CHAPTER 7
Excise Taxation and Product Quality Substitution

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Commodity taxes come in two forms: per unit and ad valorem. Per unit taxes are taxes imposed as a fixed amount per unit of a good sold or purchased. For example, the current federal gasoline tax is levied at 18.4¢ per gallon of gasoline purchased. Ad valorem taxes, such as the general sales tax and the tax on distilled spirits in many states, are taxes levied as a percentage of the value of the commodity. The choice between the two forms of taxation may be influenced by convenience, collection and enforcement costs, and the incentives introduced for market participants to change their behavior. It is this latter relationship—how the behavioral responses differ in response to the two types of commodity taxes—that is the topic of this chapter.

Commodity taxes lead to behavioral responses on many margins. For instance, consumers may, in response to a new or increased tax, choose to purchase less of the taxed good or adjust the timing (Drenkard and Henchman 2016) and location (Kaplan 2017) of purchase. While both ad valorem and per unit taxes can induce these behavioral responses, only per unit taxes are theorized to potentially lead to a shift in purchases across product quality grades. Specifically, per unit taxes are argued to cause consumers to purchase less of a particular good (quantity substitution) and to cause a subset of other

consumers choosing to continue consuming the good to purchase higher quality versions of the good (quality substitution). This quality substitution can be explained by two theorems. The Alchian-Allen theorem suggests quality substitution results from a reduction in the relative price of higher quality versions of the good. The Barzel theorem suggests that the quality substitution is due to quality going untaxed under per unit taxation, so that consumers substitute from the taxed attribute—quantity—and toward the untaxed attribute—quality. These two theorems will be explored further in the second section of this chapter.

Quality substitution is important for two primary policy reasons. First, the quality substitution response to taxes designed to reduce consumption of addictive and habit-forming substances can at least partially offset the direct benefits of a reduction in consumption. For instance, consumers may choose to imbibe fewer alcoholic drinks in light of an increased per unit tax on alcohol; however, the alcohol content of each drink consumed could rise, possibly to the point where the resulting health problems linked to alcohol consumption are worsened. Given the addictive and habit-forming nature of many so-called sin goods (i.e., cigarettes, alcohol, and gambling), quality substitution is an important aspect to consider when evaluating the appropriateness and effectiveness of sin taxes in encouraging desirable outcomes. Second, the effects of quality substitution on firm revenues may invite further rent-seeking, particularly in sin good industries, in which the expectation is generally that taxes will be imposed or increased.

This chapter proceeds as follows. The two relevant theorems—the Barzel theorem and the Alchian-Allen theorem—are explained in the next section before discussing the empirical evidence supporting these theorems in light of various fixed charges, including the per unit tax. I conclude with a discussion of the policy implications, detailing the importance of understanding and considering quality substitution when developing tax policy.

WHY QUALITY SUBSTITUTION OCCURS

An individual adjusts her behavior in response to changes in prices and other factors in an effort to maximize her individual utility. Standard tax theory, as it is typically covered in a classroom setting, focuses on the individual's substitution away from the taxed good and toward greater consumption of untaxed alternative goods. However, the quantity of a good that is consumed is not the only margin on which consumers can adjust. Barzel (1976) acknowledges that quantity is just one attribute of consumption. The

quality—taste, texture, durability, among many other characteristics—of a good consumed represents another primary attribute of consumption. Instead of only considering which goods are taxed, Barzel shifted the discussion to which attributes of taxed goods are taxed, specifically considering whether quality attributes are taxed in addition to the quantity attribute. He theorized that consumers substitute away from taxed attributes of a good and toward untaxed attributes.

Applying Barzel's logic to selective goods taxation, Barzel indicates that per unit taxes, which only tax the quantity attribute of a good, will cause a substitution away from the taxed attribute (quantity) and toward the untaxed attribute (quality). Consider a tax imposed on consumers of $10 per bottle of wine purchased and assume the full burden of the tax is on consumers. Regardless of the choice between a higher quality and lower quality wine, the consumer pays the same $10 tax. As a percentage of price, the per bottle tax is smaller for higher priced items. Consider a $40 bottle of higher quality wine and a lower quality $10 bottle of wine. The $10 per bottle tax represents a 100 percent tax for the lower quality wine, while it is only a 25 percent tax on the higher quality wine. So, while the $10 tax is likely to lead some consumers to reduce their consumption of wine (quantity substitution), there will be others who continue to purchase wine, and some of those individuals will choose to substitute higher quality wine (quality substitution) due to a lower effective tax rate on the higher quality wine.

In contrast, ad valorem taxes tax both attributes of the good and therefore cause no substitution between quantity and quality. This is because quality attributes of a good are capitalized in the price of the good. The absolute tax paid on a 100 percent ad valorem tax will be a larger sum if a consumer purchases a higher quality $40 bottle of wine than if she purchases a lower quality $10 bottle. Maintaining the assumption of full tax shifting to the consumer, the absolute tax paid on the high-quality wine is four times as much as that paid on the lower quality wine ($40 relative to $10). Thus, under the ad valorem tax, the absolute tax paid adjusts in accordance with quality such that the tax paid as a percentage of the price remains constant across all quality grades. As such, the only behavioral response expected is a reduction in consumption of wine generally (i.e., quantity substitution).

An alternative explanation of the incentives leading to quality substitution can be drawn from Armen Alchian and William Allen (1964, 74–75) in their classic and influential textbook. Alchian and Allen explain that the imposition of a "fixed charge" causes the price of the higher quality version of a good to fall relative to the lower quality version. A fixed charge can be described as any

type of cost that is the same regardless of the choice of the quality version of the good.

