 A-weighted decibel (dB(A)) outside the dwellings of respondents."[33]

They ask the question: Why are people annoyed by IWTs at much lower dBA than other forms of community noise (See Figure 1 above)? In trying to answer this question, they noted perhaps the visual impact of the wind turbines interacted with the response to turbine noise. Respondents living in the proximity of wind turbines talked primarily about the noise, but also about the spoiled view and the constant movement of the rotor blades always attracting the eyes. This has since been labeled "flicker" and is claimed to be an adverse effect, much like living with a strobe light going on continuously, when the sun is at the right angle to catch the spinning of the blades. In any case, they specified a model to quantify the visual impact of the IWTs upon a respondent's "Visual Attitude." They then attempted to differentiate the impacts of "Visual Attitude" from the impacts of the noise itself, hypothesizing that people were measured as being more sensitive to IWT noise at lower dBA because they could also see the looming behemoth of an IWT and suffer from its flicker, in addition to the noise.

As they talked with the survey respondents, they found that an adverse response to IWT noise was ***positively correlated with noise*** (A-weighted SPL); ***positively correlated with negative general attitudes*** toward IWTs; and ***positively correlated with Visual Attitude toward the specific local IWT*** they could see. However, any trained statistician knows that correlation is not causation. The problem with the modeling effort is that all of the proposed factors are correlated and it is unclear what causes what. Even when the authors allow all three factors to have an

[33] Quotes in this paragraph are from p. 380.

independent effect on annoyance, noise still had a positive and statistically significant effect. This is remarkable, as a statistical result, since the three variables are quite collinear. It is well known that when such multi-collinearity exists, it is difficult to identify with statistical precision the independent effects of the multi-collinear variables.

Unfortunately, their model and data are incapable of distinguishing causality from correlation. Do all three factors have independent effects? Or does one factor cause annoyance and also cause the other factor? For example, if I live very close to an IWT and it looms mightily above my home and I am suffering from the adverse effects of the noise I hear and feel (from the sub-audible range), I will certainly have a negative Visual Attitude toward the proximate IWT; I will certainly see the IWT clearly (line-of-sight improves noise dispersion); I will certainly develop generally negative attitudes toward IWTs. So, if true, it is the noise itself that causes the other two attitudes to be more negative; which in turn can be found to have a measureable effect on annoyance. When all three variables are included in a regression, they may appear to display separate effects, and the measured effect of each will be less than if the entire effect was due to, and recognized as due to, the adverse response to noise (audible and inaudible).

The authors understand this: "The ***proposed model was based on*** theoretical assumptions about causality and on ***the assumption that attitude towards the source influences noise annoyance***. [34] However, we cannot exclude the possibility that the causality is directed the opposite way so that annoyance causes a negative attitude towards the source. Being annoyed by wind turbine noise in the home environment could initiate a negative attitude towards wind turbines. There may also be a feedback loop between these variables." After considering these possibilities of correlation and causation, the authors conclude that "noise immission [sic] levels are possibly still the best predictor of noise annoyance."[35]

The relevance of this paper to the Chapman and Crichton papers is the same as above. Reaction to the complex audible and inaudible noises emitted by IWTs is a complicated phenomenon requiring careful study of the typography in which the noises are experienced and the time frame over which they are experienced. The correlation and/or causation of a variety of physical and psychological factors must be carefully analyzed. The Crichton paper gives us no insight into that complexity. The Chapman paper claims that there are no real adverse responses to IWT noises; negative general attitudes have been compromised and drive reactions; complaints are in the minds of the complainants; and they are nocebo effects or mass hysteria. While Pedersen, *et.al.* have conducted these extensive surveys and developed these nuanced models, it would seem that according to Chapman those efforts are for naught. Since ***only 3***

[34] Specifically, one may just hate IWTs altogether, for whatever reason. In that case, one's general negative attitude will certainly cause one to have a negative Visual Attitude to the specific IWT one sees and will predispose one to be annoyed by the noises heard. In that case, the negative general attitude is the main causal factor.

[35] P. 388.

people complained about adverse effects of IWTs over 1993-2003 in his data, what do you need a model for? Those 3 people must have been suffering from some mental defect, since the only reason one would complain is if one had been contaminated by the mass hysteria induced by "vitriolic anti-wind" forces. Chapman is incorrect.

D. E. Pedersen, F. van den Berg, R. Bakker, and J. Bouma, "Response to noise from modern wind farms in The Netherlands", ***Journal of the Acoustical Society of America,*** **126(2), August 2009, pp. 634–643**

Contrary to Chapman's conclusion that complaints reflect mass hysteria in Australia beginning in 2009 or so, these authors begin their 2009 paper stating:[36]

> ***"Community noise is recognized as an environmental stressor, causing nuisance, decreased wellbeing, and possibly non-auditory adverse effects on health.*** The main sources of community noise are transportation and industry. Air transport is the most annoying of the dominant means of transport. … Increasing awareness of the adverse effects of noise has led to noise management recommendations, including [World Health Organization – WHO] guideline values to limit health effects in various situations and action plans for reducing noise and preserving quietness, all with the aim of decreasing the overall noise load. Noise impact is quantified based on the relationship between noise dose and response, the latter measured as the proportion of the public annoyed or highly annoyed by noise from a specified source."
>
> "Wind turbines are a new source of community noise to which relatively few people have yet been exposed. The number of exposed people is growing, as in many countries the number of wind turbines is rapidly increasing. The need for guidelines for maximum exposure to wind turbine noise is urgent: While not unnecessarily curbing the development of new wind farms, it is also important to avoid possible adverse health effects."

As do the previous 3 papers, this paper estimates and finds a statistically significant positive dose-response relationship between *A*-weighted sound pressure levels and reported perception of and annoyance from the noise in a 2007 field study in The Netherlands in which 725 respondents participated. The same survey questionnaire used in the Swedish studies was used here. As in Pedersen and Waye (2004; Figure 1 above), wind turbine noise was found more annoying than transportation noise or industrial noise at comparable levels, possibly due to specific sound properties such as a "swishing" quality, temporal variability, and ***lack of nighttime abatement,*** which of course causes sleep disruption. "Response to wind turbine noise was similar to that found in Sweden so the dose-response relationship should be generalizable."[37]

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[36] P. 634, citations excluded.

[37] *Ibid.*

They note that there have been only a few studies measuring IWT dose-response relationships,[38] which have found the following evidence. The sizes and heights of IWTs have increased over time; this is important since the evidence suggests that annoyance and sleep disorders increase with the size of the IWTs. Wind turbines differ in several respects from other sources of community noise**.** Specifically, modern IWTs mainly emit noise from turbulence at the trailing edge of the rotor blades. The turbine sound varies with the wind speed at hub height and varies rhythmically and more rapidly as the sound is amplitude-modulated, due to the variation in wind speed. Amplitude-modulated sound is more easily perceived than is constant-level sound and has been found to be more annoying. This is particularly true when turbines are placed in open rural areas with low levels of background sound.

The authors find the following analytic results.

- The degree of perception and annoyance increased with increasing sound level, for both outdoor and indoor annoyance. The proportion of respondents who were annoyed (rather or very) by the sound increased with increasing sound level up to 40–45 dB(A).
- The proportions of respondents annoyed by wind turbine noise were comparable to the previous Swedish studies.[39] However, "this study found a stronger relationship between immission [sic] levels of wind turbine noise and annoyance than the … Swedish studies,"[40] which may be due to the larger wind turbines included in the present study. Higher towers push the rotors to heights with stronger winds, increasing the time a wind turbine operates and increasing differences between emission levels and the background ambient sound levels, especially at night.
- The probability of being annoyed by wind turbine sound was higher if wind turbines were visible rather than not. Again, since the annoying audible and inaudible sounds produced by IWTs will increase with line-of-sight prevalence, this finding is not surprising.
- Figure 2 below presents the proportion of respondents annoyed and highly annoyed with wind turbine noise above 35 dBA and below 55 dB(A). It is larger than the proportion annoyed with noise levels from ***all other noise sources except railroad shunting yards***, at comparable Lden.[41] Shunting yards are rail yards in which trains and train cars are moved back and forth; connected, disconnected and reconnected; at random intervals; creating significant time-variant noise. The percentage of people "annoyed" or "very

[38] See p. 635, which cites a European study carried out in Denmark, The Netherlands and Germany in 1993; a complementary Danish study carried out in 1994; and the Swedish studies discussed in Sections IV, A-C above.

[39] See Figure 2, p. 640. Also, see p. 642 and Sections IV.A-IV.C above.

[40] P. 642.

[41] This is a reproduction of their Figure 3, p. 641. Lden is a dBA-based noise exposure level (den=day-evening-night) metric that has been found most appropriate for these analyses; see p. 634.

annoyed" with noise created at shunting yards is significantly higher than railway noise itself.

- "… the relatively high annoyance with shunting yard noise has partly been explained by the impulsive nature of some yard activities.[42] Wind turbine sound also varies unpredictably in level within a relatively short time span, i.e., minutes to hours. It can be postulated that it could be even more important that ***neither type of noise ceases at night***. In contrast, in areas with traffic noise and/or industrial noise, background levels usually return to lower levels at night, ***allowing residents to restore themselves psycho-physiologically***. A large proportion of respondents in the present study reported ***hearing wind turbine sound more clearly at night,*** an observation supported by previous findings. … ***Taken together, this implies that nighttime conditions should be treated as crucial in recommendations for wind turbine noise limits.***"[43]

Regarding the relevance of this study to Chapman and Crichton, I note that the appearance of this study [in English] is cotemporaneous with the Pierpont book. I do not know whether Chapman finds this study to be "vitriolic," "anti-wind," or "non-scientific lay evidence." It certainly is none of these. It is certainly a much more professional scientific report, based upon properly gathered survey data and data analysis, than that put forward by Chapman. If this is one of the pieces of evidence that began to influence the discussion regarding the adverse health effects of IWTs globally and in Australia, then this is evidence that ***should have informed the discussion***, as should the other three articles discussed above. This is not a source of mass hysteria; this is a source of informed discourse.

E. D. Shepherd, D. McBride, D. Welch, K. Dirks, and E. Hill, "Evaluating the impact of wind turbine noise on health-related quality of life," *Noise Health*, 13 (54), September-October 2011, pp. 333–339.

