Synthesizing Econometric Evidence: The Case of Price Elasticity Estimates

Philip DeCicca (McMaster University), Don Kenkel (Cornell University)*

Working Paper prepared for:

Methods for Research Synthesis:
A Cross-Disciplinary Workshop

Harvard Center for Risk Analysis

October 3, 2013

www.hcra.harvard.edu

***Corresponding author: dsk10@cornell.edu**

Title: Synthesizing Econometric Evidence: The Case of Demand Elasticity Estimates

Authors: Philip DeCicca and Don Kenkel

Abstract:

Econometric estimates of the responsiveness of consumer demand to higher prices are often key ingredients for public policy research. We review the potential advantages and challenges of synthesizing econometric evidence on the price-responsiveness of consumer demand. Based on our expertise we mainly draw on examples of research on consumer demand for health-related goods, especially cigarettes. We argue that the overarching goal of research synthesis in this context is to provide policy-relevant evidence for broad brush conclusions. We propose two main criteria to select among research synthesis methods. We discuss how in principle and in current practice synthesis of research on the price-elasticity of smoking meets our proposed criteria. Although we point out challenges and limitations, we believe more work on research synthesis in this area will be productive and important.

Key Words: price elasticity, econometrics, meta-analysis, policy analysis

1. Introduction

Econometric estimates of the responsiveness of consumer demand to higher prices are often key ingredients for public policy research. Indeed, econometric research helped establish excise taxes on cigarettes and alcoholic beverages as important public health policies. The 2000 Report of the Surgeon General reviews over 50 econometric studies and draws the strong conclusion that: "Substantial increases in the excise taxes on cigarettes would have a considerable impact on the prevalence of smoking and, in the long term, reduce the adverse health effects caused by tobacco." (USDHHS 2000, p. 359) The World Health Organization reaches similar conclusions about alcohol taxes: "One of the most effective strategies for reducing consumption of alcohol at the population level is through increasing alcohol prices, usually accomplished by raising alcohol taxes." (WHO 2011, p. 45). With increased policy interest in obesity, the price-elasticities of consumer demand for calorie-dense foods, such as fast foods and soft drinks, become policy-relevant as new taxes are considered (Chou, Grossman, and Saffer 2004, Fletcher, Friswold and Teft 2011). The price-elasticities of the demand for illegal drugs are extremely relevant to the effectiveness of supply-side drug policies (Manski, Pepper and Petrie 2001).

Because of the relevance for public health policy, researchers and policy makers have also tried to synthesize the econometric evidence on the price-responsiveness of demand. Econometric studies typically report results in terms of an estimate or range of estimates of the price-elasticity of demand. The price-elasticity of demand equals the percentage change in demand over the percentage change in price. For example, if the price-elasticity of cigarette demand is estimated to be -0.5, it means that a 10 percent increase in the price of cigarettes is predicted to reduce demand of cigarettes by 5 percent. Usually there are many price-elasticity estimates available from econometric studies that use almost as many different sources of data, specifications, and other research design differences. One approach to synthesize the available evidence is to conduct a narrative review of existing estimates, which typically involves the review authors' judgments about the quality, reliability, and relevance of the studies. An example is Chaloupka and Warner's (2000) oft-cited review of estimates of the price-elasticity of cigarette demand. More recently, there have been several important meta-analyses of econometric research on price-elasticities of the demand for health-related goods. Gallet and List (2003) report a meta-analysis of 523 price-elasticity estimates from 86 empirical studies of

the demand for cigarettes. Wagenaar, Salois, and Komro (2009) report a meta-analysis of 1003 price-elasticity estimates from 112 studies of the demand for alcoholic beverages. Gallet (2013) reports a meta-analysis of 462 estimates from 42 studies of the price-elasticities of marijuana, cocaine, and heroin.

In this paper, we review the potential advantages and challenges of synthesizing econometric evidence on the price-responsiveness of consumer demand. Based on our expertise we mainly draw on examples of research on consumer demand for health-related goods, especially cigarettes. However, most of the discussion is relevant for econometric research on consumer demand more generally.

2. Criteria for Selecting Among Research Synthesis Methods

The appropriate criteria for selecting among research synthesis methods depend upon how the results will be used. If the goal of the synthesis is to provide insights for academic research, methods such as meta-regression have scientific value because they explore sources of methodological diversity in estimates (Thompson and Higgins 2002). Our focus is on synthesizing econometric research to provide guidance for public policy. As illustrated by the quotes above from the Surgeon General Report and the WHO, policy makers typically use econometric research on to make broad brush statements. The overarching concern then is to use research synthesis methods that provide the best guidance for such broad brush statements. For example, how should econometric research on cigarette and alcohol demand be synthesized to provide a strong basis for policy makers to decide if higher cigarette and alcohol taxes "have a considerable impact" or are "one of the most effective policies"?