These two theorems—the Barzel and the Alchian-Allen theorems—can be viewed as special applications of the First Law of Demand. Most textbook discussions of tax-induced quantity substitution consider only the substitution from the taxed commodity and toward untaxed alternatives, ignoring quality variation altogether. However, Barzel and Alchian and Allen suggest the proper market definition is not (in this case) wine generally but is, for example, lower quality wine. The full range of substitutes for lower quality wine necessarily includes higher quality wine in addition to the traditionally included list of alternatives of distilled spirits, beer, soda, and so forth. Consumers naturally economize, seeking out options that provide the highest value per dollar spent on a commodity. In other words, consumers modify their purchases in an attempt to maximize the ratio of product value to after-tax price.

For some, the per unit tax will lead consumers to purchase less lower quality wine and more higher quality wine, as explained by both Barzel and Alchian and Allen; other consumers may instead purchase less higher quality wine and more lower quality wine, the opposite of the result theorized above. What will ultimately determine the direction of this quality substitution for a given consumer is the relative dominance of the income and substitution effects. The substitution effect is the result of changes in the relative price of alternative goods; this is consistent with the Alchian-Allen theorem. Per unit taxes reduce the relative price of higher quality versions of the good, leading consumers to substitute toward higher quality. However, the income effect will generally work in the opposite direction. The increased tax reduces the consumer's real income—because of higher after-tax prices, she can no long purchase the same consumption bundle on a fixed income—leading consumers to substitute lower priced (lower quality) options. A priori, we cannot theoretically predict whether the substitution effect or the income effect will dominate, making this question empirical. In cases where the substitution effect is larger in magnitude than the income effect, we will observe outcomes consistent with the predictions of the Barzel and Alchian-Allen theorems.

Some common applications of the theorems include shipping costs, travel costs, payment of a babysitter, and, of importance for this chapter, per unit taxation (additional examples are detailed in the next section). Parents who must pay for a babysitter to enjoy a date night are (1) likely to consume fewer date nights (First Law of Demand) and (2) more likely to go to a fancier restaurant and the opera or play rather than to a sit-down chain restaurant and a movie. The latter holds only if the substitution effect dominates the income

effect, an observation that is less likely to occur for less wealthy households. When shipping costs are incurred, consumers in distant markets are likely to prefer higher quality versions of the good more than do consumers who are more local. Bertonazzi et al. (1993) explain that the implications of the theorem do not depend on whether the goods travel to the consumer or the consumer travels to the goods; travel costs are expected to produce similar results as shipping charges. One must be careful when attempting to apply the theorem to travel costs. The logic applies only to a scenario in which the location of travel has been determined (e.g., a vacation to Charleston, SC) and the cost of travel varies, such as when a household observes airfares and begins to plan their vacation activities only to find out that airfares have increased by the time they begin booking the vacation. Some households may respond by canceling vacation plans or opting for a lower travel cost destination. Others, according to the Barzel and Alchian-Allen theorems, short of strong income effects, are expected to change some of the vacation plans in favor of an even higher quality experience. The theorem specifically does not apply to quality of vacation when comparing airfares across two destinations.

For the sake of discussion of the theorems' application to taxation, consider the 100 percent ad valorem and $10 per unit taxes on wine discussed above. Given the initial prices ($40 and $10), the higher quality wine is four times as expensive as the lower quality wine, as depicted in panel (a) of figure 1; an individual could purchase four bottles of low-quality wine for the same price as the high-quality wine. With the imposition of a $10 per bottle tax, the prices increase to $50 and $20, respectively, for a ratio of 2.5 to 1; see figure 1, panel (b). An individual can now only purchase 2.5 bottles of the low-quality wine for the same price of the high-quality wine. While the absolute difference in price has remained constant at $30, the relative price of high-quality wine has been reduced, and consumers are expected to substitute accordingly by purchasing less wine and, for those who continue to purchase wine, higher quality wine.

Now consider the 100 percent ad valorem tax on wine. After the tax—still assuming the full burden is shifted to consumers—the price of high-quality wine is $80 and the price of low-quality wine is $20; see figure 1, panel (c). High-quality wine is still four times more expensive than low-quality wine; an individual can still purchase four bottles of low-quality wine for the same price as one bottle of high-quality wine. Provided that price- and income-elasticity are roughly equal across the two quality grades, we should not observe any sizable shift in consumption across quality grades. Consumers purchase less of each quality grade of wine in roughly equal proportions.