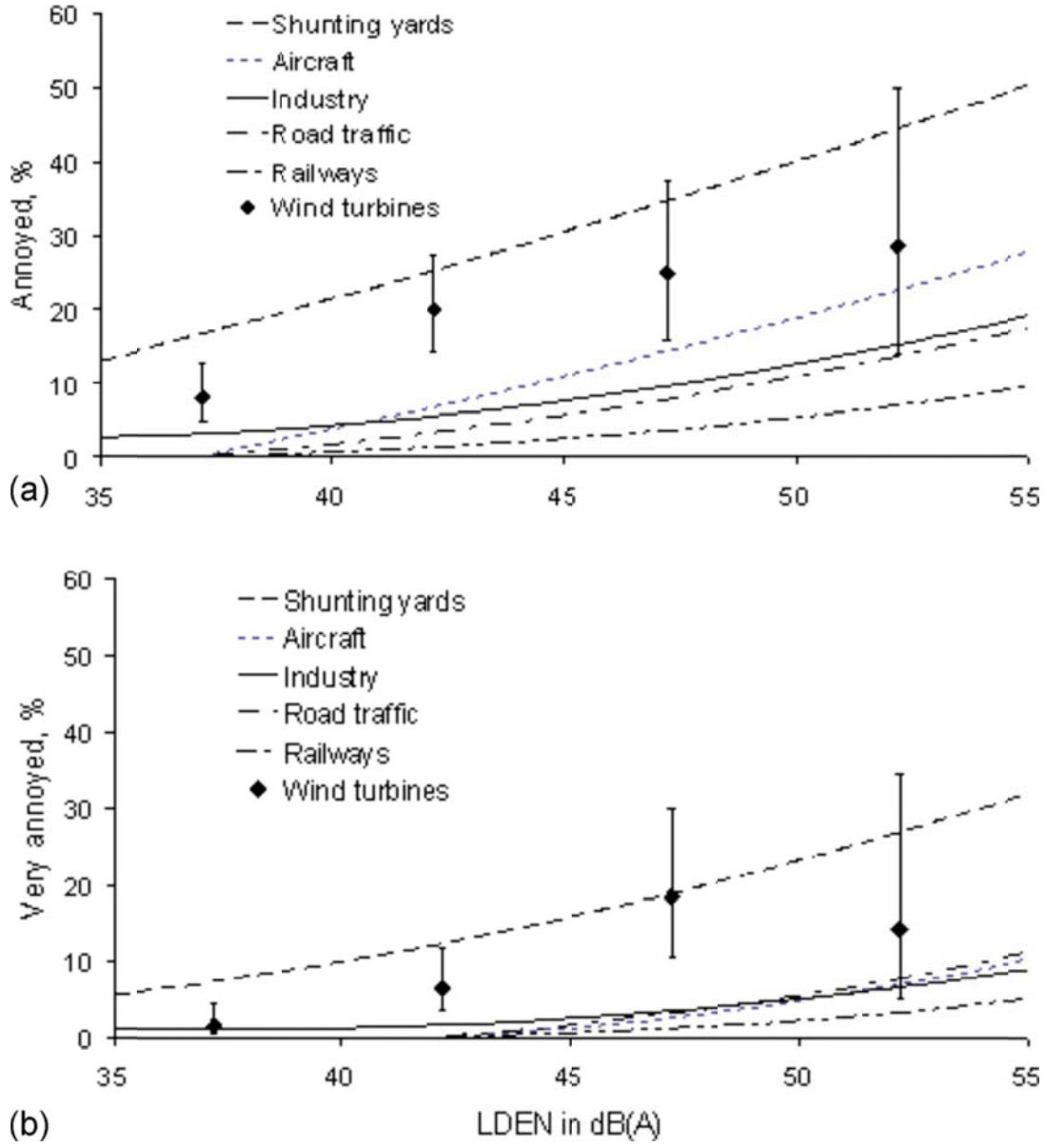
This paper reports on the analysis of a 2010 cross-sectional survey conducted in New Zealand under the guise of a "*Well-being and Neighbourhood Survey*," named to mask the true intent of the study. That intent was to analyze and measure the health-related quality of life (HRQOL) of individuals residing in the proximity of a wind farm relative to those individuals residing in a demographically matched area sufficiently displaced from wind turbines (the control group).[44] The survey was in principle similar to the surveys discussed in the previous 4 papers. However, in designing the survey instrument, the authors considered a variety of

[42] See H. Miedema and H. Vos, "Noise annoyance from stationary sources: Relationships with exposure metric day-evening night level (DENL) and their confidence intervals," *Journal of Acoustical Society of America*, 2004.

[43] P. 642.

[44] Samples were drawn from two demographically matched areas differing only in their distances from a wind farm in the Makara Valley, a coastal area 10 km west of New Zealand's capital city, Wellington.

Figure 2: Proportion of Respondents Annoyed (a) and Very Annoyed (b) by IWT Noise Compared to the Noise from Road Traffic, Aircraft and Railways (Miedema and Oudshoorn (2001)) and from Industry and Shunting Yards (Miedema and Vos (2004))



outcome measures to assess the noise impacts including annoyance (used above), sleep disturbance, cardiovascular disease, cortisol levels and the subjective appraisal of health-related quality of life (HRQOL). The HRQOL is a concept that measures general well-being and well-being in the physical, psychological, and social domains. Because changes in HRQOL are

expected to closely co-vary with changes in health, the World Health Organization (WHO) recommends the use of HRQOL measures as an outcome variable.[45]

Statistically significant differences were found in some HRQOL scores, with residents living within 2 km of a turbine installation reporting lower overall quality of life, physical quality of life, and environmental quality of life. Those exposed to turbine noise also reported significantly lower sleep quality, and rated their environment as less restful.

The authors conclude the following:[46]

- "Our data suggest that wind farm noise can negatively impact facets of HRQOL**."**
- A large proportion of respondents from the turbine group identified turbine noise as a problem and rated it to be extremely annoying. The authors state that "***It should be noted that, in contemporary medicine, annoyance exists as a precise technical term describing a mental state characterized by distress and aversion, which if maintained, can lead to a deterioration of health and well-being.*** A Swedish study [Pedersen and Waye (2007)] reported that, for respondents who were annoyed by wind turbine noise, feelings of resignation, violation, strain, and fatigue were statistically greater than for respondents not annoyed by turbine noise."
- "We also observed lower sleep satisfaction in the turbine group than in the comparison group, a finding which is consistent with previous research. One study directly related to wind turbine noise reported that 16% of respondents experiencing 35 dB(A) or more of noise suffered sleep disturbances due to turbine noise [Pedersen and Waye (2004)]). Another study investigating the effects of wind turbine noise on sleep showed that 36% of respondents who were annoyed at wind turbine noise also reported that they suffered disturbed sleep (versus 9% of those not annoyed). A case-study approach examining exposure to turbine noise likewise identified turbine noise as an agent of sleep disturbance [a study for the WHO]. In relation to turbine noise levels, one study reported that even at the lowest noise levels (≈25 dB(A)), 20% of respondents reported disturbed sleep at least one night per month, and that interrupted sleep and difficulty in returning to sleep increased with calculated noise level. Demonstrably, our data have also captured the effects of wind turbine noise on sleep, reinforcing previous studies suggesting that the acoustic characteristics of turbine noise are well suited to disturb the sleep of exposed individuals."[47]

[45] The authors cite scientific evidence linking community noise to health problems. The WHO reports that chronic noise-induced annoyance and sleep disturbance can compromise health and HRQOL (see p. 334 for the citations).

[46] Pp. 333, 337-338.

[47] A complete set of references is found on pp. 337-338.

Summary and Conclusions

The two papers subject to my review fail to meet credible standards of professionalism to be taken seriously. Chapman observes a correlation between the timing of three specific publications and general increased media coverage with a recently increased number of complaints regarding adverse impacts of audible and inaudible wind turbine noise. However, his hypothesis tests are crude and without evidentiary value. Either hypothesis is supported by the data he proffers, data which are likely subject to serious measurement error. I would not rely upon his data to come to any conclusion. However, even if one were to believe the data, they are typical of diffusion rates of information regarding the positive or negative attributes of particular products, technologies, procedures and diseases. Given the naïve and simplistic experiment upon which it is based, the Crichton paper offers no evidentiary value.

There is, however, a scientific literature that has recognized the social effects of noise upon public health. This literature has developed survey methods and analytic procedures to quantify the adverse impacts of such noises. The earlier applications have been directed at the impacts of traditional sources of noise impinging upon neighboring individuals – highways, airports, railroad lines, and railroad shunting yards. Is it a surprise to anyone that particularly loud noises can be annoying? If one's neighbor's dog sat in the backyard and barked all night, does anyone believe this to NOT be annoying; indeed very annoying? Aren't there laws against this annoyance? Does anyone believe that this annoyance would NOT be greater in a quiet neighborhood or rural area, compared to a noisy urban area. Does anyone NOT believe that if such noises interrupt one's sleep on a consistent basis, that person will begin to suffer psychological and physical (hypertension, stress-related) illnesses. Industrial wind turbines are just another form of industrial noise. The noise may have no adverse effects or it may have serious adverse effects. Serious, well-trained quantitative acousticians have analyzed the noises emitted from IWTs and found them to cause serious adverse health effects to a subset of residents living nearby. The etiology of those adverse health effects begin with sleep deprivation and annoyance and become more serious as affected individuals are continuously subjected to the noises. These effects are not the result of some mass hysteria.

Authors Qualifications

I have a BA (with high honors) from Princeton University and a Masters and PhD from MIT. All of my degrees are in mathematical economics. I have been a member (Associate Professor) of the faculties of MIT, Boston University and University of California, Berkeley. I have published more than 150 published peer-reviewed articles, book chapters and contract research using statistical and mathematical models, methods and data. I am currently Director and President of Greylock McKinnon Associates (GMA), a consulting and litigation support firm located in Cambridge, Massachusetts.

Since 1971, I have consulted to federal and state governmental bodies, private corporations, law firms, consulting companies, research organizations and international lending organizations. I have submitted oral and written testimony before United States federal and state courts of law and regulatory commissions. My testimony as an expert witness has addressed anticompetitive behavior, fraudulent pricing schemes, merger efficiencies, breach of contract, employment discrimination, patent infringement, class certification and the estimation of damages in a variety of markets and industries including, but not limited to, the electric power industry, the pharmaceutical industry, the health care services industry, the banking industry, the copper industry, the defense industry, the cable TV industry, the tobacco industry, the electrical and mechanical carbon products industry, the medical devices industry, the automobile industry, and the construction industry.

