The Wisdom of Socrates and the Statistically Based Knowledge Underlying Public Policy

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> *Well I am certainly wiser than this man. It is only too likely that neither of us has any knowledge to boast of; but he thinks that he knows something which he does not know, whereas I am quite conscious of my ignorance. At any rate it seems that I am wiser than he is to this small extent, that I do not think that I know what I do not know* (Socrates).

The statistical tendency to find what the investigator is looking for is well known among econometricians. Gregory Mankiw (1995, p. 304) discussed this in the context of "The Growth of Nations," observing that multicollinearity – correlation among the explanatory variables – confounds efforts to pin down the causal variables in explaining why some nations achieve faster economic growth than others. Mankiw explains that multiple regression fails to deal well with the multicollinearity problem even though, in theory, it might under certain special conditions, especially including the condition that unexplained residual discrepancies among observations are not correlated with each other (1995, p. 204). For example, the growth experience of the United States and of Canada might plausibly involve highly correlated unexplained residuals and the regression results therefore might include standard errors that greatly exaggerate the statistical significance of the coefficients estimated for the included variables (p. 305). If some variable such as, for example, education, is poorly measured, then another variable such as capital accumulation that correlates with the poorly measured variable will end up with a much higher coefficient than its impact on the dependent variable actually merits (Mankiw, 1995, p. 205). Accumulating machines will seem to be causing growth because it is actually indicating the rising level of, for instance, computer literacy of various countries' labor forces. A less developed country trying to accumulate machines without educating its labor force might

subsequently harvest the fruits of this regression error by experiencing a disappointing lack of resulting economic growth.

While Mankiw discusses the difficulty of determining the significance of education in promoting a nation's economic growth, other investigators have employed regression analysis to probe the impact of college education on an individual's subsequent lifetime earnings. George Psacharopoulos (1977, pp. 321-335), using a 1972 sample of British males, uses regression analysis to reach a conclusion only slightly different from Jencks' conclusions that Psacharopoulos characterizes as "widely cited around the world" (p. 321). Christopher Jencks (1972) had previously used U.S. 1962 Current Population Survey data (p. 321) to arrive at the conclusion that "efforts to keep everyone in school longer make little economic sense … the average rate of return for postsecondary education is quite low." (p. 225) Adjusting income differences between poorly and well educated males for initial test scores and family background reduces the education attributed income difference by about 40%, Jencks reports (1972, p. 222).

Multicollinearity confounds efforts to isolate education's income increasing effect, ceteris paribus, because it correlates highly with other variables that one might rightly include in a regression model. If years of school completed are included along with IQ, income of parents, income of spouse, etc., the identification of the particular effect of education alone fades, leaving the impression that maybe college graduates earn more because they had higher IQs to begin with. Apparent breakthroughs in overcoming this problem were published by Taubman (1976), Behrman, Pollak, and Taubman (1982), and, later, by Ashenfelter and Krueger (1994) and by Miller, Mulvey, and Martin (1995) and by various others who all confined their regression studies to samples of identical twins. The initial impression gained from such identical twin studies was that education explained a rather small fraction of the difference between the average earnings of college graduates and the average earnings of high school graduates. Taubman (1976) explained that his twins sample showed that roughly two thirds of the earnings difference might be due to attributes that the college graduate actually possessed upon entering college, rather than whatever it was that the college graduate had gained in college (Taubman, 1976, abstract). Taubman first treated his sample of twins as a sample of unrelated individuals and regressed annual earnings on years of schooling (and age). He then regressed, for the pairs of identical twins, the pair wise difference in earnings on the pair wise difference in years of schooling and found schooling to show only one third as large an impact on earnings (Taubman, 1976, pp. 453-454). Taubman concluded that years of schooling shows a lower impact because differences in IQ, family background, and other ability related variables have not confounded the estimate in the pair wise comparison of the identical twins, while these omitted variables have greatly biased the results in the regressions that do not make pair wise comparisons.