Figure 1. Hypothetical Taxation of Wine

(a) Price of wine before tax

(b) Price of wine with per unit tax

(c) Price of wine with ad valorem tax
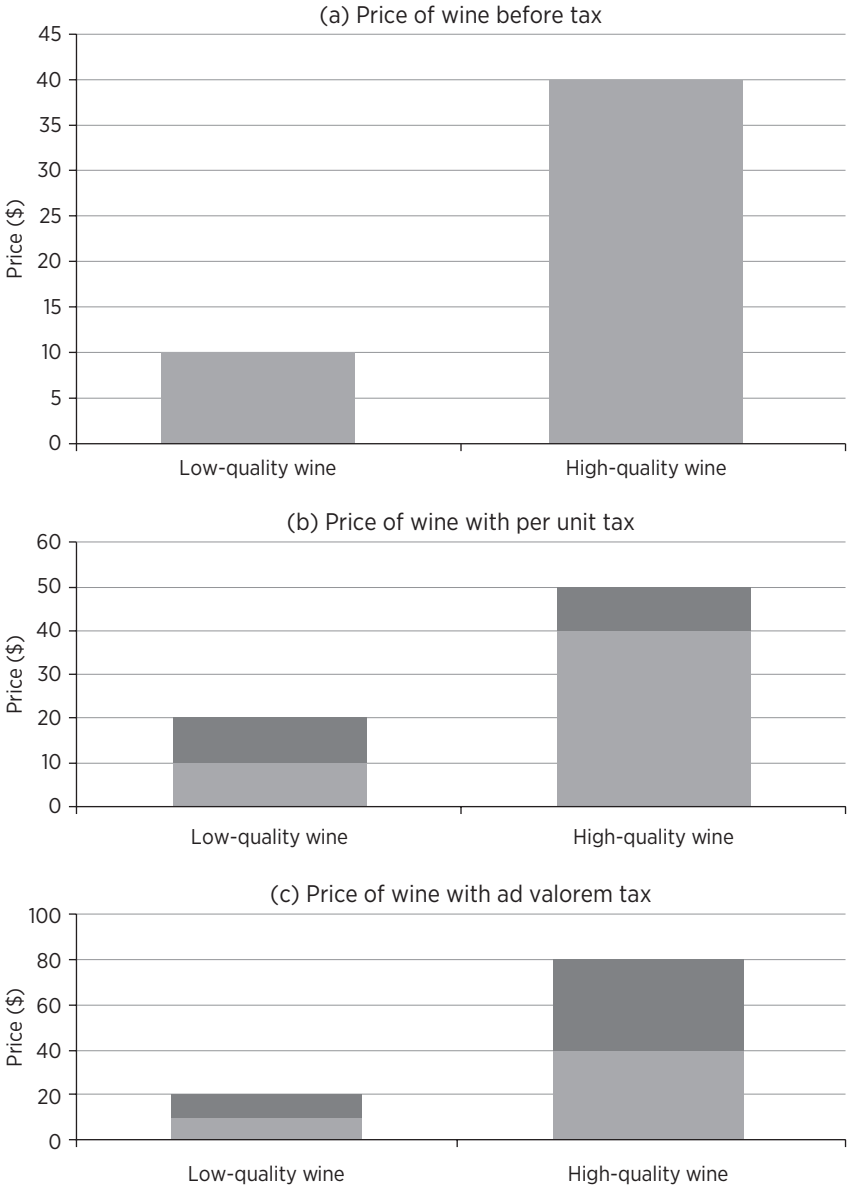
Note: Lighter shading indicates base price; darker shading indicates amount of tax.

Given the breadth of empirical validations of the theorem, some researchers, such as Bertonazzi et al. (1993), have elevated the status of the Alchian-Allen theorem to the Third Law of Demand. However, others claim that the theorem is much more limited in its application, largely due to ignored income effects. John Umbeck (1980), while admitting that Alchian and Allen were generally correct regarding the effect of shipping charges, argues that the theorem is little more than an interesting application of the First Law of Demand under strict restrictions regarding the nature of the fixed charge. According to Umbeck (1980), the theorem only applies when the common fixed charge does not reflect a change in the good itself. For instance, an increase in the airfare for a given seat on the flight to a vacation destination does not directly change the value characteristics of any possible vacation activities. However, paying a higher airfare to be upgraded to first class on the flight does change the value characteristics of the flight, which is part of the vacation experience. Along these lines, Umbeck states that Thomas Borcherding's and Eugene Silberberg's (1978) explanation of the service charge at a restaurant as a relevant fixed charge is misplaced, because it reflects a difference in the good being purchased: in addition to the physical meal, diners also consume the ambiance, friendly service, food preparation, and clean-up service on the completion of the meal. As such, the experience of dining at a restaurant is not equivalent to dining at home. Therefore, the Alchian-Allen theorem is not applicable in explaining the difference in the quality of meat consumed at home versus that consumed at a restaurant. Umbeck's (1980) argument is similar to that of Tyler Cowen and Alexander Tabarrok (1995), who conclude that the theorem is not supported when a third good is bundled with two similar goods of different quality. However, Umbeck (1980) argues that shipping offers no inherent value to the consumer, does nothing to change the good itself, and thus is a suitable application for the theorem. Likewise, Umbeck (1980) explicitly states that per unit taxes present an ideal application for the Alchian-Allen theorem.

Anderson and Kjar (2008), analyzing the issue of travel costs and product quality choices, present a criticism of Bertonazzi et al. (1993) and an alternative explanation for the Alchian-Allen theorem. They first acknowledge that, regardless of distance, some individuals do not value the good enough to incur any costs of travel or shipping and therefore will not purchase the good, and travel costs will only be imposed on consumers who decide to purchase the good. Thus, each consumer, before purchasing the good, first decides whether the benefit of the good available at a greater distance is worth the additional travel cost over options available to them locally. This decision can ultimately lead to a selection bias. The local consumers will consist of a greater percentage of less

wealthy and lower-demand individuals than will the long-distance consumers: only those who are wealthy enough and who highly value the good will be willing to incur the large travel cost. Given these self-selection issues, it is likely that those consumers with larger travel costs will opt to purchase higher quality versions of the good for reasons unrelated to relative prices. At a minimum, Anderson's and Kjar's (2008) criticisms suggest that economists conducting empirical tests of the Alchian-Allen theorem must specifically control for income and latent demand for the good generally. Some of these empirical issues may be lessened when, say, examining the consumption differences of individuals who travel similar distances but face dissimilar travel costs.

The final limitation discussed here regarding the appropriate application of the Alchian-Allen theorem is offered by Laura Razzolini, William Shughart, and Robert Tollison (2003). The authors admit that the Alchian-Allen theorem is rich in empirical implications. However, when "placed in the context of a market model, its range of applications is narrower than has been acknowledged in the literature heretofore" (Razzolini et al. 2003, 292). Razzolini et al. (2003) present a theoretical model indicating that the theorem's conclusions are correct only under the assumptions of perfect competition and a constant cost industry. Under alternative market assumptions, it is possible that relative prices (and therefore the choice of quality versions) will be unchanged or for the price of the lower quality version of the good to become relatively cheaper. Indeed, as noted by the authors, outlet malls offer a counterexample to the conclusions of the Alchian-Allen theorem. Customers of outlet malls drive nonnegligible distances—a fixed cost of shopping—to buy lower quality (out-of-season, blemished, etc.), lower priced items.