I regularly have testified as an expert witness on behalf of the Massachusetts Attorney General's office in a variety of matters, including the 1995-1996 tobacco litigation (the results of which the Commonwealth received billions of dollars in settlement from "Big Tobacco"); litigation against large drug companies for defrauding the Massachusetts Medicaid Program (2008-2011); the restructuring of the electric power industry (1990s); and a variety of utility rate cases (2000s). Over the past 40 years, I have reviewed and responded to hundreds of "Expert Reports" like the "The Wind Turbine Health Impact Study" which was commissioned by Massachusetts to support a predetermined incorrect conclusion that there is no evidence of adverse health effects caused by Industrial Wind Turbines.

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DEGREES

B.A. (MAGNA CUM LAUDE) Princeton University 1969
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An Oligopolistic Pricing Model of the U.S. Copper Industry (MIT, 1977)

HONORS, SCHOLARSHIPS, AND FELLOWSHIPS

1969-71	National Science Foundation Fellowship to MIT
1965-69	Alfred P. Sloan Scholarship to Princeton
1969	Woodrow Wilson Fellowship Honorable Mention
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RESEARCH AND TEACHING INTERESTS

Econometrics/Statistics
The Economics of Regulated Industries
Energy and Environmental Economics
Microeconomics
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POSITIONS

1967-1969	Research Staff, Financial Research Center and Center for Economic Research, Princeton University
1970	Research Staff, Board of Governors, Federal Reserve Board, Washington, DC
1972-1992	Consultant and Staff Economist, Arthur D. Little, Inc.
1977-1984	Research Faculty, Massachusetts Institute of Technology
1977-1983	Assistant Professor, Department of Economics, Boston University
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1988-1993	Visiting Associate Professor/Visiting Faculty, Boalt School of Law, University of California, Berkeley
1988-1995	Founding Principal, The Law and Economics Consulting Group
1995-1996	Vice President, Charles River Associates
1996-1999	Senior Consultant, Charles River Associates
1996-2000	Director, Cambridge Economics, Inc.
2000-2004	Special Consultant, Lexecon Inc.
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OTHER PROFESSIONAL ACTIVITIES

Research Referee, *Bell/Rand Journal of Economics, Resources Policy, IPC Science and Technology Press, Management Science, Land Economics, Science, Energy Journal, Applied Economics, Econometrica, Review of Economics and Statistics, Journal of Business and Economic Statistics, International Economic Review, Journal of Economics and Management Strategy, Pakistan Journal of Applied Economics, Journal of Health Economics, American Economic Review, Review of Industrial Organization*

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"A Model of Residential Energy Demand," MIT Energy Laboratory Working Paper, #MIT-EL-79-041WP, August 1979.

"The Incorporation of Solar Photovoltaics into a Model of Residential Energy Demand," MIT Energy Laboratory Working Paper #MIT-El 80-014WP, May 1980.

"Consumer Choice Among Alternative Fuels and Appliance Technologies: An Analysis of the Effects of Alternative Energy Conservation Strategies," MIT Energy Laboratory Working Paper #MIT-EL 82-036WP, June 1982.

"Estimation of Hedonic Supply Curves For Residential Water Heaters Using Technical Data and Federal Testing Guidelines," with Alan Cox and Mary Litterman, MIT Energy Laboratory Working Paper #MIT-EL 82-037WP, June 1982.

"A Monte Carlo Examination of the Heckman and the Manski-Lerman Estimators in Discrete/Continuous Models of Demand," October 1986.

"The Value of Service Reliability: Alternative Welfare Measures," with C.K. Woo, October, 1988.
"The Use of Hedonic Analysis in Defining and Measuring Market Size: The Extension of the Merger Guidelines to Heterogeneous Products," Working Paper No. 91-12, Program in Law and Economics. School of Law, Boalt Hall

EXPERIENCE IN CONSULTING AND EXPERT TESTIMONY

Overview of Qualifications

Dr. Hartman is an economist specializing in microeconomics, econometrics and the study of industrial organization. Microeconomics is the science used to analyze and characterize the behavior of groups of consumers and producers that constitute markets. Econometrics is a science that makes use of mathematics and statistics to measure and quantify economic behavior and economic phenomena in markets. The study of industrial organization makes use of both microeconomic theory and econometrics. It focuses upon the structure, conduct and performance of the participants (consumers and producing firms) in markets and industries, for the purposes of predicting behavior and addressing such policy issues as antitrust, regulation and industrial policy.

He has taught economics, conducted economic research and provided economic consulting in his areas of specialization for thirty-five years. He taught economics as an Assistant Professor and Associate Professor within the Department of Economics at Boston University over the period 1977-1988. He taught economics as a Visiting Associate Professor and member of the Visiting Faculty at the School of Law, Boalt Hall, University of California at Berkeley over the period 1988-1993. He was a member of the research faculty at MIT over the period 1977-1982, during which time he conducted research in energy markets for the United States Department of Energy. During the same time, he declined the offer of a Visiting Assistant Professorship within the Department of Applied Economics at MIT, and instead lectured on a selective basis. Since 1971, he has consulted to federal and state governmental bodies, private corporations, law firms, consulting companies, research organizations and international lending organizations. He has been and continues to be a research referee for a variety of academic journals, including the top academic journals in the country. He is the author of more than 100 refereed journal articles, book chapters and research/consulting reports.

He has submitted oral and written testimony before federal and state courts of law and regulatory commissions. His testimony as an expert witness has addressed anticompetitive behavior, merger efficiencies, breach of contract, employment discrimination, patent infringement, class certification and the estimation of damages in a variety of markets and industries including, but not limited to, the pharmaceutical industry, the health care services industry, the electric power industry, the banking industry, the agrochemical industry, the copper industry, the defense industry, the cable TV industry, the tobacco industry, the electrical and mechanical carbon products industry, the medical devices industry and the construction industry. He has consulted to counsel on litigation matters in a broader array of markets.

While his experience has been broadly-based across industries, two industries/markets have been primary subjects of substantial consulting, research and litigation support.

Experience in Energy Markets and Regulated Industries

Since 1977, Dr. Hartman's expertise and experience have involved regulated industries generally and the markets for electric power and natural gas specifically. His consulting and/or litigation assignments

have included load forecasting, evaluation of conservation and load management programs, econometric cost analysis, analysis of revenue requirements and rate-making, analysis of value of service reliability, the analysis of mergers and acquisitions, analysis of industry restructuring, analysis of manipulation of spot and future prices in energy markets, and analysis of contract damages arising from DOE's partial breach of the Standard Contract regarding storage of spent nuclear fuel waste. In these assignments, Dr. Hartman has consulted for such clients as Arizona Public Service, the Pacific Gas and Electric Company, the Southern California Edison Company, the Southern California Gas Company, the San Diego Gas and Electric Company, Portland General Electric Company, Bonneville Power Administration, General Public Utilities, Northeast Utilities, Niagara Mohawk Power Corporation, the Delmarva Power Corporation, Florida Power Corporation, Sithe Energies, the California Energy Commission and Public Utilities Commission, the Missouri Public Service Commission, the Rhode Island Division of Public Utilities, the Attorney General of the State of Massachusetts, the Electric Power Research Institute, the Gas Research Institute, the U.S. Department of Energy, the U.S. Department of Justice, the World Bank, and the governments of Indonesia and Thailand. He has consulted for a number of other clients whose identity must remain confidential. Over the last five years, he has testified numerous times before the United States Court of Federal Claims on behalf of the DOJ and DOE with regard to damages cased by DOE's partial breach of the Standard Contract.

Experience in Health Care and Pharmaceutical Markets

Over the past 15 years, Dr. Hartman has participated as testifying or consulting expert in a wide array of matters related to health-care markets generally and, more specifically, markets for medical devices and pharmaceutical products. For examples, working with a team of health care experts, he submitted written testimony assessing and measuring the impacts of smoking on Medicaid health care costs in the Commonwealth of Massachusetts. He submitted testimony analyzing the competitive impacts upon and damages to a class of dental laboratories caused by the restrictive dealer practices of a dominant U.S. manufacturer of medical prostheses - false teeth. He consulted to the group of wholesaler defendants in the Brand-Name Prescription Drugs Antitrust Litigation, addressing issues of wholesaler pricing across classes of trade. He consulted to and/or submitted testimony for counsel to manufacturers of cardiovascular stents, related cardiovascular devices and generic drugs in a variety of patent infringement matters, addressing such issues as competition, market definition, liability, market penetration of new products and economic damages arising from patent infringement. He consulted for one group of private plaintiffs in the antitrust matter regarding the prescription drugs lorazepam & clorazepate and for the Federal Trade Commission in the matter of Hoechst Marion Roussel, Inc., Carderm Capital L.P. and Andrx Corporation concerning antitrust claims involving the prescription drug Cardizem CD. That consultation addressed issues of market definition, product competition, class certification and damage estimation. He consulted to counsel on the matter of damages to the class of direct purchasers of the prescription drugs Taxol and Flonase. He consulted to counsel and/or submitted testimony on the matter of damages to classes of indirect end-payer purchasers of the prescription drugs K-Dur, Augmentin, Wellbutrin, Zyprexa, Bextra, Celebrex, Tricor, Nexium, Estratest, Lotrel, Ketek, Flonase and Vioxx.

He submitted testimony addressing class certification, liability and/or damages for the class of end-payer purchasers in antitrust, state consumer protection or RICO litigation concerning the prescription drugs Hytrin, BuSpar, Relafen, Lupron, Premarin, Ditropan, the hormone replacement therapy Estratest, Cipro in the states of New York and California and in the United States, K-Dur, Neurontin in the United States and Pennsylvania, and Risperdal in the State of Louisiana. In the MDL AWP litigation, he submitted testimony in support of the certification of to the class of end-payer purchasers of those pharmaceutical products produced by AstraZeneca, the Bristol-Myers Squibb Group, the Johnson & Johnson Group, the GlaxoSmithKline Group and the Schering Plough Group that were alleged to have been the subject of a

scheme to fraudulently inflate their Average Wholesale Price (AWP); he subsequently submitted and presented at trial testimony supporting findings of causation, liability and the calculation of damages for those end-payer groups for which class certification was granted and upheld at the appellate level. He has consulted to and/or submitted testimony for the Offices of the Attorneys General for the states of Massachusetts, Texas, New York, Connecticut, Montana and Nevada in analogous matters. He submitted testimony addressing class certification, liability, damages and settlement allocation in the MDL litigation, *New England Carpenters Health Benefits Fund, et al, Plaintiffs, v. First Databank, Inc., a Missouri Corporation and McKesson Corporation, a Delaware Corporation, Defendants,* in which violations of U.S. RICO and state consumer protection statutes were allegedly violated. He submitted similar testimony addressing and calculating the economic damages of these alleged activities upon the Medicaid agency and other governmental agencies of several specific states. He submitted testimony regarding class certification in the MDL matter alleging ERISA violations, *In re Express Scripts, Inc., PBM Litigation.* He has consulted to drug companies on related matters when they have arisen in a patent litigation context. His testimony has been the basis for the certification of class in a variety of these matters. His testimony has been the basis for approval supporting settlement agreements in a variety of these and other pharmaceutical matters.