Finally, in 1994, Ashenfelter and Krueger studied a new sample of twins that they obtained from attending the 16th annual twins day festival in Twinsburg, Ohio. Using regression methods similar to those used by Behrman, Hrubeck, Taubman, and Wales (1980), they note that Behrman, et al., obtain an estimate of the

return to schooling only about 40% as large as Ashenfelter and Krueger get (1994, p. 1165). However, Ashenfelter and Krueger emphasize the fact that the education differences between identical twins tend to be poorly measured. In many of the pairs Ashenfelter and Krueger survey, one twin had reported a different pair of schooling numbers for him or herself and his or her sibling, than the other twin had reported. The simple correction of averaging the two sets of numbers reported separately by the two twins significantly reduced the apparent measurement error. When Ashenfelter and Krueger try various error reduction strategies, they find that a pair wise comparison of twins' earnings and twins' schooling shows a greater impact of schooling rather than a smaller impact (Ashenfelter and Krueger, 1994, p. 1165). Further efforts, such as using schooling amounts reported by the other twin for each twin rather than his or her own reported amount and regressing only the first differences in income and this cross-reported educational attainment, showed that most of the income differences were attributable to education alone. The importance of non-education variables emphasized by Taubman (and by Behrman, et. al.) evaporated as Ashenfelter and Krueger refined their methods so that most of the difference in earnings between a college graduate and a high school graduate could be seen proportionately between two identical twins when their amounts of educational attainment were used as the main explanatory variable and appropriate efforts to correct for measurement errors were employed. Miller, Mulvey, and Martin (1995) subsequently showed how a substantially larger sample of Australian twins supported contrasting conclusions depending on whether errors in measuring the amounts of schooling were corrected by means of techniques similar to those used by Ashenfelter and Krueger. When simple ordinary least squares were used following the method Behrman, Taubman, and Wales had reported in 1977, without education measurement error correction, education seemed to explain only about one third of "the overall return to schooling" while ability and shared family environment explained the other two thirds (Miller, et. al., p. 597). However, when error correction techniques like those used by Ashenfelter and Krueger were employed, ability and shared family environment faded away in importance and the impact of schooling alone increased by a factor of two or more than 3, depending on the procedure used (Miller, et. al., 1995, p. 597).

An important contrast between the twins samples may have affected the outcomes of these studies. Taubman (1976) used a sample of only males while Ashenfelter, et. al., and Miller, et. al. both pool males and females together in their samples. If differences in education among female twins stems largely from one dropping out of school due to marriage and the other finishing school and becoming a "career girl," then the statistical results of staying in school longer would seem likely to be dramatically exaggerated. Bonjour, et. al., (2003) perform a subsequent study using a sample of all female twins from the United Kingdom. Using error correction techniques similar to Ashenfelter, et al., they find a return to schooling about half as large as Ashenfelter, et al., but, in addition, ask twins why they differ in amount of schooling. Bonjour, et al. (p. 1809), provoke suspicion of selection bias in which one twin sought to be a housewife and the other a career girl when the authors report that

"the only correlate of within-twin-pair differences in schooling is within-twin-pair differences in age at first marriage." The all female sample may have failed to produce a rate of return estimate as high as Ashenfelter, et. al., because of differences in U.K. female labor market conditions relative to the U.S. regions relevant for the Ohio Twins Festival.

While the multicollinearity problem frustrates efforts to confidently identify the impact of education on earnings or economic growth, a complex and abstract understanding of the limitations of regression is required to perceive that there is even a problem at all. The public at large is easily persuaded by observing that high income correlates strongly with college completion and has been attending college in ever larger numbers; oblivious to the issues raised by Taubman and likeminded others. It is even somewhat surprising that we were given this revelation from academia of a fly in its own ointment to begin with, except that the learned studies revealing it were effectively obscure enough to minimally threaten the rent-seeking instincts of academics.