The above criticisms and limitations should not be viewed as arguments that the logic of the Alchian-Allen theorem is wrong. Rather, at worst, the theorem should be viewed as a special case rather than a law of demand. Given these concerns, the occurrence of quality substitution in response to various fixed charges largely becomes an empirical question. I address the empirical evidence in the next section, starting first with broader applications that are relevant only to the Alchian-Allen theorem. I then discuss the empirical findings regarding per unit excise taxes as tests of both the Alchian-Allen and the Barzel theorems.

EMPIRICAL EVIDENCE

Many intriguing empirical confirmations and theoretical proofs have been presented to support the implications of the Alchian-Allen theorem in various

markets. For space considerations, I choose not to provide detailed discussions of any of the theoretical proofs, opting instead to focus attention on select empirical studies. Some of those applications not discussed here include wages and the leisure-childcare tradeoff (Minagawa and Upmann 2013), the use of the contraceptive pill and the preference between masculine or sensitive men in sexual activity (Cuellar 2005), labor market opportunity costs and the choice of college (Caudill et al. 2008), and college tuition and the number of registered credits per semester (Caudill et al. 2008). Their exclusion is purely for space considerations and in no way is a reflection of the quality of the work or importance of its implications.

Nontax Applications

While the primary interest of this chapter in the Alchian-Allen theorem is with regard to its application to excise taxation, I do want to briefly highlight some nontax applications as an indication of the large number of areas to which the theory can be applied. The discussion in this section of the chapter is not an exhaustive coverage of the literature concerning the Alchian-Allen theorem.

Sports offers numerous cases to which the Alchian-Allen theorem can be applied. Bertonazzi et al. (1993) examine the choice of seat at Clemson University football games based on variation in travel distance to attend the game. The authors do, indeed, find that fans who travel the farthest tend to purchase the highest quality seats, as measured by seats purchased across the six seat-quality categories established by the university. Matthew Brown et al. (2007) use a survey of Ohio golf course patrons to test whether golf tourists treat travel costs as a sunk cost or as a bundled cost in planning their golf outings. Their results indicate a strong correlation between distance traveled and expenditures on greens fees, suggesting that tourists treat travel costs as a bundled expense and offering support for the Alchian-Allen theorem. Steven Cobb and Douglas Olberding (2010) conduct a similar test of sports tourists in Ohio who participated in the 2008 Flying Pig half and full marathons. They show that runners who spend more time traveling to Cincinnati enjoyed a higher quality visit, as measured by discretionary expenditures.

The Alchian-Allen theorem also exhibits strong explanatory power in underground markets. For those engaging in the consumption of illegal goods, the threat of detection and arrest by police can be viewed as a unit charge for consuming such goods. This is particularly true of marijuana, where weight and packaging of the product in possession of the accused influences the extent of legal action, and tetrahydrocannabinol (THC) levels specifically play

no role in the enforcement of the law. In most cases, the THC levels of confiscated marijuana—the measure of its potency (i.e., quality)—is never tested. In a coauthored paper, Robert Lawson and I examine whether the Alchian-Allen theorem helps explain the observed average marijuana price differences across the states (Lawson and Nesbit 2013). Employing user-reported data on the website PriceOfWeed.com, we determined that the price of user-identified high-quality marijuana is higher in states with a higher perceived level of law enforcement. However, the price of user-identified low-quality marijuana is lower in these states. These findings suggest that consumers in states with greater perceived law enforcement are switching from lower quality to higher quality marijuana, consistent with the Alchian-Allen theorem.

Along these lines, the Alchian-Allen theorem may be useful in explaining the consumption trends of prohibited goods, such as alcohol during the Prohibition era and many narcotics today. Mark Thornton (1991) explains the fixed charge nature of prohibitions as follows:

> Prohibition establishes a gambling environment rather than an explicit tax. Participants who are actually caught face huge losses from lost revenue, fines, confiscations, and jail terms. Those not caught reap large monetary profits. All market participants, however, incur large costs of risk bearing. The tax is evaluated as a function of the penalties and the likelihood of capture and conviction. (Thornton 1991, 96)

Given imperfect enforcement of Prohibition, concealment becomes desirable. To better conceal the product from authorities, the potency is generally increased, allowing for smaller packages. As such, there are multiple margins of quality—taste, quality of the "high," and concealment, among others—in these examples that could confound an analysis. Despite these potential confounding issues, it is a reasonable hypothesis to expect the quality substitution to take the form of a shift from kegs of beer to quart jars of moonshine or other distilled spirits. Based on estimates by Clark Warburton (1932), the price ratio of spirits to beer in the absence of Prohibition would have been 15.42 to 1; the actual estimated ratio in 1929–1930 was 11.78 to 1. Irving Fisher (1927) produced an alcohol price index indicating that the price of beer rose by approximately 700 percent during Prohibition, while the price of rye whiskey increased by only 312 percent. It should be noted that it is not clear what share of these price effects are due to supply-side adjustments to risk and what is due

to demand-side quality substitution. With that said, Warburton (1932, 170) estimates changes in alcohol expenditures that are at least consistent with the Alchian-Allen theorem: "Prohibition has raised the amount spent for spirits to three and a half billion dollars, and reduced that for beer to less than a billion dollars."

Finally, as a transition back to a discussion of excise taxation, I explore the empirical literature applying the Barzel and Alchian-Allen theorems to the shipping industry, specifically with regard to transportation costs, import quotas, and tariffs. Yoram Barzel and Christopher Hall (1977, 65–71) present evidence of quality substitution in response to import quotas on crude oil. David Hummels and Alexandre Skiba (2004) hypothesize that shipping costs lead firms to ship high-quality goods abroad while leaving lower quality goods for consumption domestically, extending the "shipping the good apples out" argument to a broad case. Using detailed shipping data for every three-digit commodity classification covered in the Harmonized System, they find strong evidence in support of their hypothesis. Specifically, the authors estimate that a doubling of freight costs increases average free on board prices (exclusive of shipping prices) by 80–141 percent, suggesting in most cases a substitution to higher value commodities.