The first criterion we propose is that the synthesis method should provide evidence about the unbiased, cause-and-effect relationship between price and consumer demand. For a single study, this criterion corresponds to whether the research uses a strong design in terms of internal validity. The econometric estimates of the price-elasticities of the demand for cigarettes, alcohol, and illicit drugs synthesized in the meta-analyses cited above are all based on nonexperimental data. In what has been termed the "credibility revolution in empirical economics" there is an increasing focus on the importance of research design in nonexperimental studies (Angrist and Pischke 2010). To use the analogy from randomized experiments, the credibility of a nonexperimental econometric study hinges on finding a plausible control group. For example, econometric studies of youth cigarette demand that use cross-sectional data essentially compare

the smoking rates in the treatment group of high-tax states with the smoking rates in the control group of low-tax states. This approach yields biased estimates of the price-elasticity of youth smoking if there are other systematic differences between the treatment and control groups. To use terminology from econometrics, problems such as omitted variables bias, endogeneity bias, and simultaneous equations bias boil down to doubts about the internal validity of the estimate. Ideally, there would be enough studies with strong research designs that synthesis methods could simply exclude studies with weaker designs from the analysis. In practice, econometric research on consumer demand relies on research designs of varying strength. As we discuss in more detail below, this poses a challenge for research synthesis methods to glean some evidence from the weaker studies that yield statistical associations that might, or might not, reflect causation. An additional challenge is to communicate this methodological uncertainty when summarizing the evidence in a research synthesis provided to policy makers.

The second criterion we propose is that the synthesis method should provide evidence about the magnitude and practical significance of the relationship between price and consumer demand. In a single econometric study, the main focus is often on statistical significance: Did the relationship in the data sample occur by chance, or is it estimated precisely enough to reject the null hypothesis of no relationship with a reasonable degree of statistical confidence? McCloskey and ZIliak (1996) argue that many empirical economists confuse statistical significance with practical significance. They urge empirical economists to pay attention to the scientific question: How large is the estimated effect in terms of the present conversation? The conversation among academic economists might sometimes mainly be about the null hypothesis. For example, evidence that the demand for addictive goods such as cigarettes or heroin responds at all to higher prices sheds light on the relevance of the still-controversial rational addiction model (Becker and Murphy 1988). But for the conversation among policy makers about how to discourage smoking or heroin use, what matters is the magnitude of the impact of policy-relevant (e.g., feasible) changes in prices on consumer demand. Regardless of the underlying academic conversation, the research synthesis should contribute to the policy conversation.

We see the standard criterion of precision mainly as it relates to our proposed criterion about magnitude and practical significance. In a single econometric study, the standard practice is to present both a point estimate and the associated statistical confidence interval around the point estimate. However, when the results are summarized it is not uncommon to provide a single

price-elasticity estimate. Depending upon the study's statistical precision, this practice might obscure the fact that the study's estimate might not contribute that much to the policy conversation. For example, the standard 95 percent confidence interval around an imprecisely estimated elasticity might include very small effect sizes, in which case the study's results do not rule of the possibility that a price increase might do very little to reduce unhealthy consumption. Research synthesis methods clearly need to take into account the statistical precision of the estimates that form the research base, in addition to the more fundamental concerns about research design and practice significance.

3. The Usefulness of the Price-elasticity of Demand as a Summary Measure

Typically, the first step in research synthesis is to express the results of different studies in a common metric in order to obtain an "effect size." Econometric research on the size of the effect of prices on consumer demand is typically summarized by the price-elasticity of demand. To set the stage for a discussion of the usefulness of this common metric, in this section we first review some basic economic concepts. We then apply our criteria from section 2 to discuss the advantages and disadvantages of the price-elasticity as a summary measure.

A large body of empirical econometric research provides estimates of consumer demand curves for a wide range of goods and services. Conceptually, the demand curve shows the shows the quantity of a good consumers purchase at different prices, holding other demand determinants constant. The slope of this curve reflects the price-responsiveness of demand. Econometric studies use multivariate linear regression and its extensions to estimate the determinants of consumer demand, including the slope of demand with respect to price. The price-elasticity normalizes this slope in percentage terms. The price elasticity of demand is given generically by the following equation, where the first ratio represents the marginal effect of price on quantity and the second ratio is the normalizing ratio and is typically evaluated at average levels of price and quantity.

$$\eta = \frac{\partial Q}{\partial P}\frac{P}{Q}$$

Econometric demand functions are estimated with aggregate market-level data and with individual-level data. Individual-level data can be used to estimate demand functions for

different groups of consumers, for example adults versus youth smokers. When the data are rich enough, individual-level models can distinguish between demand price-responsiveness at the intensive and extensive margins. For example, many empirical health economics studies estimate the price-elasticity of smoking participation (the intensive margin) and conditional on being a smoker, the price-elasticity of the demand for the number of cigarettes smoked per day (the extensive margin). In the formula for the participation elasticity, "Q" refers to the fraction of the sample who are smokers (i.e. smoking prevalence); in the formula for the conditional demand elasticity "Q" refers to the number of cigarettes smoked per day by smokers. DeCicca, Kenkel and Mathios (2008) emphasize that smoking participation at a point in time reflects a series of past decisions about smoking initiation and cessation. As even richer data become available, econometric studies also estimate initiation and cessation elasticities, where now "Q" refers the fraction of non-smokers initiating smoking or the fraction of smokers who quit. We use "the price-elasticity of demand" as a general term that encompasses the elasticities of participation, conditional demand, initiation, and cessation. Below, we provide more discussion of the distinctions between these various elasticities.

