Pigouvian Gun Taxation

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Abstract:

Despite increasing rates of gun violence in the United States in recent years, few estimates of the marginal social costs of guns have been undertaken, and the use of Pigouvian taxation to induce the internalization of negative externalities from firearms has rarely been discussed. This study presents estimates of the annual volume of gun sales and the average price of firearms in the market, and then estimates their marginal external costs. The analysis indicates that existing taxes on firearms erode at least $2.22 billion per year in deadweight loss, but fail to fully induce internalization of the negative externalities of guns. For every additional million guns sold, there are about 100 additional firearm-related homicidal and accidental deaths. The marginal external cost per gun is conservatively estimated to be at least $619. Allocative efficiency would require a Pigouvian tax of at least 59.62 percent of the retail price.

Keywords: Pigouvian taxation, negative externalities, marginal social cost, firearm-related deaths, guns.

JEL codes: D04, H23, L64, I31

I. Introduction

American society has experienced increasing levels of gun violence in recent years. Firearm-related deaths increased by more than 50 percent over the first two decades of this century, and have exceeded 45,000 mortalities annually since 2020 (National Safety Council, 2024). As the leading cause of death among children and teenagers (McGough *et al*., 2023), gun violence has

been declared a public health crisis by the American Medical Association (Leonard, 2016), the American Public Health Association (2021), and the U.S. Surgeon General (2024), among others. In public opinion polls, gun violence ranks among the nation's top concerns (Pew Research Center, 2023; Maher, 2024; Ad Council, 2024).[1] Recent estimates of the total annual cost to society from gun violence range from $280 billion to $557 billion (Pereira, 2021; Smith, 2016; Centers for Disease Control and Prevention, 2020; Miller *et al*., 2024; Everytown Research & Policy, 2022).

A traditional remedy for the negative external costs imposed on society by the sale of goods and services is Pigouvian taxation. The basic premise is that by raising the price paid by buyers and reducing the price received by sellers, the tax forces consumers and producers to internalize the costs that would otherwise be shifted to third parties. Yet, while Pigouvian taxes have long been applied to products such as alcohol, tobacco, and gasoline, the internalization of negative externalities from firearms has rarely been studied. Much of the discussion that has occurred concerns the legality of taxing products whose ownership is protected by the Second Amendment to the Constitution. The general (though not universal) consensus appears to be that Pigouvian gun taxes would be lawful, especially if the tax revenue was used to mitigate firearm-related harms (Shearer and Anderman, 2018; Salib, 2021; Griffith and Staudt, 2021).

The federal government currently assesses a Firearms and Ammunition Excise Tax (FAET) of 10 percent on handguns and 11 percent on long guns and ammunition; these rates have remained constant for seven decades, with exemptions for firearm parts, small producers, and production for military, police, educational, and personal use (Gravelle, 2023). Recent Congressional proposals, if enacted, would have raised the federal tax to 30 percent on all guns

[1] Using contingent valuation, Cook *et al*. (2025) found that American households would be willing to pay an average of $744 per year to reduce gun violence by 20 percent.

(Eisenhauer, 2025a), but those bills were never brought to a vote. While most states levy general sales taxes that apply to guns, only Pennsylvania, California, and Colorado assess excise taxes on gun sales—Pennsylvania at a flat $3 per gun, California at 11 percent since July 1, 2024, and Colorado at 6.5 percent since April 1, 2025 (Associated Press, 2023; McCleary, 2024).[2] At the local level, Cook County, Illinois (encompassing Chicago), Tacoma, and Seattle assess excise taxes on firearms (Brownlee, 2024). Although none of these taxes appear to have resulted from an explicit analysis of social costs, their existence nevertheless induces some internalization of externalities, as do the general sales taxes that apply to guns in almost every state.[3] The extent to which they do so, however, has not previously been determined.

The present paper attempts to measure the marginal external cost of firearms in the U.S., the deadweight loss resulting from their overproduction, the extent to which current taxes correct the inefficiency, and the Pigouvian tax rate that would induce buyers and sellers to fully internalize the negative externalities. The next section outlines the basic model, and the empirical implementation follows. After providing estimates of annual firearm sales as well as their average prices and tax rates, we estimate the marginal external costs of guns. We then use the results to estimate the deadweight loss at equilibrium, the deadweight loss with existing taxes, and the tax rate that would eliminate all deadweight loss. Several limitations are discussed in the conclusion.

[2] For the impacts of the California and Colorado taxes on gun sales and tax revenues, see Eisenhauer (2025e). Other states, including Maryland, Massachusetts, New Mexico, New York, Vermont, and Washington, have considered, but not yet enacted, special excise taxes on guns (Brownlee, 2024).

[3] Flat taxes, such as Pennsylvania's $3 per gun and Seattle's $25 per gun, lose value over time due to inflation. We focus here on *ad valorem* taxes, including the federal FAET and general sales taxes levied at the state and municipal levels.