Additionally, Hummels and Skiba (2004) examine the potential for ad valorem tariffs to cause quality substitution. Ad valorem costs are generally argued to have no effect on quality substitution. However, Hummels and Skiba suggest that in the presence of a second cost in the form of a per unit cost (shipping charges), an increase in the ad valorem cost dampens the effect of the per unit cost. As such, they argue, the ad valorem tariff is expected to reduce average product quality as measured by free on board prices. Their results are consistent with their logic. They find that a doubling of ad valorem tariffs reduces average free on board prices by 146–256 percent. Their argument that ad valorem charges work to dampen the Alchian-Allen quality substitution is also supported by the results of Pramesti Resiandini (2012), who investigates Japanese and Korean automobile exports. Resiandini finds that insurance and other charges, which are ad valorem in nature, tend to reduce or eliminate the Alchian-Allen effect expected from per unit freight charges.

Excise Tax Applications

Barzel (1976) originally tested his hypothesis in three markets: cigarettes, gasoline, and alcohol. His empirical results were only weakly supportive of his theory, as only the cigarette market generated statistically significant results.

Terry Johnson (1978) and Michael Sumner and Robert Ward (1981) made improvements to Barzel's (1976) model to better account for ad valorem taxes, adding state fixed effects and adjusting for backlogged inflation, but both still rely on tests concerning the change in price. Johnson's (1978) results offer support of the expected quality substitution, while Sumner and Ward (1981) found no evidence of such substitution. Although the findings of these three studies offer, at best, mixed evidence in favor of Barzel's theorem, when interpreted in the context of a modeling bias, the results may be more supportive than they initially seem.

Each of the three papers discussed above suffered from data limitations that prevented their authors from conducting a direct test of the theory. Without data on market shares, the researchers relied on a test involving whether the average price increased by more than the tax. They interpret a price change exceeding the tax as an indication that consumers bought a higher percentage of higher quality and higher priced versions of the good. This method, which assumes the full burden of the tax falls on consumers, biases the results against finding supportive evidence of the theory. Consider a scenario with a $1 unit tax where only $0.80 of the tax burden falls on consumers. In such a scenario, had the researcher found evidence that the price increased by $0.95, he would have concluded that there is insufficient evidence to support quality substitution, since the price did not increase by more than $1. This conclusion would be mistaken, as the proper test is whether the price increased by more than $0.80, the share of the tax shifted to consumers: in this example, the price did indeed increase by more than the consumers' share of the tax burden. Each of these studies also are based on a pure cross-section of state-level data such that the results rely on the quality of cigarettes differing from state to state, something that even Barzel (1976) mentions as a potential limitation.

Russell Sobel and Thomas Garrett (1997) avoid the modeling issues faced by Barzel (1976) and others by using data on the quantities of premium and generic brand cigarettes sold—data not previously available. Generic brand cigarettes were introduced and began to acquire a sizable market share in 1982. Sobel and Garrett (1997) explain that generic cigarettes are of a lower quality relative to premium brands on several margins: taste, quality of tobacco, and freshness, to name a few. As Sobel and Garrett (1997) suggest, the timing of the arrival of generic cigarettes to the market offers support for Barzel's theorem. The authors explain that the theory indicates that the introduction of generic cigarettes should coincide with a period of low unit taxes preceded by a period of relatively high per unit taxes that initially supported high-quality versions

of the good. At the time of their writing (1997), Sobel and Garrett explain that 1972 represented the highest historical real value of cigarette taxation, and the taxes of 1982 represented the lowest historical real cigarette taxation after the high inflation rates of the 1970s eroded the real value of unit taxation. Thus, it appears that the theorem may apply symmetrically. That is, the imposition of a fixed charge (e.g., a unit tax) leads to a substitution toward higher quality, while the removal or reduction of a fixed charge provides incentives to substitute toward lower quality. I discuss this symmetry in greater detail below.

Given the modern availability of market share data, Sobel and Garrett (1997) are able to test the Barzel and Alchian-Allen theorems directly for the period 1990–1994. Specifically, they look for systematic changes in the market share of premium-brand cigarettes that can be explained by variation in state tax rates. Their results indicate that for every 3¢ increase in a state's per pack cigarette tax, the market share of premium-brand cigarettes increases by one percentage point. Given the average per pack cigarette tax ($0.54) in their sample, their results imply that the market share of premium-brand cigarettes was, on average, 17 percentage points larger than it otherwise would have been, solely due to the taxation of cigarettes. Sobel and Garrett (1997) also test for the impact of ad valorem taxes. While no state imposed an ad valorem excise tax on cigarettes—New Hampshire switched to the per unit tax prior to the introduction of generic cigarettes in 1982—forty-four states applied the state sales tax to cigarettes, and a handful of those states also applied the sales tax to the excise tax on cigarettes. Ultimately, sales taxes were found to have a negative but statistically insignificant impact on the market share of premium cigarettes. The direction of this estimated relationship may be consistent with the Hummels and Skiba (2004) argument that ad valorem costs work to dampen the effects of per unit charges, leading to a potential reduction in average quality. Ultimately, as Hummels and Skiba (2004) argue, the magnitude of this effect will depend on the size of the ad valorem charge relative to the per unit charge. In this case, the ad valorem taxes are not very large relative to the per unit taxes, suggesting that the quality substitution effect attributed to the sales tax may be statistically weak.