In many applications, a key advantage of the price-elasticity of demand is that it satisfies our second criterion and provides evidence about the magnitude and practical significance of the relationship between price and consumer demand. The normalization in percentage terms is often useful to judge policy relevance. For example, if the estimated price elasticity is small in absolute value, say -0.01, it means that a 100 percent increase in price would only reduce demand by one percent. It should usually be straight-forward for a policy maker to judge if a price increase of 100 percent or larger is policy-relevant in terms of feasibility, unintended consequences, and so on. In principle, the policy maker should also be able to judge whether a reduction in demand by one percent is large relative to what might be achieved by other policies, but of course this requires evidence about the other policies in question. Whether a price-elasticity is large enough to be policy-relevant will differ across policy contexts, but in general the magnitude of the price-elasticity will often be useful to help policy makers draw broad brush guidance from econometric research.

However, the normalization in percentage terms that often makes the price-elasticity useful for policy sometimes makes it misleading. Researchers and policy makers are often interested in comparisons across the price sensitivity of various demographic groups. When different

demographic groups consume much different levels of health-related goods, two groups may exhibit the same marginal effects of price on a given behavior (i.e., the same degree of price sensitivity), but the price-elasticity will be much different. For example, part of the appeal of higher cigarette taxes is the conventional wisdom that youth are more price-responsive than adults, on the extensive margin.[1] However, because the fraction of adults who smoke is greater than that of a representative sample of youth, this will generate larger magnitude participation elasticities for youth than adults, all else equal. In the extreme, it is possible to estimate a larger marginal effect of price on adult smoking behavior, relative to that of a sample of youth, but end up with smaller magnitude elasticities for adults due to their higher smoking rates. Thus, a finding of larger magnitude participation elasticities for youth relative to adults does not, on its own, imply a greater degree of price sensitivity among youth, the concept we really would like to measure.[2] More generally, price elasticities are limited in their ability to allow researchers and policymakers to make comparisons of price sensitivity across demographic groups, even though such comparisons are made routinely (and incorrectly).

Another disadvantage to using the price-elasticity in research synthesis is that a single "effect size" cannot in general summarize the results of an econometric study of consumer demand. The demand curve or function is a schedule that shows the quantity demanded at various different prices. Neither the marginal effect of price nor the price-elasticity is necessarily constant along the demand curve, except for the mutually exclusive special cases of a linear demand curve or a constant elasticity demand curve.[3] Using a single price-elasticity to summarize the demand curve is analogous to using the effect of a specific drug treatment dosage to summarize the entire dose-response curve. In the context of drug treatments, the solution is to conduct additional clinical trials that provide evidence on the relative effects of different dosages compared to each other, as well as when compared to the control group. In that context, the RCTs generally consider a fairly limited range of alternative dosages. Extending econometric research to provide evidence of alternative "policy dosages" can be more difficult because the range of policies can be quite broad. For example, the cigarette tax rates chosen by different

[1] Put differently, initiation behavior is more price sensitive than cessation behavior.
[2] Similar logic applies to comparisons made across racial groups or by gender.
[3] The cases are mutually exclusive because of the normalization involved in the elasticity formula. Although the slope showing the marginal effect of price is constant along a linear demand curve, the price-elasticity is different at each point on a linear demand curve. Conversely, the slope or marginal effect of price is different at each point along a constant elasticity demand curve.

states within the US currently vary by more than an order of magnitude, from $0.17 per pack in Missouri to $4.35 per pack in New York (Federation of Tax Administrators 2013). Because policy makers often look at other countries' experiences, it should be noted that policies can vary even more widely across countries. The challenge for research synthesis is thus not only to summarize evidence about the price-consumption relationship in the observed data, but also to consider policy makers' interest in extrapolating beyond the range of policies observed in any given country.