He has provided testimony and/or white papers for counsel used in arbitration for a hospital seeking to revoke surgical privileges for an allegedly incompetent thoracic surgeon and for an insurance company that alleged physicians were overcharging for services provided under Medicare.

Specific Assignments

1972-1975: In consultation with Arthur D. Little, Inc., Dr. Hartman developed economic impact models to assess the effects of environmental regulations upon the U.S. pollution abatement equipment industry and upon a particular U.S. copper smelting company.

1972-1975: In consultation with Arthur D. Little, Inc., Dr. Hartman developed economic models to assess the regional macroeconomic and industrial impacts of alternative strategies to promote tourism-related industries. The models were used in the United States by the states of Maryland and Maine and for the Philadelphia Bicentennial Commission. Internationally, the models were used by the Ministry of Planning of Mexico to assess the national and regional importance of tourism coming into Acapulco.

1976-1977: Consultation with Arthur D. Little, Inc. for the U.S. Environmental Protection Agency. The effort involved the design, estimation and implementation of an econometric simulation model that was used to assess the impact of pollution abatement legislation on the U.S. copper industry. The model was designed to incorporate engineering cost estimates attributable to the abatement legislation while accounting for the noncompetitive pricing behavior in the industry. The model was used to evaluate and revise proposed abatement legislation. This analysis was the basis for Dr. Hartman's Ph.D. dissertation and several of his publications.

1977-1982: Working as the testifying expert, Dr. Hartman analyzed the presence of a price-fixing conspiracy among the major U.S. copper producers during the 1970's. His testimony addressed issues of liability and developed a model of damages. See

> Affidavit to United States District Court for the Southern District of New York, *J.N. Futia Co., Inc., Plaintiff, Against Phelps Dodge Corporation, et al., Defendants,* 78 Civ. 4547 (ADS), 1978.
>
> Deposition for United States District Court, Southern District of New York for *Reading Industries, Inc., et al. (Plaintiffs) against Kennecott Copper Corporation, et al. (Defendants),* 17 Civ. 1736

(MEL), 1982.

1979: Working for the California Energy Commission, Dr. Hartman developed and presented a Statement of Opinion and Critical Review of Selected Energy End-Use Models and Proposed Specifications for PG&E End-Use Modeling Efforts before the California Energy Commission Hearings on Utility Construction and Siting, November 26-30, 1979.

1984: Testifying expert for the class of all individuals who employed the services of members of Massachusetts Furniture and Piano Movers Association. The analysis developed an econometric model to assist in certifying the class and measuring the damages common to that class. See

> Affidavit to United States District Court for the District of Massachusetts in the Matter of *Kenett Corporation et al v. Massachusetts Furniture and Piano Movers Association Inc. et al*, May 1984, Civil Action No. 82-140-Z.

1984-1986: In consultation with the U. S. Postal Service, Dr. Hartman identified appropriate econometric methods for analysis of the determinants of Postal Service costs. The particular methods he suggested were "hedonic" cost techniques, which are specifically designed to account for the fact that both increased levels of production and improved product attributes increase costs. The techniques assisted the Postal Service in quantification of the cost impacts of the attributes of service quality for alternative classes of service. For example, the techniques allowed for estimation of the differential cost impacts of alternative service priorities, size and weight attributes of the various classes of mail.

He later applied these techniques for a group of second class mailers. The analysis was introduced before the Postal Service Commission to assess whether proposed postal rate changes reflected actual costs.

1984-1986: The development of econometrically-based strategic planning models, which allow for estimation of the effects on corporate profits of alternative product design and pricing strategies. The models allow for examining specific design strategies by explicitly incorporating detailed product attributes. The models were developed for Westin Hotels and Shell Oil. The Westin models have been implemented into an interactive PC tool that facilitates pricing decisions at the front desk.

1985: For analysis presented before the International Trade Commission, Dr. Hartman helped develop and estimate a model to evaluate the domestic effects of importation of certain synthetic aramid fibers. The analysis was used in adjudicating an international patent infringement complaint.

1985-1986: Dr. Hartman participated in an analysis of one of the nation's largest mutual funds. The study was undertaken as part of a class action alleging inappropriate management fees. The study assessed competition in the money market mutual fund industry. It measured investors' sensitivity to changes in yield and to the level of services provided. It also statistically identified the determinants of the costs of providing mutual fund services.

1985-1986: The development for GTE Laboratories of econometric demand models for analysis and measurement of the determinants of demand for telecommunications services. The models explicitly address the separate customer decisions to subscribe to one of several telecommunications carriers and the demand for telecommunications services, conditional upon the subscription decision. The analysis was employed by GTE to assist their subsidiary, GTE Sprint, in the design of marketable services, where the services were differentiated by tariff, perceived service quality, provider reputation, and specialized customer services. The analysis is summarized in the paper

"Estimation of Household Preferences for Long Distance Telecommunications Carrier", *Journal of Regulatory Economics*, Volume 6, 1994.

1985-Present: Dr. Hartman has performed a variety of economic damage analyses in cases of personal injury, wrongful injury and wrongful death. He has worked for both plaintiff and defendant. He was last deposed in such matters in 1995.

1986: For a major natural gas pipeline, preparation of an analysis of the effects of natural gas deregulation as proposed in the Federal Energy Regulatory Commission's Notice of Proposed Rulemaking No. 436.

1986-1987: Working for the class of owners of selected General Motors' X Cars and VW Rabbits, Dr. Hartman specified and estimated econometric models that assisted in the certification of class and estimation of class damages. The damages flowed directly from allegedly-concealed design flaws in these automobiles. The methods are described in

"The Use of Hedonic Analysis for Certification and Damage Calculations in Class Action Complaints," with M. Doane, *The Journal of Law, Economics and Organization*, Fall 1987.

1986-1987: Development of damage models for litigation in high technology industries. The models were developed in several cases. One involved alleged patent infringement by a major Japanese semiconductor firm, and the second involved market foreclosure of a domestic minicomputer emulator. In these efforts, Dr. Hartman developed econometric models to estimate the market potential, absent the violation, for the particular product foreclosed or whose patent was infringed. The methods are described generically in

"Product Emulation Strategies in the Presence of Reputation Effects and Network Externalities: Some Evidence from the Minicomputer Industry," with D. Teece, *Economics of Innovation and New Technology*, Volume 1, 1990.

1987: Analysis of the competitive effects of relaxing the restrictions on the Bell Regional Operating Companies regarding their vertical extension upstream into equipment manufacture and downstream into the provision of selected telecommunication services. The study was introduced before Judge Greene in the triennial review of the divestiture of the Bell operating companies from AT&T.

1987-1988: For a major gas utility, participation in analysis of the economic effects arising if bypass of an existing pipeline were allowed by state and federal regulation. The analysis developed methods for assessing when competitive bypass is socially desirable. The analysis also developed and used an econometric model to simulate the effects of bypass on demand and prices.

1988: Analysis of the competitive effects the acquisition of trade secrets through the predatory hiring of a competitor's essential labor force. See

Analysis submitted in testimony in the case *Universal Analytics Inc. v. MacNeil Schwendler, Corp*.

1988-1989: As part of their proposed acquisition of Public Service of New Hampshire, Dr. Hartman was retained by Northeast Utilities, Inc. to develop and estimate load forecasting models. The models were used to assess the demand implications of alternative rate assumptions proposed as part of the acquisition.

The forecasts were introduced as part of Northeast Utilities' filings before the bankruptcy court, the state public utility commissions, the SEC and the FERC.

1989: As part of major antitrust litigation against the leading vendors of airline computer reservation systems, Dr. Hartman helped develop liability analysis and models for the estimation of damages.

1989: As a proposed testifying expert for Parnelli Jones, Inc., Dr. Hartman analyzed the antitrust implications of Firestone's retail trade practices, particularly alleged vertical and horizontal restraints of trade. He designed damage models for the alleged violations.

1989 - 2000: Dr. Hartman performed the market analyses required for Hart-Scott-Rodino applications and second requests supporting mergers and acquisitions in a variety of industries, including specialty chemicals, airlines, health care and medical diagnostic products, and energy products and services.

1989-1990: Dr. Hartman participated as a principal investigator and testifying expert for the Division of RatePayer Advocates of the California Public Utility Commission in an analysis of the economic and legal implications of the proposed merger between Southern California Edison Company and San Diego Gas and Electric Company. Dr. Hartman's responsibilities included overall study design, econometric analysis of scale and scope economies arising with the merger, and analysis of efficiencies purportedly arising with the coordination of the demand-side management programs of the two utilities. His direct and surrebuttal testimony is found in

> California Public Utilities Commission, Division of Rate Payer Advocates, Report on the Proposed Merger of the Southern California Edison Company and the San Diego Gas and Electric Company, Volume V, Chapter II, Application 88-12-035, February, 1990, Exhibit 10,500; and
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> California Public Utilities Commission, Division of Rate Payer Advocates, Report on the Proposed Merger of the Southern California Edison Company and the San Diego Gas and Electric Company, Surrebuttal: Econometric Analysis of Merger Impacts, Application 88-12-035, July, 1990, Exhibit 10,511.

1989-1990: Working with Arthur D. Little, Inc., Dr. Hartman participated as a principal investigator and testifying expert in a merger study for several small New England utilities within Nepool. Dr. Hartman designed and implemented a statistical study of returns to scale and scope in the industry. Using the statistical results, Dr. Hartman developed opinions regarding the efficiency effects of the proposed merger. His analysis appears as an independent Appendix to

> Arthur D. Little, Inc., Evaluation of EUA's Proposed Acquisitions of UNITIL and Fitchburg, Report to Gaston and Snow, March 12, 1990, presented in support of the acquisition to the Securities and Exchange Commission and the New Hampshire Public Utilities Commission.