Gary Koop and Lise Tole (2004, p. 30) consider the relationship between air pollution and health or mortality. First they explain that a perceived large impact on health underlies air pollution mitigating regulations that cost many billions of dollars to comply with and this impact has been inferred from a variety of time series and cohort regression studies (p. 31). They then illustrate the techniques by analyzing a large collection of data from Toronto, Canada. Most studies, they allege, attempt to find a relationship between a health variable such as mortality and a variety of pollution and meteorological variables by regressing the former on the latter (2004, p. 33). Which pollution variables, which meteorological variables, what time lags, and what interaction terms should be included in the model leads to the realization, however, that literally billions of possible model specifications could be considered (2004, p. 33). Koop and Tole show that at least some of these models for their Toronto data will yield significant apparent causal relationships. Perceived causal connections between air pollution variables and mortality are based on a traditional procedure of selecting from among billions of possible models the single one that yields the strongest regression results (or strongest desired results) (p. 33) and the numerous studies underlying public perception simply repeat this procedure over many data sets. However, Koop and Tole explain, and show with their data, that a Bayesian model averaging procedure is really needed to establish a true relationship when the precise specification of the relationship is not known beforehand. Otherwise, the single model, point estimate result is just the product of "data mining" or trying one erroneous specification after another until the misspecification goes strongly in favor of the desired result (p. 31). They then go on to explain that such a procedure, employing their own Toronto data, yields results that indicate a clear inability to dismiss the possibility that no causal connection between air pollution and mortality exist at all and they recommend rejecting the use of studies that find it does as a basis for pollution regulatory policy (Koop and Tole, 2004, pp. 46-47).

Alan Krueger used dummy variable regressions to contend that the use of computers increases a person's wages by 10% to 15% and accounts for between a third and a half of the increase during the

1980s in the rate of return to investing in education (Krueger, 1993, p. 33). Using data from the Current Population Survey (CPS) conducted by the Census Bureau for the Bureau of Labor statistics, a monthly survey of about 50,000 households that is also used for estimating the unemployment rate, Krueger tries including and excluding a variety of dummy variables representing use of a computer at work, use of a computer at home, male, female, married, not married, union, nonunion, specific tasks such as email, computer games, etc. He likewise includes and excludes a computer use dummy in a regression of income on years of schooling completed, first for 1984 and then for 1989, finding that including the dummy reduces the apparent increase in return to education by over 40% when a sample of both men and women from the private sector is studied Krueger, 1993, p. 51). With a variety of subsidiary arguments, Krueger concludes that computer use is the cause of higher earnings and the causality does not run in the opposite direction to any significant extent (Krueger, 1993, pp. 43-51).

John DiNardo and Jorn-Steffen Pischke (1996) construct a spoof of "Krueger's (1993) careful and influential study that finds that the use of a computer at work is associated with a 10-15 percent wage differential" (p. 2). Using data from large cross-sectional samples from Germany (nearly 30,000 observations per sample), DiNardo and Pischke first find similar statistical results for the association between computer usage and income that Krueger (1993) found (1996, p. 2). The more detailed German data, however, enables them to subsequently determine that the use of pencils at work associates with nearly as large and robust an increase in worker wages as does computer usage (DiNardo and Pischke, 1996, p. 2). In fact, their data show that calculator using workers earn 9% to 13% more, telephone users 12% to 14% more, and workers who sit in chairs while working earn 10% more (p. 5). Suspecting that such implements might just identify people with office jobs, they run similar regressions on the use of hand tools such as hammers, screwdrivers or drills and find that these lower one's earnings by about 10% (DiNardo and Pischke, 1996, pp. 5-6). When many of these variables are regressed together, computer usage still retains a significant explanatory role suggesting that pencils or chairs are not merely a proxy for computers (p. 6). Computers, like pencils or chairs, are indicating an unobserved heterogeneity, the authors argue, rather than contributing a great productivity enhancement (p. 10). DiNardo and Pischke (p. 18) feel vindicated by 1994 findings of Sichel and Oliner who concluded that computers contributed much less to productivity growth than Krueger's findings would have led one to expect. Indeed, subsequent revelations by Robert Gordon, McKinsey Global Institute, and Dale Jorgenson suggest that most computer using sectors of the American economy appear to have lagged behind in the productivity growth surge of the second half of the 1990s that explosive growth of the productivity of computer and related product manufacturing alone largely propelled.