We stress that the disadvantage of using a single elasticity to summarize the price-consumption relationship can arise within a given study, especially when the relevant sample data cover a long time period when consumer demand has changed appreciably. Cigarette demand is a good example, because adult smoking rates have dramatically fallen over time in the US and other high-income countries. In this situation, the relevant question is *when* to measure smoking participation (i.e., the fraction of the sample categorized as a smoker). For example, should smoking participation be measured at the start of the data series or at the end, or perhaps an average over all sample periods? An example of the magnitudes involved is instructive: If, for example, we have a marginal effect of -0.00015 and P=350 cents, with a smoking rate declining from Q=0.22 to Q=0.12, the difference in the implied participation elasticity would be -0.24 using the initial smoking rate versus -0.44 using end-point smoking rate, nearly double in magnitude.[4] In our experience, such calculations are not made in a consistent manner across studies, and are often not even discussed. This issue also makes cross-study comparisons of price sensitivity more problematic.[5]

As noted above, there are two types of elasticities: a participation elasticity of demand and a conditional demand elasticity of demand. The former refers to behavior on the extensive margin, while the latter refers to behavior conditional on being a smoker (i.e., the impact of price on amount smoked). In order to compute a "total" or "overall" elasticity of demand, studies in this literature commonly sum estimates of these two measures. However, they represent very different concepts. As a result, two studies that report the same or similar total elasticities may represent very different findings if participation and conditional demand elasticities vary greatly.

[4] Using an overall sample average, if smoking declined in a uniform fashion, would imply an elasticity of -0.31.
[5] The same logic implies difficulty in comparing price elasticities from studies conducted at very different points in time, when smoking rates and amounts smoked differ appreciably.

The solution is to report these two types of elasticities separately, and to treat them as separate concepts.

Our critique of the use of price elasticity as a measure of price sensitivity implies that any method of research synthesis such as a meta analysis should control for issues/variables such as demographic group studied, elasticity type (i.e., whether a participation or conditional demand elasticity), the time period of the data, etc. In sum, while we recognize authors will continue to report price-elasticities, we suggest that research synthesis should also use the marginal effects of various price increases implied by their coefficient estimates.[6] While this sort of representation has its own limitations (e.g., potential non-linearity in the impact of price), we believe it more accurately conveys price sensitivity and allows for more valid cross-group comparisons as well as comparisons over time. By mapping out the estimated price-consumption relationship over the range of prices observed in the data, this approach better meets our criterion that research synthesis should provide policy-relevant evidence about the magnitude and practical significance of the econometric results.

4. Comparing Methods to Synthesize Econometric Evidence on Price-elasticities

Regardless of whether econometric results are summarized by price-elasticity estimates or schedules showing marginal effects of various price increases, the next step is to use a systematic method to synthesize the evidence from multiple studies. In this section we compare two methods commonly used to synthesize econometric research: a narrative review of existing estimates; or a systematic meta-analysis of estimates. We focus on their relative strengths and weaknesses in terms of our proposed criteria for selecting synthesis methods.

In principle, either a narrative review or a meta-analysis can address our first criterion that the synthesis method should provide evidence about the unbiased cause-and-effect price-consumption relationship. Because of the sometimes subtle research design issues involved, however, the method of narrative review has advantages in meeting this criterion. As noted above, econometric research on the effects of price on health-related consumption relies almost exclusively on non-experimental data. The identification of cause-and-effect relationships in non-experimental data is arguably the central challenge of applied econometrics. Meyer (1995)

[6] Often, such results are presented as the impact of an X cent increase in cigarette price on smoking behavior.

emphasizes: "If one cannot experimentally control the variation one is using [to identify a key parameter of interest], one should understand its source." Modern applied econometric research often involves lengthy discussions of a variety of sources of evidence to shed light on whether the source of variation provides "clean identification" corresponding to a credible quasi-experiment (Angrist and Pischke 2010). While narrative reviews can summarize each study's discussion of the source of identification, the nature of these discussions makes it harder to incorporate in a systematic meta-analysis.

In the practice of research synthesis of econometric estimates of cigarette price-elasticities, neither narrative reviews nor meta-analysis meet our first criterion very well. For example, neither the prominent narrative review by Chaloupka and Warner (2000) nor the meta-analysis by Gallet and List (2003) discuss the identification of the price-consumption relationship in the sense of whether the studies reviewed use a credible research design.[7] These gaps might be explained by the fact that these reviews, and in particular the studies reviewed, were completed during the early days of, and sometimes pre-date, the "credibility revolution" in applied econometrics. However, the gap is still apparent in more recent narrative reviews of cigarette price-elasticities including Bader, Boislclair and Ferrence (2011), WHO (2011), and Guindon (2013).