In a more recent study of the Barzel theorem in the cigarette industry, Javier Espinosa and William Evans (2013) employ high-frequency price and quantity data available from supermarket scanners in 812 stores across twenty-nine states during 2001–2006. Their sample includes thirty-two state tax increases and one tax reduction. They present three interesting and relevant results. First, they find a pass-through rate of roughly 100 percent for both premium-brand

and generic cigarettes; that is, for every $1.00 tax increase, retail prices increase by $0.99. The estimated pass-through rate is nearly identical to that found by Lesley Chiou and Erich Muehlegger (2010), who also use scanner data. Thus, it appears that consumers bear the full burden of the excise tax on cigarettes. This finding at least suggests that any bias in the empirical models of Barzel (1976), Johnson (1978), and Sumner and Ward (1981) is minimal.

Espinosa and Evans (2013) also test the Barzel theorem, allowing for the substitution in quality to be revealed in two fashions. The first test is the standard substitution across brands, similar to that of Sobel and Garrett (1997). They find no tax-induced shift toward premium-brand cigarettes, despite a reduction in the relative price of such brands. The authors thus conclude that there is no flight to higher quality in response to per pack cigarette taxes, as is suggested by the Barzel theorem. While this result differs substantially from that of Sobel and Garrett (1997), the authors note that circumstances are substantially different in the two time periods examined. Specifically, Espinosa and Evans note the greater industry concentration, substantially higher taxes, and increased restrictions on advertising during the period studied relative to the 1990–1994 sample of Sobel and Garrett (1997).

Espinosa and Evans do offer support for the Barzel theorem when accounting for convenience as a measure of quality. Specifically, they hypothesize that if "the convenience of purchasing single packs (e.g., easier to store, more convenient to carry around) is an untaxed quality dimension, we should see a shift to single pack purchases" (Espinosa and Evans 2013, 149). This is, in fact, what the authors observe. A $1.00 increase in the per pack cigarette tax rate is shown to reduce the carton market share by about 6.2 percentage points, a nearly 14 percent reduction from the mean market share.

This shift toward individual packs of cigarettes may also lead to shifts in the location of purchase, as consumers will visit stores more frequently to purchase cigarettes, albeit buying a smaller quantity each trip. It may be a reasonable assumption, then, that these consumers will attempt to minimize the inconvenience of such purchases and favor convenience stores/gas stations over grocery stores and supermarkets. As such, the earlier discussion of consumers shifting their preference of location for purchases may be an outcome that is at least partially explained by the Barzel and Alchian-Allen theorems. For instance, according to industry interviews summarized by Bloomberg writer Jennifer Kaplan (2017), the tax of 1.5¢ per ounce of sugary drink tax imposed in January 2017 in Philadelphia is "hurting grocery stores and bodegas in poor neighborhoods, where shoppers tend to buy in bulk, more than [it hurts] convenience stores." After little more than a month into the new Philadelphia

sugary drink tax, retailers are also observing a shift toward smaller, single-serve containers of soda.

I earlier mentioned the possible symmetric nature of the Alchian-Allen theorem. Critics of the theorem often attempt to use narratives involving the removal of or reduction in fixed charges to suggest the nonuniversal nature of the Alchian-Allen theorem. For instance, in their critique of Bertonazzi et al. (1993), Anderson and Kjar state:

> If a fan living a long distance away were able to find a less expensive . . . mode of travel to the games, then he or she would be more likely to stay in a Motel 6 or a KOA camp-ground instead of the usual luxury accommodations. Although this seems to be a ridiculous example, never-theless, if the theory were to hold one way (adding a fixed cost drives consumers to the higher-quality good), then it also would have to hold in the other direction (subtracting a fixed cost drives consumers to the lower-quality good). (Anderson and Kjar 2008, 655–56)

Although the authors use an unrealistic and extreme substitution—luxury hotels to KOA campgrounds—to make their point (substitutions occur at the margin, not in the extremes), their message is correct. If the Alchian-Allen theorem is to be considered a law of demand, it must hold in both directions.

Philip DeCicca, Donald Kenkel, and Feng Liu (2015) provide such a test of the Alchian-Allen theorem in the reverse direction. New York State excise taxes historically need not be collected on sales of cigarettes on Indian res-ervations. Although taxes on sales to nontribal members are to be collected, this has been difficult to enforce, given that the state has relied on voluntary reporting by the tribes of such sales. The tax advantage to nontribal members traveling to tribal land to purchase cigarettes is thus substantial and effectively represents the removal of a unit tax.[1] DeCicca et al. (2015) find that nontribal members purchasing cigarettes on New York Indian Reservations are nearly 20 percentage points more likely to purchase low-quality cigarettes and are about 15 percentage points less likely to purchase high-quality, premium-brand cigarettes. Their results thus offer some empirical evidence that the Alchian-Allen theorem does, indeed, hold in the other direction: subtracting a fixed cost does appear to drive consumers to purchase more of the lower quality versions of a good. The remainder of my discussion returns to the

Alchian-Allen theorem in its original direction, the imposition or increase of a fixed charge leading to increased product quality.

Empirical tests of the Barzel and Alchian-Allen theorems extend beyond the cigarette industry. In a 2007 publication, I test for tax-induced quality substitution in the gasoline industry, measuring quality not by brand but by octane rating (Nesbit 2007). This particular test of the Alchian-Allen theorem is interesting, as the predictions of the theoretical literature have thus far not arrived at a consensus regarding the applicability of the theorem in a world of three or more quality grades of a good. John Gould and Joel Segall (1968) suggest that the introduction of a third quality option leads to conclusions that violate the Alchian-Allen theorem. In contrast, Borcherding and Silberberg (1978) show that the introduction of the third good will not violate the theorem as long as the other two goods are close substitutes. Liquin Liu (2011) presents a theoretical model generalizing the Alchian-Allen theorem to a commodity group with three quality-differentiable versions. My empirical analysis (Nesbit 2007), in which I conclude that per gallon gasoline taxes tend to lead to proportionately more consumption of premium-grade gasoline, proportionately less consumption of regular-grade gasoline, and no net effect on the consumption of mid-grade gasoline, ultimately appears to be more consistent with the theoretical modeling of Liu (2011). A 10¢ increase in the gasoline tax rate is shown to increase the market share of premium-grade gasoline by 1.6 percentage points (a 9.4 percent increase) and reduce the market share of regular-grade gasoline by roughly 1.6 percentage points (a 2.2 percent decrease).[2]