So it is in economics as in the other social sciences. Deprived of the ability to conduct laboratory experiments with perfectly controlled conditions, and unable to measure with precision of confidence, data is tortured in hope that it will confess the truth. Economics is a science in transition as the transformation from a liar to a Cassandra. However, other sciences

use statistical analysis as the basis for knowledge. Medicine relies on epidemiological evidence to identify the harmfulness of tobacco smoking and other health risk factors, although double blind studies with placebo taking control groups are generally required to substantiate the effectiveness of treatments with pharmaceuticals. The inability to conduct controlled experiments greatly hinders the field of climatology that likewise bases its findings on statistical inferences. One of the greatest policy issues of our times involves the seemingly well-established theory that the earth is gradually warming do to an increasing amount of anthropogenic carbon dioxide in the atmosphere. Proponents of the global warming hypothesis charge (Solomon, 2008, pp. 2-3) that people who deny the truth of the theory are, as Al Gore puts it, like people who still believe the earth is flat or that Hollywood staged the moon landings on a movie set. Gore, the United Nations, and the media all cast the global warming problem as if identified beyond reasonable dispute.

A recent book that George Gilder (2008) reports became Amazon.com's number 3 bestseller in Canada, examines the contentions of academic and professional experts who nevertheless do deny the validity of the global warming hypothesis. In Solomon's 2008 book, *The Deniers*, Chapter 2 is devoted to Edward Wegman, a member of the Board of the American Statistical Association and a former Chairman of the Committee on Applied and Theoretical Statistics of the National Academy of Sciences, who questions the famous "hockey stick" graph showing the recent unprecedented and explosive rise in global temperatures. Wegman emphasizes that statistical procedures calibrated past global temperature information, often estimated from proxy variables, and aligned it with more recent temperature measurements, also statistically aggregated with many adjustments, to produce the "hockey stick" pattern. When Wegman corrects procedural errors in its statistical underpinnings, the "hockey stick" disappears and the recent apparent warming flattens out so that the data used demonstrates no recent warming at all (Solomon, 2008, p. 16). In Chapter 7, Solomon summarizes Zbigniew Jaworowski's contentions concerning historical data about the earth's atmosphere obtained from air bubbles trapped inside ice cores drilled from glaciers. Over the long periods involved, the carbon dioxide content of the air in the bubbles tends naturally to change so that samples drastically misrepresent the actual carbon dioxide content of the air in the past (Solomon, 2008, p. 99). Apparent recent increases in carbon dioxide levels may be little different from similar anomalies in the past that do not show up now in ice cores. Moreover, Dr. Tom Segalstad questions the widely accepted premise that fossil fuel combustion is raising the percentage of carbon dioxide in the atmosphere (Solomon, 2008, pp. 79-86). The United Nations' IPCC concludes that carbon dioxide has a residence time in the atmosphere of from 50 to 200 years before it is absorbed into the oceans and land. Much relevant knowledge of this residence time comes from statistical analysis of radioisotopes such as carbon 14 and radon gas in the atmosphere and their changes after nuclear explosions and other events that change their amounts. Solomon (pp. 82-83) lists more than three-dozen studies concluding that carbon dioxide has a very short

residence time in the atmosphere – time in the order of 5 to 10 or 15 years. Automobile exhaust emitted into the atmosphere as little as 20 years ago is already absorbed into natural sinks and is no longer up there in the atmosphere any more! This implies that fossil fuel burning cannot account for much of the rise in atmospheric carbon dioxide in the past 100 years and that other processes must be dominating such as warming of the oceans and releases by the land. Warming (due to brightening of the sun) may be causing the atmospheric carbon dioxide percentage change rather than the causality running in the other direction. Indeed, Nir Shaviv, examining statistical evidence, discredits Al Gore's contention that carbon dioxide levels and global temperature have moved together over the past 600,000 years, showing that carbon dioxide changes have come several hundred to one thousand years after the temperature changes (Solomon, 2008, pp. 94-95). A simple experiment reinforces skepticism concerning allegations that carbon dioxide has a long residence time in the atmosphere before being absorbed into surface waters. If one vigorously shakes a carbonated soft drink, he or she will find that the pressure in the bottle from the released carbon dioxide diminishes in a very short time due to its prompt reabsorption by the liquid.