A weakness of a narrative review compared to a meta-analysis is the potential for reviewer bias to creep in, which in turn implies that the results of the research synthesis might not provide unbiased evidence. In contrast, the econometric meta-analyses aim to provide a systematic summary of estimates, and are at least partly motivated by the goal to avoid potential pitfalls in narrative reviews, such as "the subjective decision of the reviewer to discount certain studies or characteristics…" (Gallet 2013). Although we are involved in the academic research debate on the price-elasticity of youth smoking, we note that the simple fact that different narrative reviews of the same body of research reach different conclusions is suggestive of bias. For example, while previous narrative reviews led to a claimed consensus that youth smoking is much more

[7] Both Chaloupka and Warner (2000) and Gallet and List (2003) discuss a related identification issue: the problem that prices and quantities are simultaneously determined by the forces of supply and demand. For example, Gallet and List explore whether studies that use the method of two-stage least squares to address this problem yield systematically different price-elasticity estimates. However, this does not address the question of whether the underlying source of variation in prices, typically variation in taxes over time or across jurisdictions, is a credible source of identification. For example, policy endogeneity suggests that taxes and consumption may be correlated for reasons other than the cause-and-effect demand relationship between prices and consumption.

price-responsive than adult smoking, DeCicca, Kenkel and Mathios (2002) characterize the empirical evidence as "mixed." The controversy has not been resolved over time. A recent narrative review by Bader et al (2011, p. 4123) identifies 21 studies of the impact of higher prices on smoking initiation and concludes from these studies that "There was strong evidence that raising cigarette prices through increased taxes is a more effective tobacco control policy measure for reducing smoking behavior among youth…." In contrast, the recent narrative review by Guindon (2013, p. 13) concludes: "…this review concludes that the evidence is too limited to make any conclusive statements about the impact of tobacco prices or taxes on smoking onset."

We reach similar conclusions about the potential and practice of research synthesis methods in terms of our second proposed criterion about the magnitude and practical, policy-relevant significance of the evidence. In principle, either a narrative review or a meta-analysis can meet this criterion. In current practice as applied to research on cigarette demand price-elasticities, the methods used to date do not meet our criterion very well.

Finally, although we do not see precision as a criterion per se, the precision of the estimates underlying either a narrative review or a meta-analysis has important implications for whether the evidence provides useful guidance about magnitude and practical significance. Although narrative reviews can discuss precision, here the method of meta-analysis has advantages. However it is important to keep in mind that the goal of a meta-analysis of price-elasticity estimates is different than the goal of meta-analysis in many clinical and public health applications. In many health applications, Petitti (1994, p. 15) suggests that meta-analysis "is most useful in summarizing prior research when individual studies are small and they are individually too small to yield a valid conclusion." In addition to combining the results of small randomized trials, Pettiti (p. 16) argues that "For nonexperimental studies, the method is also most useful when there are many studies with low statistical power." In contrast, a lack of statistical power and the need for more statistically precise estimates are not the main motivation for many meta-analyses of demand elasticity estimates. Instead, as noted above part of the motivation is to use a systematic approach that avoids potential biases in narrative reviews. The different goals lead to different meta-analytic methods. Wagenaar, Salois and Komro (2009, p. 180) compare the approaches of econometric meta-analytic studies which implicitly weight each estimate equally and "report results from simple ordinary least squares (OLS) regressions of study characteristics on reported elasticity" with their study "from the systematic review and

meta-analysis traditions in epidemiology and the social sciences, where evidence … is cumulated across studies based on the point estimates and estimated variances from individual studies using multi-level random-effects models."

To sum up, narrative review and meta-analysis both have weaknesses and strengths as methods to synthesize econometric evidence on the effect of higher prices on consumer demand for health-related goods. The special context for meta-analysis of econometric estimates poses difficult and unresolved challenges. For example, instead of taking into account the precision of a study's estimate, in principle it seems desirable to take into account the credibility of its research design. If the implicit control group in a nonexperimental study is flawed, the concern is not precision, but bias. Moreover, the number of studies that reach similar estimates does not help reduce bias, if the studies rely on similarly flawed research designs. One approach to resolve these problems is to rely on strict eligibility criteria for inclusion in the meta-analysis. Just as non-experimental studies are not eligible to be included in a meta-analysis of clinical trials, econometric studies that use flawed research designs could be excluded from a meta-analysis of price elasticity estimates. At the least, the meta-analysis should test for systematic differences in the estimates from studies that rely on different research designs.

5. Evaluating a meta-analysis of demand elasticities

In this section, we put the results of previous research synthesis to the test and ask: Do the "best" estimates of the price-elasticity of smoking demand help predict what happened to smoking prevalence in the US from 1995 – 2010? Over this time period, after adjusting for inflation the average cigarette price more than doubled from $2.57 per pack to $5.55 (in constant 2010 dollars). The 1998 Master Settlement Agreement with the tobacco industry, several federal tax hikes and over 100 state tax hikes contributed to the price increase. This sharp increase in prices provides a policy experiment to evaluate whether the 2000 Surgeon General Report drew the correct lesson from previous research synthesis that higher prices have a "considerable impact on the prevalence of smoking." The exercise is relevant to both of the criteria we propose in section 2 to select among research synthesis methods. First, if previous research synthesis yields an unbiased estimate of the cause-and-effect relationship of higher prices on smoking, the estimate should be useful for the prediction exercise. Second, the exercise also sheds light on the magnitude and practical significance of the relationship between cigarette prices and smoking.