Using an empirical model similar to that of Sobel and Garrett (1997) and Nesbit (2007), Martin Ljunge (2011) finds that the market share of high-quality wine increases in response to unit taxes on wine, while ad valorem taxes have no significant effects. The sample covers 1995–2000 and is restricted to thirty-two US states plus the District of Columbia, because the remaining eighteen states are control states, where the sale of wine is directly controlled by the government such that it is difficult to separate a markup from any sort of effective tax. Per unit excise taxes on wine are levied on a per gallon basis and range from 10¢ to $2.46 with an average of 71¢ during the sample period. Ljunge (2011) finds that the effect of the average per gallon tax on wine is to increase the market share of high-quality, imported wine by 1.35 percentage points, an 8 percent increase from the mean market share. These results are qualitatively consistent with estimates by Christian Rojas and Tianji Shi (2011) of an increase in the sales of high-quality beer in response to higher transportation costs.

THE POLICY RELEVANCE OF TAX-INDUCED QUALITY SUBSTITUTION

The implications of the Barzel theorem and Alchian-Allen theorem must be understood and taken into account by policymakers to develop appropriate tax policy. In this chapter, I focus the discussion on two primary concerns: (1) the use of unit taxation as a nudge to reduce the consumption of addictive and habit-forming goods can backfire, and (2) an understanding of tax-induced quality substitution offers another margin on which firms engage in active and reactive rent-seeking. I discuss each concern and offer appropriate policy responses below.

Selective Taxation, Nudges, and Addictive and Habit-Forming Consumption

The use of excise taxes to discourage the consumption of socially undesirable, addictive, and habit-forming goods has been common throughout US history. Taxes on alcohol, cigarettes, gambling, and—before their prohibition—opium and cocaine all gained at least some public support, because the proponents promised that the tax would reduce the consumption of the respective good. Whether this support for reduced consumption has its origins in religious, moral, health, or other arguments is irrelevant to this discussion. If per unit taxes are employed in an attempt to reduce the consumption of such goods, we should observe consumers buy fewer units while also substituting toward higher quality versions of the good. In other words, we should observe consumers shift toward more potent versions of the good. According to Adam Gifford (1999), to determine whether such an outcome is desirable, we must also examine the biological and behavioral aspects of addiction and habit formation.

Gifford (1999) presents two biological mechanisms of addiction that ultimately will have policy consequences. First, he argues that addictive substances activate the motivational area of the brain, establishing cues that develop into a desirable complementary component of consuming the good. The complementary associations, say, between smoking and drinking can make it difficult to quit one without quitting the other (Gulliver et al. 1995). The sight of a needle can reinforce the effects of heroin such that seeing a needle stimulates the craving of the drug. Similarly, the sight of a particular person with whom an individual regularly consumed an addictive substance can stimulate a desire for the good.

Second, Gifford (1999) discusses how addictive goods tend to lead to set-point behavior: individuals will seek to maintain the set-point level of blood

or brain concentrations of the active drug. The set point is established based on the blood or brain concentrations resulting from the initial consumption of the good and then is updated as longer term consumption patterns change. For example, in response to a mandate to reduce nicotine levels in each cigarette, the set-point response by an individual would be simply increase "the volume and depth of inhalations or the number of cigarettes smoked in a given period of time" (Gifford 1999, 304). Such a response ultimately increases the health dangers caused by tars and other harmful substances in cigarettes.

Both biological mechanisms, particularly when taken combined with the implications of the Barzel and Alchian-Allen theorems, can be problematic for designing excise taxes intended to reduce the prevalence of a particular addictive good. Premium-brand cigarettes generally are more flavorful, but it is the tars that give cigarettes their taste (Gifford 1999). When consumers respond to increased unit taxes on cigarettes by substituting premium brands, they expose themselves to greater concentrations of tars and other substances. The taste of the cigarettes can serve as the complementary good that ultimately reinforces the effects of nicotine. Furthermore, given that consumers are also purchasing fewer packs of cigarettes (First Law of Demand), it is quite possible that many consumers do increase the volume and depth of inhalations of the higher quality cigarettes, which already have increased tar content. William Evans and Matthew Farrelly (1998) find that, in response to per unit cigarette taxes, consumers do substitute toward cigarettes with greater concentrations of tar and nicotine. Furthermore, while adults consume fewer cigarettes, their nicotine and tar intake is unaffected. This is in contrast to teenagers, whose demand is more elastic. According to Evans and Farrelly (1998), teenagers' average daily tar and nicotine intake is estimated to rise after a tax hike.

Following from Gifford (1999), prohibition—whether through outright bans or via prohibitions by price (see chapter 15, this volume, by Michael LaFaive)—ultimately "results in substitutions along several margins, most of which, when coupled with biological effects, work in the opposite direction of the goal of reducing harmful outcomes" (Gifford 1999, 306). The preceding discussion of tax-induced quality substitution alongside the biological mechanisms may lead some readers to conclude that ad valorem taxation might be preferable to per unit taxation. This would be misguided. Ad valorem taxation that is large enough to overcome the complementary characteristic of addictive goods and substantially reduce the legal consumption of the commodity will still fall prey to the same set-point behavioral response discussed above. Furthermore, such a tax also will not avoid the incentives of many consumers to

instead purchase the product in underground markets with questionable quality and content and with increased health risks. A better policy might be one of not employing taxes to nudge consumers. This does not necessarily eliminate the role of the government in reducing the occurrence of addictions. For instance, the government could still provide funding for educational campaigns concerning the harmful effects of addictive substances, but it may be wiser to raise the tax revenue to fund such a program via a broad-based tax.