CO_2 induced global warming predictions ultimately come from models relating global temperature to atmospheric carbon dioxide levels. Dr. Richard Lindzen participated in writing some of the IPCC's 2001 report and he testified that many of the scientists who had participated in developing underlying climate models warned that the models contained numerous misspecifications and errors (Solomon, 2008, pp. 49-50). In addition, Lindzen emphasized that summaries written and press reports presented to the public glossed over resulting major qualifications and substantial uncertainties. Political attack and threats to grants and funding deterred scientists from protesting gross distortions of the truth they had tried carefully to assert. Bad models, thus justified through deliberate misrepresentation, an alarmism that even the models themselves could not really substantiate, according to Lindzen (Solomon, 2008, p. 50). Hendrik Tennekes, former Director of Research at the Royal Netherlands Meteorological Institute, explains that the global warming models reach so great a level of complexity that their predictions altogether cease from being scientific propositions (Solomon, 2008, p. 119). The models make manifold mistakes apparent in even their short run performance because they bite off more than they can chew, as Solomon puts it (p. 119).

The later chapters in Solomon's book look to the heavens to help explain changes in the earth's temperature. Some scientists suffered denunciation by the IPCC for diverting attention from the orthodox greenhouse gas theory – some published graphs depicting powerful correlations between solar activity and the earth's climate (Solomon, 2008, p. 135). After listing 10 from the dozens of scientists who have contributed studies in the relevant field, Solomon (pp. 136-141) summarizes the work of Eigil Friis-Christensen who showed a "startling correlation between global temperatures and the sunspot cycle." Sarni Solanki of the Max Planck Institute augmented knowledge of the solar influence by showing that cosmic rays are also at work and can explain more than two

thirds of the earth's temperature variance historically (Solomon, 2008, pp. 149-153). Another scientist, Jasper Kirkby, told a journalist that he thought cosmic ray flux might "account for somewhere between a half and the whole of the increase in the Earth's temperature that we have seen in the last century" (Solomon, 2008, p. 157) and he was subsequently attacked and had his research funding frozen. Likewise, Dr. Habibullo Abdussamatov, the head of the Space Research Laboratory at St. Petersburg's Pulkovo Astronomical Observatory contends, "the Sun directly accounts for about half the warming that we have seen on Earth in the 20th century" (Solomon, 2008, p. 163). "The other half is caused by the natural greenhouse effect and by the natural variations in the albedo of the Earth's surface… but almost none of it stems from a manmade greenhouse effect" he further argues (Solomon, 2008, p. 163). Abdussamatov emphasizes that Mars exhibits a recent warming similar to the warming seen on Earth, but obviously could not be warming because of anthropogenic greenhouse gasses (Solomon, 2008, p. 163). George Kukla of Columbia University issued warnings of a coming ice age and both he and Abdussamatov think a recent downtrend in solar activity portends cooling in the very near future (Solomon, 2008, pp. 167-168). Rhodes Fairbridge, also of Columbia University, theorizes that variations in the suns activity are predictable from shifts in the solar system's center of gravity as the positions of the planets change as they all circle the sun at different speeds (Solomon, 2008, pp. 172-173).

Solomon (p. 6) states in his introduction that he has also written a series of newspaper columns and that he has profiled three dozen scientists, "all recognized leaders in their fields," who deny anthropogenic greenhouse gas global warming theory. He (pp. 7-8) points out that, while 14000 scientists have signed a statement affirming the theory, another 14001 have signed a statement that it is a hoax. If we want a second opinion after hearing Al Gore declare a "planet emergency," then one is certainly available to contradict that assessment.

Much public policy costing taxpayers billions if not hundreds of billions of dollars derives from the scientific findings of many researchers processing their models and statistical evidence. Think of the money – no, the value of the resources, that could be saved if the taxpayers in today's modern industrial democracies simply possessed more of the wisdom of Socrates! As Robert Solow wrote, "It ain't the things you don't know that hurt you, it's the things you know that ain't so" (Solow, 1997, p. 107)

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