To conduct the exercise, we need to describe the counter-factual of what smoking prevalence would have been, in the counter-factual world where cigarette prices stayed constant at the 1995 level. Fortunately, a series of studies by Mendez and colleagues essentially describe this counter-factual. Mendez, Warner and Courant (1998) develop a population dynamic model to predict smoking prevalence rates in the US. The model uses estimates of birth, mortality, and age-specific smoking initiation and cessation rates to simulate the number of adults smoking in the US over time. The results of their simulation model show that "the demographics of smoking imply that prevalence will inexorably continue to decline over the next several decades, even without any intensified efforts aimed at tobacco control." The model is calibrated with actual data through 1995, when adult smoking prevalence in the US was 24.7 percent. The model predicted 2005 smoking prevalence (as measured in the National Health Interview Survey) exactly at 20.9 percent; the model predicted 2010 smoking prevalence at 19.9 percent, 0.6 percentage points higher than the NHIS2010 estimate (Warner and Mendez 2012). The key for our exercise is that these predictions reflect only the demographics of smoking and do not incorporate any adjustments to capture the effects of higher cigarette prices or other tobacco control policies. As such, they describe what would have happened to US smoking rates in the counter-factual world where cigarette prices stayed constant.

As a preliminary quantitative exercise, following the general strategy used by Harris (1998) we use a simple constant elasticity model of smoking prevalence:

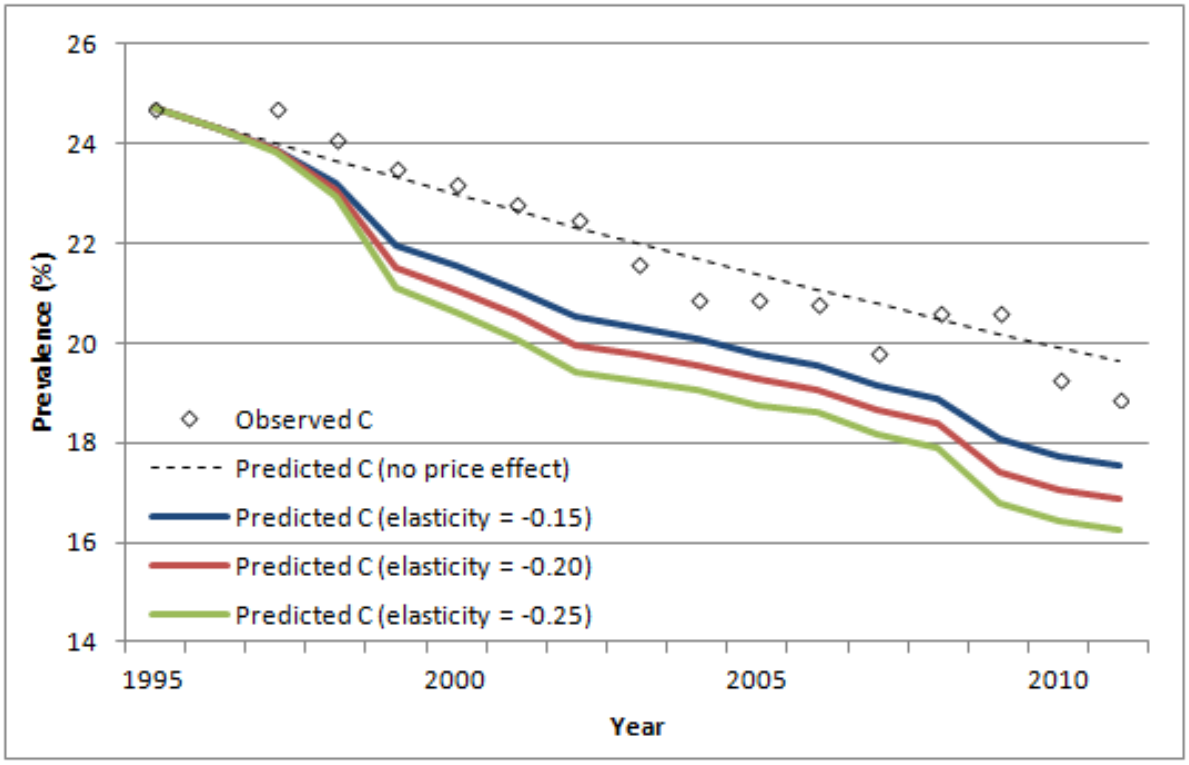
$$\text{Ln}(Q) = \alpha + \beta T + \delta \text{Ln}(P)$$