1990: Working for a group of commodity futures exchanges, Dr. Hartman participated as Principal Investigator in a critical review of a statistical and econometric study performed by the Commodity Futures Trading Commission. The CFTC study was developed to assess the effects of dual trading on commodity futures markets, in order to implement proposed regulations curtailing such trading.

1990: Working with Barakat and Chamberlin, Inc., Dr. Hartman developed a Ramsey pricing model for Arizona Public Service Corporation. The Ramsey pricing model was used to develop and

explore alternative rate strategies for a variety of residential, commercial and industrial market segments. The analysis was submitted in formal rate hearings.

1990-1992: Working with the Technology Research Center of Arthur D. Little, Inc. for the United States Postal Service, Dr. Hartman specified and estimated econometric models to analyze the determinants of productivity for the largest 120 post offices in the United States. The econometric models are being used to identify the most and least productive offices, with the purpose of learning from the performance of the most productive offices in order to improve the performance of the least productive offices. The models are being used to design and implement incentive regulation mechanisms to increase productivity across post offices.

A second set of econometric models have been specified and estimated to quantify the effects of the attributes of alternative postal services and rate classes upon total postal service costs. The results of this analysis are being used to design postal rates for alternative classes of service which reflect the real costs of providing the services. The analysis and its results will be introduced into the postal rate hearings.

1990-1997: Working with the World Bank, Dr. Hartman has specified and is estimating a set of econometric models to measure both the level and types of pollutants emitted by United States plants and establishments and the costs of abating those pollutants. The models identify and quantify, at the plant level, the relationship between the emission of approximately 300 pollutants and the scale of production, the types of technology used, the age and characteristics of the plant and equipment used, the extent to which abatement equipment has been installed, and the costs (capital and operating) of abating alternative pollutants.

The models will be used in the following ways in developing countries and Eastern European countries: to assist the countries to predict and assess the environmental implications of reliance upon certain technologies and industries in development; to assess the effectiveness of alternative regulatory methods for abating pollution, including effluent standards, effluent taxes, effluent licenses, technology standards, effluent banks, and alternative property right schemes; to implement incentive regulation mechanisms to better stimulate abatement compliance; and to identify and prioritize those industries that can abate certain pollutants at least cost.

As part of this effort, Dr. Hartman has also designed a specific incentive regulation system for pollution abatement compliance in Indonesia. The system is based upon the most recent theory in regulated incentive mechanisms. The system will ultimately evolve into an effluent bank or a system of effluent fees. If the effort is successful, it will form the basis for environmental institutions in other developing countries. In the process of designing this system, he has reviewed the institutional and statutory basis for environmental policy in Indonesia.

Also as part of this work, Dr. Hartman is in the process of designing the institutional and statutory structures for Environmental Protection Agencies in a variety of developing countries. The institutional structures will be designed to articulate and implement pollution abatement policies that are informed by the econometric modeling described above.

1991: Dr. Hartman participated as a principal investigator and testifying expert for the Missouri Public Service Commission in a critical analysis of the proposed merger between Kansas Power and Light Company and Kansas Gas and Electric Company. Dr. Hartman's responsibilities included overall study design, analysis of scale and scope economies arising with the merger, analysis of unanticipated transitional cost arising with the merger and an econometric event study of the stock market's response to the merger. His testimony appears in

A Critical Analysis of the Proposed Merger Between Kansas Power and Light Company and Kansas and Electric Company, Report to the Missouri Public Service Commission, March 25, 1991.

1991: Working for the Resolution Trust Corporation in its litigation against Michael Milken and Drexel Burnham Lambert Inc., Dr. Hartman developed data and econometric models to measure the size of the relevant antitrust markets dominated by Drexel and to estimate the size of the economic damages produced by Drexel's alleged monopolization of those markets.

1991-1992: Working for the Indonesian government and the United States Agency for International Development, Dr. Hartman critically reviewed the structure of the Indonesian electric power industry and the institutions regulating that industry. The purpose of the analysis was to assist the government with privatizing their energy industries. His analysis focused upon the following: developing better data and models for predicting demand and supply; identifying and implementing more efficient industrial structures; and developing better regulatory regimes.

1992: Working for the World Bank, Dr. Hartman designed methods to measure and compare the social value of the environmental effects of alternative development projects, at the microeconomic and macroeconomic levels. His analysis focused upon standard and contingent valuation survey approaches and their use in econometric settings.

1992-1993: Working for the World Bank in Bangkok, Dr. Hartman characterized and critically analyzed the environmental effects of Thailand's energy use patterns. He focused upon the use and production of electric power, petroleum, coal and natural gas. He developed recommendations for environmental policy changes that included, but were not limited to, fuel taxes, effluent standards, technology standards, and privatization of environmental monitoring within a "bubble" policy approach.

1992-1993: Working for a biomedical company (a producer of vascular grafts) in an antitrust situation, Dr. Hartman designed and implemented survey techniques and econometric models to measure the size of the relevant markets and market power within those markets.

1992-1993: In a proceeding before the International Trade Commission, Dr. Hartman critiqued ITC econometric methods used for estimating elasticities of demand, supply and substitution among domestic and imported products. His focus was selected steel products. He formulated and estimated alternative models and methods to improve the existing estimates. He developed presentation materials for the Commission and testified before the Commission. His testimony is included in

LECG, Petitioners' Economic Testimony in the Matter of Certain Carbon Steel Flat Products, Final Hearing before the United States International Trade Commission, June 29-30, 1993; and

LECG, Petitioners' Post Hearing Brief in the Matter of Certain Carbon Steel Flat Products, before the United States International Trade Commission, July 7, 1993.

1992-1997: Working for the World Bank, Dr. Hartman has designed and is currently implementing a set of regional econometric/engineering models that accurately portray and predict the economic, environmental, infrastructural and socio-demographic effects of large-scale, World-Bank-funded infrastructural projects. The models combine input-output and econometric methods.

Given the Bank experience that many of their financially-sponsored projects create significant

unanticipated environmental effects, the models are designed to be broad and comprehensive enough to incorporate and predict all important effects. The models systematically characterize the relationship between resource-based economic growth and the regional environment in which that growth occurs.

The models are currently being implemented for assessing project developments in the Carajas region of the Brazilian Amazonian rain forest, which is a large, dynamic and ecologically sensitive frontier area. The methods implemented for Brazil will be generalized for analysis of economic growth in ecologically similar areas, such as the Lake Baikal region of the former Soviet Union.

1993-1994: Working for the Commonwealth of the Northern Mariana Islands, Dr. Hartman developed and presented testimony rebutting a complaint by the United States Department of Justice that the Public School System of the Commonwealth practiced employment discrimination against teachers of Filipino and native Carolinian origin. Dr. Hartman's testimony examined both hiring and compensation practices. His testimony included hedonic regression analysis of the market for public school teachers in the islands. This analysis measured how teacher attributes and qualifications determined teacher salaries and hiring. The results of the analysis indicated that salary differentials resulted from differences in teacher qualifications rather than discrimination.

1993-Present: Working either as the testifying expert or supporting other testifying experts, Dr. Hartman has participated in a variety of patent infringement cases. He has developed, supported and estimated alternative theories and measures of damages for manufacturers of coaxial cable, a variety of alternative medical devices and several generic drug manufacturers.

1993-1998: Working as the testifying expert, Dr. Hartman developed models estimating the damages to the business of a construction general contractor that were caused by the malicious prosecution of the contractor's insurance company.

1994: Working for the United States Wheat Associates in a proceeding before the ITC, Dr. Hartman designed and implemented an econometric study to assess and quantify the extent to which Canadian Wheat Board imports into the U.S. undersold domestic supplies and thereby materially interfered with the United States Department of Agriculture Wheat Program. The econometric study was hedonic. The study measured how non-price attributes are valued in U.S. wheat markets. The non-price attributes analyzed included such things as protein content, shipment defects, moisture content and a number of end-use performance characteristics. Having measured the value of these attributes in U.S. markets, the analysis indicated how the Canadian Wheat Board fixed import prices below market levels, given the attributes of the imported wheat.

1994: Working as a testifying expert for Gallo Wines in a proceeding before the ITC, Dr. Hartman designed and implemented a statistical study of the US wine industry that analyzed the impacts of Chilean wine imports upon the domestic industry that would result from the inclusion of Chile in a Free Trade Agreement with the US.

1994: Working as a testifying expert for an insurer of a member of the Asbestos Claims Facility and Center for Claims Resolution, Dr. Hartman developed a statistical analysis estimating alternative indemnification liabilities expected under the Settlement Share Analysis of the Center for Claims Resolution and under the tort system. The results were used to make strategic decisions regarding the desirability of participating in the Class Action Settlement relative to litigating the claims.

1994: Working for several regional Bell Operating companies, Dr. Hartman has developed models and survey procedures to analyze and quantify the determinants of demand for local services, long-distance

services and PCS services. The models quantify how consumers respond to and select among alternative carriers who differentiate their services by performance attributes and vendor reputation. The models also estimate the level of service demand, conditional upon the selection of service vendor. The models are being used to quantify the nature of competition among local carriers and long-distance carriers in the Intralata market. The models are also being used to help develop bidding strategies for specific RBOCs as they participate in the FCC auctions for the PCS spectra.

1995: Working as a testifying expert for a group of independent television stations and program producers, Dr. Hartman developed an econometric analysis of the impacts of the Prime Time Access Rule (PTAR) upon the economic performance of independent television stations. The analysis was submitted to the Federal Communications Commissions as part of their consideration of the repeal of the Rule. Dr. Hartman's analysis proved that PTAR had a strong, statistically significant effect upon the economic performance of these stations, and that its repeal would adversely impact them.

His testimony is included in

The Economic Effects of Repealing the Prime Time Access Rule: Impact on Broadcasting Markets and the Syndicated Program Market, Report prepared by LECG and presented before the Federal Communications Commission, MM Docket No. 94-123, March 7, 1995.

1995: Working for a big six accounting firm, Dr. Hartman designed and implemented a hedonic regression analysis to calculate transfer prices under the comparable uncontrolled price (CUP) method. The analysis is discussed in

"The Use of Regression Techniques in Transfer Price Analysis," with Delores Wright and J.D. Opdyke, *European Taxation,* 1996.