Tax–Induced Quality Substitution and Rent–Seeking

In 2010, California's Proposition 19, which proposed to legalize marijuana for recreational purposes for individuals aged 21 and older, was opposed by the majority of residents of the tri-county region known as the "Emerald Triangle," a region known to be highly dependent on the marijuana crop for medicinal purposes.[3] At first thought, this might be a surprising outcome. Legalization would arguably bring about additional demand, and those in the Emerald Triangle have the experience and know-how to accommodate a significant expansion of that demand. However, legalization would also bring about additional competition, particularly from to-be growers of lower quality marijuana that would not require the complex hydroponic grow systems common in the Emerald Triangle. Many of the marijuana growers of the Emerald Triangle, then, appear to have voted against legalization in an effort to protect their market share and their past investments in complex growing systems. Prohibition of recreational marijuana also benefits law enforcement bureaus who maintain a level demand for their services and those skilled in the production and distribution of marijuana in the underground economy who profit from the demand left unfulfilled in legal markets. This is a classic case of Bruce Yandle's (1983) "Bootleggers and Baptists" theory in which individuals who otherwise are on opposite sides of a broader issue find themselves benefiting from the same policy but for entirely different reasons.

I introduce Yandle's "Bootleggers and Baptists" because the implications of the Barzel and Alchian-Allen theorems can make for some strange bedfellows in other cases involving excise tax policy. For instance, if the cigarette industry is confident that new taxes on the industry are forthcoming, the health lobby may find themselves on the same side with premium-brand cigarette manufacturers arguing in favor of unit taxation. Premium-brand manufacturers would want to minimize the damage to their profits. If the choice is between an ad valorem tax (which does nothing more than reduce demand generally)

and a per unit tax (which reduces demand generally but shifts a portion of the remaining demand toward premium-brand cigarettes), it should be obvious that the premium-brand manufacturers would favor the latter and might go to considerable expense to promote that option. Generic-brand manufacturers likely would not sit idly by, as they stand to lose in two respects: reduced sales following from the First Law of Demand (quantity substitution) and reduced sales following from the Barzel and Alchian-Allen theorems (quality substitution). Lobbying expenditures on one side begets additional lobbying expenditures on the other.

Consider other examples. The health lobby and convenience store owners likely share common interests in supporting the 1.5¢ per ounce sugary drink tax in Philadelphia. It is possible that convenience stores may lose some revenue due to an overall reduction in the consumption of sugary drinks; however, if consumers are responsive enough on the quality (convenience) margin, it is possible, although not likely on a large scale, that some individual convenience stores would experience an increase in net sales.

Finally, environmental activists favoring an increase in the federal gasoline tax may not face strong opposition from gasoline retailers. Profits of gasoline retailers could feasibly remain largely unchanged if (1) the markup on premium-grade gas is sufficiently higher than on regular-grade gas, and (2) if the substitution between quality grades is sizable enough to offset the loss in total sales. In regards to the first condition, *The Chicago Tribune* (Zwahlen 1990) reported that the typical markup for premium-grade gasoline is 7 percent while it is only 3 percent for other grades. Determining whether the quality substitution is large enough to fully offset the loss in sales generally is an empirical question that is beyond the scope of this chapter. However, it is feasible that gasoline retailer profits could remain largely unaffected by modest gasoline tax increases such that the industry would expend few resources opposing proposed tax increases.

The primary point I am making here is that firms are likely adjusting their lobbying efforts in light of their own observations of outcomes consistent with the Barzel and Alchian-Allen theorems. While it is highly unlikely that firms lobby in favor of new or increased taxation on their own industry, it would not be surprising to observe producers of higher quality, name-brand commodities lobbying in favor of per unit taxes over ad valorem taxes when new taxes are eminent. This lobbying can lead to costly and inefficient policy outcomes that come at the expense of consumers or smaller, less politically connected firms.

CONCLUSION

Yoram Barzel (1976) and Armen Alchian and William Allen (1964) have both theorized that the imposition of per unit taxes, while reducing the overall quantity of a good consumed, can create incentives for those consumers who choose to still purchase the good to substitute, on average, toward higher quality versions of the good. The quality substitution theorems are not without their detractors. Ultimately, in light of the various concerns brought forward since its introduction, the question of whether the Alchian-Allen theorem applies in various circumstances must be resolved empirically. The empirical evidence with respect to unit taxation has been generally supportive of the Alchian-Allen and Barzel theorems. As such, it may be reasonable to expect that the imposition of per unit taxes is likely to systematically lead to a shift from lower quality and newer brands of a good toward higher quality and well-established brands. As such, per unit taxes can potentially serve as additional obstacles to new market entrants, further protecting the already entrenched firms.

This chapter leads to one primary policy implication: to minimize the impact that tax policy has on changing consumer choices, it may be preferable to impose ad valorem taxes rather than per unit taxes when commodity taxation is to be employed as a means to fulfill a revenue requirement. Ad valorem taxes have been argued and empirically shown not to alter relative prices or the choice between different quality grades of the taxed commodity. This is not to suggest that a universal sales tax is preferable; indeed, the ad valorem tax rate could vary by commodity in line with other theories, such as the Ramsey Rule, regarding efficient commodity taxation. My argument here is simply that by favoring ad valorem taxation as opposed to per unit taxation, the efficiency of the tax code can be improved and the potential for political favoritism toward select firms is reduced.

NOTES

1. While the unit tax is removed, it is replaced by a smaller fixed charge in the form of transportation costs. As such, a more accurate description of this scenario may be a reduction in the aggregated fixed charge of purchasing cigarettes.

2. Coats et al. (2005) also find modest evidence in the gasoline market in support of the Barzel theorem.

3. See http://www.allgov.com/news/unusual-news/marijuana-growers-voted-against -legalization?news=841715.

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