where Ln (Q) is the natural logarithm of smoking prevalence (Q), T is a time trend measured in years since 1995, and Ln(P) is the natural logarithm of the inflation-adjusted cigarette price (P). Given this form of the demand equation, the coefficient δ is the price-elasticity. We explore the sensitivity of our predictions to the use of three estimates of δ around -0.2. The narrative review by Chaloupka and Warner (2000) and the meta-analysis by Gallet and List (2003) both suggest a synthesis estimate of the total price-elasticity of around -0.3 to -0.5. Chaloupka and Warner (2000) suggest that the price-elasticity of smoking participation or prevalence is about half the total price-elasticity, which implies δ is in the range around -0.2. We calibrate α to fit the 1995 data, and we calibrate the time trend β to fit the predictions from Warner and Mendez (2012). In other words, our calibrated time trend captures the demographic factors build into the Warner

and Mendez population dynamic model. Although their model is more complicated, a linear time trend fits their predictions reasonably well.

The Figure below shows the results of the exercise. As in Warner and Mendez (2012), if we hold P constant at its 1995 value we slightly over-estimate the actual smoking rate in 2010, although over much of the period the predictions are fairly close to observed smoking prevalence. Using the actual history of cigarette prices and the consensus price elasticity, smoking is predicted to fall to about 17 percent in 2010, compared to the observed rate of 19.3 percent. Put differently, while observed smoking prevalence fell by 5.4 percentage points (from 24.7 percent to 19.3 percent), taking into account the price increase we predict it should have fallen by about an additional 2 percentage points. As is clear from the accuracy of the predictions reported in Warner and Mendez (2012), the observed decline in smoking prevalence from 1995 to 2010 corresponds very closely to what would be predicted for a counter-factual world with no price increase. In addition to the demographic dynamics in Warner and Mendez, there have been multiple new tobacco control efforts since 1995 including: increased availability of smoking cessation products; widespread bans on smoking in worksites, restaurants, and other public places; state tobacco control programs including telephone quitlines and mass media anti-smoking campaigns; and national mass media anti-smoking campaigns. Quantifying the impacts of these policies is beyond the scope of our preliminary empirical exercise, but including their influence would cause our model to even more substantially under-predict smoking prevalence/ over-predict the drop in smoking prevalence attributable to the effect of the observed price increase.

In sum, the results of our preliminary quantitative exercise are suggestive evidence that previous efforts to synthesize econometric research on the price-smoking prevalence relationship do not perform well.



6. A New Meta-analysis of Price-Elasticity Estimates of Smoking

In work-in-progress, we are conducting a new meta-analysis of econometric estimates of the price-elasticity of smoking. Our meta-analysis will try to address the criteria and challenges we identify above. Because it will update the meta-analysis by Gallet and List (2003), to set the stage we summarize here that study.

Gallet and List (2003) synthesize 523 estimates of the price-elasticity of cigarette demand drawn from 86 studies published between 1955 and 2001. [8] It provides two main contributions: First, the authors report mean and median price elasticities of cigarette demand by various demographic and study characteristics. Second, they examine the impact of various study characteristics such as the demographic group studied, the type of data used and the research methodology employed on estimated price elasticities of cigarette demand. They regress the 523 estimates noted above on a large set of study characteristics in order to examine their relative impact on these estimates. They find, for example, that studies which use cross-sectional data and studies that focus on teen smoking tend to find price elasticities

[8] Gallet and List (2003) also focus on the income elasticity of cigarette demand and what they call the "advertising elasticity" of cigarette demand, but we focus only on the portion of their work which deals with price elasticities.

that are larger in magnitude than those which use time-series data or focus on the smoking behavior of adults, respectively.

Of particular interest is their finding that the price elasticity of cigarette demand decreases in magnitude (i.e., moves closer to zero/becomes less negative) as date of publication becomes more recent. In particular, Gallet and List (2003) estimate that a one year's increase in publication date is associated with a 0.01 increase in the price elasticity of cigarette demand, hence a simple straight-line projection implies an increase of 0.10 per decade which seems substantial enough to warrant follow-up analysis/synthesis in order to assess whether this pattern has continued in more recent time periods. The usefulness of such a follow-up analysis is further bolstered by the fact that the latest study included in Gallet and List (2003) was published in 2001 and used data from the 1990s. If this decreasing pattern uncovered by Gallet and List (2003) represents the availability of improved data and an increasing recognition of the importance of research design issues over their sample period (i.e., 1955-2001), then we might expect to see a further decline in the price elasticity of cigarette demand in newer studies since the last 15-20 years has seen an increased availability of data which allow for more credible research designs to be implemented (e.g., individual level smoking data with longitudinal aspects).