1995-1996: Working as the testifying expert for a major high tech firm in New England, Dr. Hartman has developed rebuttal and affirmative testimony to rebut claims of age discrimination in the termination of a group of employees over forty. His rebuttal testimony involved critically reviewing statistical analyses purporting to demonstrate disparate treatment and disparate impact. His affirmative testimony has involved designing and implementing econometric models to identify and estimate those factors actually determining the compensation and termination decisions of the defendant.

1995-1996: Working as the testifying expert for the Office of Attorney General of the State of Massachusetts, Dr. Hartman has analyzed and helped develop the State's positions on the following issues: restructuring the electric utility industry in Massachusetts and New England; regulating those entities in the restructured industry that will remain subject to regulation; and valuing those assets that may be stranded as a result of restructuring. As part of the effort, Dr. Hartman also critically reviewed the restructuring proposals of the largest utilities in the state. His testimony appears in

"The Market for Power in New England: The Competitive Implications of Restructuring," a report prepared for the Office of the Attorney General, Commonwealth of Massachusetts and submitted February 16, 1996 in support of their filing to the Department of Public Utilities as part of DPU 95-30, which was initiated August 15, 1995.

1995-1996: Working as the testifying expert, Dr. Hartman represented Florida Power Corporation in a contract dispute with Independent Power Producers. His analysis and testimony focused upon issues of damages incurred as a result of a breach of contract.

1995-1999: Working with a team of economists, Dr. Hartman represented the group of wholesalers in the retail prescription drug price fixing conspiracy case. His efforts included industry analysis and participation in cross examination of plaintiffs' experts.

1996: Working as the testifying expert for the Division of Public Utilities of the State of Rhode Island, Dr. Hartman has analyzed and helped develop the State's positions on restructuring the electric utility industry in Rhode Island and New England, for both the State's Public Utilities Commission and the FERC. As part of the effort, Dr. Hartman also critically reviewed the restructuring proposals of some of the utilities in the state. His testimony appears in

> "The Division Plan to Restructure the Electric Utility Industry in Rhode Island," Volume 2 of Supporting Testimony to the State of Rhode Island and Providence Plantations Public Utilities Commission, in re: Electric Industry Restructuring, Docket 2320, April 12, 1996.

1996: Working with a team of engineering firms, an international investment banking firm, a big six accounting firm and several national law firms, Dr. Hartman developed models of demand, supply and futures markets in restructured electric power markets to assist a major industry participant in evaluating specific alternative acquisition strategies.

1996: Working with a team of economists developing evidence for presentation before the High Court of New Zealand, Dr. Hartman critically reviewed and rebutted a variety of econometric analyses of natural gas markets and more broadly-defined energy markets in New Zealand. These analyses were used to determine the size of antitrust markets for a variety of energy products.

1996: Dr. Hartman was retained by a major mid-west utility to critically review and rebut analyses and evidence presented before the FERC and the relevant State Commissions concerning the competitive impacts of the proposed Primergy merger.

1996-2003: Working as the testifying expert, Dr. Hartman analyzed the employment practices and procedures of the Florida Power Corporation during a reduction in force, to assess the validity of a complaint that those practices and procedures resulted in a pattern of age discrimination. In his testimony, Dr. Hartman implemented a variety of statistical and econometric analyses to address and quantify claims of disparate impact and disparate treatment.

1996-1997: Working for US Airways with a team of economists, Dr. Hartman specified and estimated a variety of econometric consumer choice models to measure customer preferences for the services of alternative air carriers in a cross section of US-European origin-destination markets. The models were used to evaluate the economic impacts of both the proposed alliance between American Airlines and British Airways and alternative proposals to condition that alliance.

1996-1997: Working as the testifying expert, Dr. Hartman represented a major national retail pharmaceuticals wholesaler in litigation brought by a regional distributor alleging monopolization of wholesale services to distinct classes of trade. His analysis addressed market definition, the analysis of competition generally and analysis of the competitive impact of specific contractual arrangements.

1997: Working with a team of experts, Dr. Hartman analyzed economic impacts of the construction of the Warrior Run Cogeneration plant which was under construction in Western Maryland and was contracted to sell power to Allegheny Power System's (APS) Maryland subsidiary, Potomac Edison.

1997: Working as the testifying expert for the Office of Ratepayer Advocates of the California Public Utilities Commission, Dr. Hartman critically reviewed the efficiencies estimated by Applicants to be induced by the proposed merger of Pacific Enterprises and Enova Corporation.

1997: Working with a team of economists, Dr. Hartman prepared affirmative and rebuttal testimony in a breach of contract matter in the pharmaceutical industry arbitrated before the International Chamber of Commerce.

1997-2000: Working as the testifying expert, Dr. Hartman developed analysis supporting certification of class and estimation of damages for the class of purchasers of thermal fax paper in the US over the period 1990-1992 who were damaged as a result of a price fixing conspiracy by major suppliers.

1998: Working as the testifying expert, Dr. Hartman analyzed the employment practices, procedures and personnel data of the Florida Power Corporation, in general and in particular, to assess the validity of a complaint that a specific employee had been subjected to racial discrimination.

1998-1999: Working with a team of economists for the Office of the Attorney General of the State of Massachusetts, Dr. Hartman developed and implemented econometric models to analyze and measure the health care costs arising under the Medicaid program that have been attributable to smoking. The analysis appears in the following documents:

> David M. Cutler, Arnold M. Epstein, Richard G. Frank, Raymond S. Hartman, Charles King and Joseph P, Newhouse, *The Impact of Smoking on Medicaid Spending in Massachusetts: 1970-1998 -- Report on Methods*, June 15, 1998;
>
> David M. Cutler, *et. al., The Impact of Smoking on Medicaid Spending in Massachusetts: 1970-1998 -- Results From The Inclusive Approach for Adults*, July 1, 1998;
>
> David M. Cutler, *et. al., The Impact of Smoking on Medicaid Spending in Massachusetts: 1991-1998 -- Results From The Disease-Specific Approach for Adults and Overall Summary*, July 11, 1998.

Drawing upon these efforts, Dr. Hartman worked with the same team of experts to analyze the economic impacts of the Master Settlement Agreement and to present their findings to the Tobacco Fee Arbitration Panel.

1999: Working as one of two testifying experts for the Office of the Attorney General of the Commonwealth of Massachusetts, Dr. Hartman critically analyzed potential rate increases relevant to Joint Petitions introduced by both Eastern Enterprises/Colonial Gas Company and Boston Edison/Commonwealth Energy Systems. His testimony appears as

> Joint Testimony of Seabron Adamson and Raymond Hartman on Behalf of the Massachusetts Attorney General, in the matter of the Joint Petition of Eastern Enterprises and Colonial Gas Company For Approvals of Merger Pursuant to G.L. c. 164, §§ 96 and 94, DTE 98-128, March 26, 1999.
>
> Joint Testimony of Seabron Adamson and Raymond Hartman on Behalf of the Massachusetts Attorney General, in the matter of the Joint Petition of Boston Edison Company, Cambridge Electric Light Company, Commonwealth Electric Company and Commonwealth Gas Company For Approval of Rate Plan Pursuant to G.L. c. 164, §§ 76 and 94, DTE 99-19, April 30, 1999.

1999-2000: Dr. Hartman was retained by a group of industrial purchasers of copper to develop and implement methods and models to assess liability and measure damages in the matter involving the manipulation of the spot and future prices of copper on the London Metals Exchange by Sumitomo Corporation and Yasuo Hamanaka over the period 1987-1996.

1999-Present: Dr. Hartman consulted with counsel and the testifying expert in the development of data and models needed to certify class and measure damages in a price fixing case involving the manufacturer (Mylan) of generic clorazepate and lorazepam.

1999-2001: Working as the testifying expert, Dr. Hartman analyzed liability arising from a variety of restrictive dealer arrangements implemented by Dentsply International Inc., a U.S. manufacturer of artificial teeth, to foreclose entry by rival manufacturers from the US dental-laboratory dealer network. Dr. Hartman developed and implemented methods to measure damages to the class of dental laboratories that purchased artificial teeth from Dentsply at prices above the competitive prices that would have obtained absent the restrictive dealer arrangements.

1999-2000: Working with a team of economists for the Federal Trade Commission, Dr. Hartman analyzed the pro-competitive and anti-competitive nature of settlement agreements between generic and pioneer drug manufacturers resolving patent infringement litigation arising from certification under Paragraph IV of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act). Particular settlements analyzed include the settlement between Abbott Laboratories and Geneva Pharmaceuticals regarding the drug Hytrin and the settlement between Hoechst Marion Roussel (Aventis) and Andrx Corporation regarding the drug Cardizem.

1999-2000: Working as the testifying expert for the class of purchasers of Nine West shoes, Dr. Hartman was asked to analyze liability and measure damages arising from an alleged conspiracy to raise and maintain the prices of women's shoes manufactured by the Nine West Group Inc. and sold by a variety of general merchandise retailers through their upscale retail department stores. The defendants in the case included Nine West Group Inc., Federated Department Stores, Inc., Dayton Hudson Corporation, Lord and Taylor, Nordstrom, Inc., May Department Stores, Macy's, Bloomingdale's, Inc., and other general merchandise retailers.

2000: Working with the testifying expert, Dr. Hartman assisted in the analysis and estimation of economic damages to a Class defined as all smokers with 20-pack years each of whom contracted lung cancer which was substantially contributed to by cigarette smoking.

2000: Working with a team of economists, Dr. Hartman developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of structural steel beams during the period 1998-1999. The work was presented before the International Trade Commission.

2001: Working with a team of economists, Dr. Hartman developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of structural steel beams and during 2000. He also developed econometric models to analyze and measure the impacts of subject imports, non-subject imports and factor price changes upon the prices of cold rolled and hot rolled steel during the Period of Inquiry of 1997-1999. Both efforts were presented before the International Trade Commission.

2001-2004: Working as the testifying expert, Dr. Hartman developed and submitted testimony in support

of class certification of and the calculation of damages to the class of indirect purchasers of the anti-hypertensive drug, Hytrin, produced by Abbott Laboratories and the generic equivalent of Hytrin, generic terazosin hydrochloride, produced by Geneva Pharmaceuticals. The class alleges monopolization and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act).

2001-Present: Working as consultant and testifying expert, Dr. Hartman has been retained by counsel to the classes of indirect or direct purchasers of a variety of branded pharmaceuticals (including but not limited to Augmentin, Bextra, Cipro (New York, California, U.S.), BuSpar, Celebrex, Vioxx, K-Dur, Taxol, Lupron, Relafen, Paxil, Neurontin, Remeron, Ditropan, Tamoxifen, Premarin, Wellbutrin and Zyprexa) to analyze and submit testimony dealing with class certification, liability, market definition, damage calculations and settlement allocations arising from violations of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act), related state-specific unfair competition statutes and the RICO Act.

Dr. Hartman's testimony in this area has been relied upon (and cited thereto) for certification of end-payer consumer classes in the following matters:

- *In re: Terazosin Hydrochloride Antitrust Litigation*, United States District Court, Southern District of Florida, Case No. 99-MDL-1317-Seitz/Klein [Order Granting Indirect Purchaser Plaintiffs' Motions for Class Certification of State-Wide Classes, April 8, 2004]
- *In re Cipro Cases I and II*, D043543 (JCCP Nos. 4154, 4220), Court of Appeal, Fourth Appellate District, Division One, State of California [Decision affirming class certification not titled but marked as "Not to Be Published in Official Reports," Filed 7/21/04]
- *In re: Relafen Antitrust Litigation*, United States District Court, District of Massachusetts, Master File No. 01-12239-WGY [Memorandum granting certification for an exemplar class, May 12, 2004]
- *In re Pharmaceutical Industry Average Wholesale Price Litigation,* United States District Court for the District of Massachusetts, MDL, No. 1456, Civil Action: 01-CV-12257-PBS.
- *New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund, District Council 37, AFSCME - Health & Security Plan; June Swan; Maureen Cowie And Bernard Gorter v. First Databank, Inc., and McKesson Corporation*, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS.

Dr. Hartman's testimony has been relied upon (and cited as necessary) for approval of proposed settlement allocations in the following matters:

- *In re: Lupron® Marketing and Sales Practices Litigation*, United States District Court, District of Massachusetts, MDL No. 1430, Master File No. 01-CV-10861-RGS [Memorandum and Order Approving Settlement and Certifying the Class, May 12, 2005]
- *HIP Health Plan of Florida, Inc., On Behalf of Itself and All Others Similarly Situated v. Bristol-Myers Squibb Co. and American Bioscience,* Case Number 1:01CV01295, United States District Court for the District of Columbia
- *In re Buspirone Antitrust Litigation*, MDL No. 1413, United States District Court for

the Southern District of New York

- *In re Relafen Antitrust Litigation*, United States District Court, District of Massachusetts, Master File No. 01-CV-12222-WGY
- *In re Remeron Antitrust Litigation*, United States District Court, District of New Jersey, Master Docket No. 02-CV-2007

2001: Working as consultant to counsel for various U.S. steel producers, Dr. Hartman worked with a team of economists to develop econometric models to analyze and measure the impacts of imports, demand and factor price changes upon the prices of domestically produced carbon steel flat products and carbon steel long products in the Section 201 hearings before the International Trade Commission. Dr. Hartman testified before the ITC in the hearings. The Commission decided in favor of most of the products subject to these analyses.

2001: Working as consultant to counsel for Nucor Steel Corporation, Dr. Hartman worked with a team of economists to develop econometric models to analyze and measure the impacts of imports, demand and factor price changes upon the prices of domestically produced carbon steel cold rolled products for preliminary hearings before the International Trade Commission.

2001-2002: Consulting to counsel for the Plaintiff Class, Dr. Hartman analyzed the targeting of youth by cigarette advertisements in the matter *in re Devin Daniels, et. al., v. Philip Morris Companies, Inc., et. al.,* Case Number 719446, coordinated with JCCP 4042.

2001-2003: Working as testifying expert, Dr. Hartman developed and presented statistical evidence analyzing the relative performance of a particular cardiovascular surgeon litigating the fact that his surgical privileges had been revoked as a result of incompetent surgical performance and results. He testified before an arbitration panel in the matter.

2003: Working as the testifying expert for Defendants, Dr. Hartman submitted testimony analyzing the allegation of racial discrimination on the part of Wells Fargo Home Mortgage, Inc. and Norwest Mortgage, Inc.

2003: Working as a consulting expert to counsel for the class of purchasers of graphite electrodes, Dr. Hartman developed econometric models to assess the impact of alleged antitrust violations.

2003: Working as a consulting expert for counsel to the class of direct purchasers, Dr. Hartman reviewed materials in a matter regarding antitrust allegations concerning the manufacture and sale of microcrystalline cellulose in the United States.

2003: Working as a consulting expert to counsel for a large electrical generation company, Dr. Hartman developed economic and econometric models to analyze the allegation that this electrical generation company participated in a conspiracy to manipulate prices of power sold in California.

2003: Working as the testifying expert, Dr. Hartman submitted testimony which analyzed and calculated the economic impacts and damages to the U.S. growers and quota holders of flue-cured and burley tobacco leaf caused by a price-fixing conspiracy among the major U.S. tobacco leaf buyers and cigarette manufacturers. The $1.4 billion settlement ultimately reached in the matter was the second highest antitrust settlement in history.

2004: Working as the consulting expert for the United States Department of Justice, Dr. Hartman critically analyzed the calculation of the economic damages borne by an electric power generation utility as a result of the breach of the Standard Contract with the U.S. Department of Energy to remove spent nuclear fuel in 1998. Dr. Hartman's analysis included a critical review and rebuttal of the models and data put forward by the utility's experts in the calculation of damages; the development and presentation of alternative and improved models and corrected data to more accurately calculate damages; a critical review of econometric analyses put forward by one of the utility's experts; and a review of the economics of re-licensing existing nuclear generating facilities.

2004: Working as the testifying expert, Dr. Hartman submitted testimony in support of the certification of the class of purchasers of electrical carbon products who have been alleged to have been impacted and injured economically as a result of a price-fixing customer-allocation conspiracy of the major suppliers of such products in the United States.

2004-Present: Working as the testifying expert, Dr. Hartman submitted testimony in deposition and at trial in support of the certification of the class of end payer purchasers of those pharmaceutical products produced by AstraZeneca, the Bristol Myers Squibb Group, the Johnson and Johnson Group, the Glaxo-Smith-Kline Group and the Schering Plough Group that were subject to an alleged scheme to fraudulently inflate their Average Wholesale Price (AWP), thereby fraudulently inflating the reimbursement rates paid by the Class members for those pharmaceuticals when their reimbursement rates were formulaically related to the AWP. Dr. Hartman developed, implemented and presented at trial a theory of causation and under that theory calculated damages to the relevant indirect purchaser classes. The District Court and Appellate Court found in favor of Plaintiffs. Dr. Hartman has consulted and continues to consult and/or submit testimony on appeals and on related litigation undertaken by the Offices of the Attorneys General for the Medicaid Agencies of the states of New York, Connecticut, Arizona, Nevada, Montana, Texas, Pennsylvania and the Commonwealth of Massachusetts.

2004-2005: Working as a consulting expert to counsel for a major electricity and gas utility holding company, Dr. Hartman developed models to evaluate allegations of affiliate abuse by the regulated gas distribution entities and the trading entities of the holding company. The alleged abuses concerned spot and forward gas markets in California.

2005: Working as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the TVA for monetary damages alleged to have resulted from partial breach by the U.S. Department of Energy of the Standard Contract to remove spent nuclear fuel from TVA beginning in 2002. Dr. Hartman's analysis included a critical review and rebuttal of the models, data and cost analyses put forward by the utility and the development and implementation of alternative and improved models and corrected data to more accurately calculate costs attributable to the alleged partial breach.

2005-2007: Working again as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the Systems Fuel Inc., a subsidiary of Entergy, for monetary damages alleged to have resulted from partial breach by the U.S. Department of Energy of the Standard Contract to remove spent nuclear fuel from SFI facilities in Mississippi and Arkansas. Dr. Hartman's analysis has included a critical review and rebuttal of the SFI models, data and cost analyses put forward by the utilities and the development and implementation of alternative and improved models and corrected data to more accurately calculate costs attributable to the alleged partial breach.

2005-2010: Working as one of two testifying experts, Dr. Hartman submitted testimony calculating

monetary damages caused by the allegedly fraudulent promotion of the drug Neurontin for indications that were not approved by the FDA (off-label promotion). As part of his analysis, he consulted on the estimation of the econometric models calculating those prescriptions induced by the off-label promotion. His testimony has been submitted in the MDL and Pennsylvania matters. He has testified at trial in this matter.

2006: Working as the testifying witness for counsel to the named plaintiffs and the class, Dr. Hartman submitted testimony in support of certification of the Indirect Purchasers of the drug Ditropan.

2006-Present: Working as the testifying expert, Dr. Hartman has submitted testimony supporting class certification, liability and calculating damages resulting from an alleged conspiracy between McKesson and First Data Bank to inflate prices paid for a broad spectrum of brand name drugs by manipulating the list prices of those drugs (AWPs and WACs). Once class was certified and damages calculated, Dr. Hartman submitted testimony analyzing and supporting several proposed settlements to the litigation. Dr. Hartman is currently extending his analysis to state AG litigation, to assist those AGs to recover the overcharge damages paid on Medicaid reimbursement as a result of the conspiracy, as well as reimbursement by other governmental agencies.

2007-Present: Working as a consulting expert, Dr. Hartman worked with a team of economists estimating econometric models to analyze and quantify the extent to which allegedly illegal off-label promotion by the manufacturer of the drug Zyprexa caused increases in the amount of Zyprexa prescribed and sold.

2008: Working as the testifying expert, Dr. Hartman submitted testimony supporting certification of and calculation of damages for by the class of users of and payers for the drug Bextra as a result of fraudulent marketing activities and fraudulent clinical representations made by the drug's developers and/or manufacturers (defendants Pharmacia, Pfizer, and Searle).

2008-2009: Working as the testifying expert for the named plaintiffs and the class, Dr. Hartman submitted testimony in support of class certification for the indirect purchasers of the drug Estratest, which was marketed and promoted by its manufacturer Solvay for hormone replacement therapy, despite the fact that it had received no FDA approval to do so even though Solvay had actively sought FDA approval and repeatedly made applications to the FDA for decades.