7. Conclusions

Econometric estimates of the price-responsiveness of consumer demand for health-related goods are often used to make broad brush conclusions about policy effectiveness. In this context, we propose two criteria for research synthesis methods: the synthesis method should provide evidence about the unbiased cause-and-effect relationship between price and consumer demand; and the method should provide evidence about the magnitude and the practical significance of that relationship. We argue that to date, synthesis of econometric research on consumer demand for health-related goods fails in several ways to meet our proposed criteria. Limitations include: the focus on a summary price-elasticity measure rather than tracing out the price-demand relationship; lack of consideration of research design issues needed for credible estimates of the cause-and-effect relationship; and inadequate consideration of the magnitude and practical or policy significance of the estimated

relationships. Our work-in-progress is conducting a new meta-analysis of cigarette demand which will address these limitations.

References

Angrist, Joshua D and Jorn-Steffen Pischke (2010). "The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics." Journal of Economic Perspectives 24 (2): 3 – 30.

Bader, Pearl, David Boisclair, and Roberta Ferrence (2011). "Effects of Tobacco Taxation and Pricing on Smoking Behavior in High Risk Populations: A Knowledge Synthesis." International Journal of Environmental Research and Public Health 8: 4118 – 4139.

Becker, Gary S and Kevin M Murphy (1988). "A Theory of Rational Addiction." Journal of Political Economy.

Chaloupka, Frank J. and Kenneth E. Warner (2000). "The Economics of Smoking." In Anthony Culyer and Joseph P. Newhouse, editors, Handbook of Health Economics (Volume 1B, pp. 1539 - 1627). Amsterdam: North Holland.

Chou, S-Y., Grossman, M., and Saffer, H. 2004. An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System. Journal of Health Economics 23 (3): 565 - 87.

DeCicca, Philip, Donald Kenkel, and Alan Mathios (2002). APutting Out the Fires: Will Higher Taxes Reduce the Onset of Youth Smoking?@ Journal of Political Economy 110 (1): 144-169.

DeCicca, Philip, Donald Kenkel, and Alan Mathios (2008). "Cigarette Taxes and the Transition from Youth to Adult Smoking: Smoking Initiation, Cessation, and Participation." Journal of Health Economics 27 (4): 904-917.

Federation of Tax Administrators (2013). Http://www.taxadmin.org.

Fletcher, Jason, David E Friswold, and Nathan Teft (2011). "Are Soft Drink Taxes an Effective Mechanism for Reducing Obesity?" Journal of Policy Analysis and Management

Gallet, Craig A. (2013). "Can Price Get the Monkey Off Our Back? A Meta-Analysis of Illicit Drug Demand." Health Economics.

Gallet, C.A. and List J.A. 2003. Cigarette demand: a meta-analysis of elasticities. Health Economics 12 (10): 821 - 836.

Guindon, Godefroy Emmanuel (2013). "The Impact of Tobacco Prices on Smoking Onset: A Methodological Review." Tobacco Control March 8, 2013.

Harris, Jeffrey E. (1998). "Economic Analysis of Proposed Legislation."

Manski, Charles F, John V Pepper, and Carol V Petrie, editors (2001). Informing America's Policy on Illegal Drugs. National Academy Press, Washington DC.

Meyer, Bruce D (1995). "Natural and Quasi-Experiments in Economics." Journal of Business & Economic Statistics 13 (2): 151 – 161.

McCloskey, Deirdre N and Stephen T Ziliak (1996). "The Standard Error of Regressions." Journal of Economic Literature 34: 97-114.

Mendez, David, and Kenneth E. Warner (2000). "Smoking Prevalence in 2010: Why the Healthy People Goal is Unattainable." American Journal of Public Health 90 (3): 401 – 403.

Mendez, David, Kenneth E. Warner, and Paul N. Courant (1998). "Has Smoking Cessation Ceased? Expected Trends in the Prevalence of Smoking in the United States." American Journal of Epidemiology 148 (3): 249 – 258.

Petitti, Diana B. (1994). Meta-Analysis, Decision Analysis and Cost-Effectiveness Analysis: Methods for Quantitative Synthesis in Medicine.

Thompson, Simon G and Julian P T Higgins (2002). "How Should Meta-Regression Analyses Be Undertaken and Interpreted?" Statistics in Medicine 21: 1559 – 1573.

U.S. Department of Health and Human Services [USDHHS] (2000). Reducing Tobacco Use: A Report of the Surgeon General. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Wagenaar, A.C., M J Salois, and Komro, K.A.. 2009. Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 estimates from 112 studies. Addiction 104 (2): 179 - 190.

Wagenaar, Alexander C, Amy L Tobler, and Kelli A Komro (2010). "Effects of Alcohol Tax and Price Policies on Morbidity and Mortality: A Systematic Review." American Journal of Public Health 100 (11): 2270 - 2278.

Warner, Kenneth E. and David Mendez (2012). "Accuracy and Importance of Projections From a Dynamic Simulation Model of Smoking Prevalence in the United States." American Journal of Public Health 102 (11): 2045 - 2048.

World Health Organization (2011). IARC Handbooks of Cancer Prevention, Tobacco Control, Vol. 14: Effectiveness of Tax and Price Polices for Tobacco Control. (Lyon, France)