2008-2009: Working as the testifying expert for the United States Department of Justice, Dr. Hartman developed models to critically analyze the cost submissions to the U.S. Court of Federal Claims by the Energy Northwest. Dr. Hartman's analysis focused upon correct procedures to analyze cost effective responses in the actual world to DOE delays in taking spent nuclear fuel.

2009: Working as the testifying expert for a large health insurer, Dr. Hartman critically assessed whether providers submitted claims in excess of what was allowed under Medicare reimbursement practices and procedures.

2009-2010: Working as one of two testifying experts, Dr. Hartman submitted testimony analyzing liability and calculating monetary damages caused by the allegedly fraudulent promotion of the anti-psychotic drug Risperdal for indications that were not approved by the FDA (off-label promotion). As part of his analysis and testimony, he estimated and presented econometric models calculating those prescriptions induced by the off-label promotion.

2010-Present: Working as a testifying expert, Dr. Hartman developed and submitted testimony in support of class certification, calculation of damages and market definition for the class of indirect purchasers of Provigil.

The class alleges monopolization and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act) to foreclose generic entry.

2010-Present: Working as a testifying expert, Dr. Hartman developed and submitted testimony in support of class certification, calculation of damages and market definition for the class of indirect purchasers of Toprol XL and metoprolol succinate. The class alleges unlawful double patenting and violation of the Hatch Waxman Act (Drug Price Competition and Patent Term Restoration Act) to foreclose generic entry.

RAYMOND S. HARTMAN
RECENT APPEARANCES AT DEPOSITION AND TRIAL

2003

In re Terazosin Hydrochloride Antitrust Litigation, Case No. 99-MDL-1317 Seitz/Garber, consolidated, United States District Court for the Southern District of Florida, (deposition)

Anne Cunningham and Norman Mermelstein, Individually and on Behalf of all Others Similarly Situated, v. Bayer AG, Bayer Corporation, Barr Laboratories, Inc, The Rugby Group, Inc., Watson Pharmaceuticals, Inc. and Hoechst Marion Roussel, Inc., Index No. 603820-00, Supreme Court of the State of New York, County of New York (deposition)

In re Ciprofloxacin Hydrochloride Antitrust Litigation, Master File No. 1:00-MD-1383, United States District Court for the Eastern District of New York. (deposition)

Cipro Cases I and II, Judicial Council Coordination Proceeding Nos. 4154 and 4220 (Superior Court, San Diego County) (depositions)

In re Relafen Antitrust Litigation, United States District Court, District of Massachusetts, Master File No. 01-CV-12222-WGY (deposition)

Dr. Gregory Derderian, et. al., Plaintiffs, v Genesys Health Care Systems, et. al., Defendants, Case No. 99-64922-CK, State of Michigan, Circuit Court for the County of Genesee (testimony before arbitration panel)

In re D. Lamar DeLoach, et. al., Plaintiffs, v. Philip Morris Companies, Inc., et. al., Defendants, in the United States District Court for the Middle District of North Carolina, Greensboro Division, Case No. 00-CV-1235 (deposition)

2004

In re Ciprofloxacin Hydrochloride Antitrust Litigation, Master File No. 1:00-MD-1383, United States District Court for the Eastern District of New York (deposition)

In re Lupron Marketing and Sales Practices Litigation, MDL No. 1430, CA No. 01-CV-10861, United States District Court, District of Massachusetts (deposition)

In re Pharmaceutical Industry Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, MDL, No. 1456, CIVIL ACTION: 01-CV-12257-PBS (deposition)

2005

In re Lupron Marketing and Sales Practices Litigation, MDL No. 1430, CA No. 01-CV-10861, United States District Court, District of Massachusetts, (trial)

In re Tennessee Valley Authority, Plaintiff v. United States, Defendant, United States Court of Federal Claims, No. 01-249-C, (deposition, trial)

Lynne A. Carnegie v. Household International, Inc., Household Bank, f.s.b., successor in interest to Beneficial National Bank, Household Tax Masters Inc., formerly known as Beneficial Tax Masters, Inc., Beneficial Franchise Company, Inc., H&R Block, Inc., H&R Block Services, Inc., H&R Block Tax Services, Inc., H&R Block Eastern Tax Services, Inc., Block Financial Corp. and HRB Royalty, Inc., No. 98 C 2178, United States District Court for the Northern District of Illinois Eastern Division, (deposition)

2006

In re Pharmaceutical Industry Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, MDL, No. 1456, Civil Action: 01-CV-12257-PBS (deposition; deposition in related matters for the State of Montana and the State of Nevada; trial)

State of Connecticut v. Dey, Inc., Roxanne Laboratories, Inc., Warrick Pharmaceuticals Corp., Schering-Plough Corp. and Schering Corporation; *State of Connecticut v. Pharmacia Corp.*, and *State of Connecticut v. Glaxo Smithkline et al*., Superior Court, Complex Litigation Docket at Tolland, Docket Nos. X07 CV-03-0083297-S, X07 CV-03-0083298-S, X07 CV-03-0083299-S (deposition)

System Fuels, Inc., on its own behalf and as agent for System Energy Resources, Inc. and South Mississippi Electric Power Association, Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 03-2624C (deposition)

New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund v. First Databank, Inc., and McKesson Corporation, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS (deposition)

In re Express Scripts, Inc., PBM Litigation, United States District Court Eastern District of Missouri Eastern Division, Master Case No. 4:05-md-01672-SNL (deposition)

In re Prempro Products Liability Litigation, in the United States District Court for the Eastern District of Arkansas, Western Division, MDL Docket # 4:03CV1507WRW; *In re Hormone Therapy Litigation*, in the Court of Common Pleas Philadelphia County, November 2003, #00001 (deposition)

In re: Neurontin Marketing and Sales Practices Litigation, MDL Docket No. 1629, Master File No. 04-10981, United States District Court, District of Massachusetts (deposition)

System Fuels, Inc., on its own behalf and as agent for Entergy Arkansas Inc., Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 2623C (deposition)

2007

System Fuels, Inc., on its own behalf and as agent for System Energy Resources, Inc. and South Mississippi Electric Power Association, Plaintiff, v. The United States, Defendant, in the United States Court of Federal Claims, No. 03-2624C (trial)

New England Carpenters Health Benefits Fund; Pirelli Armstrong Retiree Medical Benefits Trust; Teamsters Health & Welfare Fund of Philadelphia and Vicinity; and Philadelphia Federation of Teachers Health and Welfare Fund v. First Databank, Inc., and McKesson Corporation, United States District Court District of Massachusetts, C.A. No. 1:05-CV-11148-PBS (video taped tutorial)

2008

Energy Northwest v. The United States, United States Court of Federal Claims, No. 04-10C (deposition)

The Commonwealth of Massachusetts v. Mylan Laboratories, et al., United States District Court for the District of Massachusetts, Civil Action No. 03-CV-11865-PBS (deposition)

Susannah K. Alexander, Individually and on Behalf of all Others Similarly Situated, Plaintiffs, v. Solvay Pharmaceuticals, Inc., et al., Defendants, Superior Court of the State of California, County of Los Angeles, Case Number BC300364 (deposition)

Gregory Clark and Linda Meashey, individually and on behalf of others similarly situated v. Pfizer Inc., and Warner-Lambert Company, LLC, No. 01819, Philadelphia County Court of Common Pleas (deposition)

2009

Energy Northwest v. The United States, United States Court of Federal Claims, No. 04-10C (trial)

In re: Neurontin Marketing and Sales Practices Litigation, MDL Docket No. 1629, Master File No. 04-10981, United States District Court, District of Massachusetts (deposition)

The State of Texas ex. rel. & Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Sandoz Inc., et.al., Mylan Pharmaceuticals Inc., et.al., and Teva Pharmaceuticals U.S.A. Inc., et.al., Defendants, Cause No. D-1-GV-07-001259, in the District Court of Travis County, Texas, 201st Judicial District (deposition)

In re Charles Foti, Attorney General ex rel, State of Louisiana v. Janssen Pharmaceutica, Inc., et al., 27th Judicial District Court, Parish of St. Landry, Docket No. 04-C-3967-D (deposition)

2010

In re: Neurontin Marketing, Sales Practice, and Products Liability Litigation, The Guardian Life Insurance Company of America v. Pfizer Inc., MDL Docket No. 1629, Master File No. 04-10981, 04 CV 10739 (PBS), United States District Court for the District of Massachusetts (trial)

In re: SmithKline Beecham Corporation, SmithKline Beecham, p.l.c., and Beecham Group, p.l.c., v. Apotex Corporation, Apotex Inc. and TorPharm, Inc., v. SmithKline Beecham Corporation, SmithKline Beecham, p.l.c., Beecham Group, p.l.c., Pentech Pharmaceuticals, Inc. and Par Pharmaceuticals, Inc., United States District Court for the Eastern District of Pennsylvania, CA No. 00-CV-4304 (deposition)

In re: The State of Texas ex. rel. Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Alpharma USPD f/k/a Barre-National, Inc., et al., Cause No. D-1-GV-08-001566, in the District Court of Travis County, Texas, 419th Judicial District (2 depositions)

In re: McKesson Governmental Entities Average Wholesale Price Litigation, United States District Court for the District of Massachusetts, Case No. 1:08-CV-10843-PBS (deposition)

The Commonwealth of Massachusetts v. Mylan Laboratories, et al., United States District Court for the District of Massachusetts, Civil Action No. 03-CV-11865-PBS (evidentiary hearing (July) and trial (September))

2011

The State of Texas ex. rel. & Ven-a-Care of the Florida Keys, Inc., Plaintiffs, v. Alpharma USPD f/k/a Barre-National, Inc., et. al, Cause No. D-1-GV-08-001566, in the District Court of Travis County, Texas, 419th Judicial District (trial).

United States of America ex rel. Kassie Westmoreland v. Amgen Inc., United States District Court for the District of Massachusetts, Civil Action No. 06-10972-WGY (deposition)

In Re: Metoprolol Succinate End-Payor Antitrust Litigation, United States District Court for the District of Delaware, CA No. 06-71 GMS (deposition).

Vista HealthPlan Inc., et. al., Plaintiffs v. Cephalon, Inc., et. al., Defendants, In the United States District Court for the Eastern District of Pennsylvania, CA No. 06-CV-01833 (deposition).

2012

Toyota Motor Corp. Unintended Acceleration Marketing, Sales Practices, and Products Liability Litigation, Case No. 8:10-ml-02151-JVS (C.D. Cal) (deposition).