II. Model

Consider the basic model of Pigouvian taxation depicted in Figure 1. Social costs are defined as the sum of private costs, including those from the production and distribution of output, and the external costs that are imposed on third parties outside the buy-sell transaction. Thus, for each additional unit of output, marginal social cost (*MSC*) is equal to marginal external cost (*MEC*) plus marginal private cost (*MPC*), the latter of which is captured by the market supply curve (Bonner, 2022; Nesheva-Kiosseva, 2023). The marginal benefit (*MB*) is assumed to accrue privately, and is reflected in the market demand curve (*ibid*). In the absence of any taxes, the market would achieve an equilibrium at Q_0, where *MB* = *MPC*, but society would incur a deadweight loss (*DWL*) because the marginal social cost would exceed the marginal benefit (*MSC* > *MB*). Existing taxes, including the federal FAET as well as state and local sales taxes that apply to guns, reduce output to Q_1, which diminishes the deadweight loss. A Pigouvian tax equal to the marginal external cost per gun would further reduce output to Q_2 and eliminate the deadweight loss entirely, resulting in a state of market efficiency (*MSC* = *MB*).[4] On the other hand, if the tax rate was set too high, then it would create a new deadweight loss by inducing underproduction such that $Q < Q_2$ and *MB* > *MSC*.

[Figure 1 here]

To formalize the model and facilitate its empirical estimation, we assume isoelastic *MB* and *MPC* curves given by

$$MB = P^D = aQ^{-\alpha} \tag{1}$$

and

[4] Although the Pigouvian tax achieves allocative efficiency at Q_2, to the extent that $MEC_2 > 0$, external costs are still imposed on some members of society. In principle, the tax revenue could be used to compensate the victims of the externalities (or their families). Colorado's gun tax revenue, for example, is primarily allocated to victim services (Eisenhauer, 2025e).

$$MPC = P^S = bQ^\gamma \tag{2}$$

respectively, where Q is the quantity of output, P^D is the price buyers pay, P^S is the price sellers receive, $a > 0$, $\alpha \geq 0$, $b > 0$, and $\gamma \geq 0$. Then $\varepsilon^D = (\partial Q/\partial P^D)/(Q/P^D) = -1/\alpha$ is the price elasticity of demand, and the price elasticity of supply is $\varepsilon^S = (\partial Q/\partial P^S)/(Q/P^S) = 1/\gamma$. For any tax rate $\tau \geq 0$,

$$P^D = (1+\tau)P^S\,, \tag{3}$$

and the quantity of output transacted in the marketplace is

$$Q = [a/b(1+\tau)]^{\frac{1}{(\alpha+\gamma)}}\,. \tag{4}$$

Using subscripts to denote the state of the market as depicted in Figure 1, the untaxed equilibrium state is 0, the current state is 1, and 2 denotes the state with a Pigouvian tax. Thus, with $\tau_0 = 0$, the market would achieve an untaxed equilibrium at an output of

$$Q_0 = [a/b]^{\frac{1}{(\alpha+\gamma)}} \tag{5}$$

and an equilibrium price of

$$P_0 = b[a/b]^{\frac{\gamma}{(\alpha+\gamma)}}\,. \tag{6}$$

Neither Q_0 nor P_0 is directly observable, but we can retrieve both of these from known values. Note that with the current tax rate of τ_1, the market produces

$$Q_1 = [a/b(1+\tau_1)]^{\frac{1}{(\alpha+\gamma)}}\,, \tag{7}$$

and the seller's price at Q_1 is

$$P_1^S = b[a/b(1+\tau_1)]^{\frac{\gamma}{(\alpha+\gamma)}}\,. \tag{8}$$

Dividing (7) by (5) and rearranging, we get

$$Q_0 = Q_1(1+\tau_1)^{\frac{1}{(\alpha+\gamma)}}\,. \tag{9}$$

Likewise, dividing (8) by (6) and rearranging yields

$$P_0 = P_1^S(1+\tau_1)^{\frac{\gamma}{(\alpha+\gamma)}} \ . \tag{10}$$

Thus, empirical knowledge of the price elasticities (and hence, α and γ), as well as current output (Q_1), the current retail price (P_1^S), and the existing tax rate (τ_1) will allow us to recover the equilibrium values. Once Q_0 and P_0 are known, the parameters *a* and *b* can be determined from (5) and (6) as

$$a = (Q_0)^{\alpha} P_0 \tag{11}$$

and

$$b = P_0/(Q_0)^{\gamma} \ . \tag{12}$$

By definition, *MSC* = *MPC* + *MEC*. We will assume that *MSC* is proportional to *MPC*, such that for any level of output, $MSC = \lambda MPC$ and thus $MEC = (\lambda - 1)MPC$, where $\lambda \geq 1$ and λ is constant across all states of the market. Empirically, we will estimate λ at the current market position, Q_1, as

$$\lambda = (MEC_1/MPC_1) + 1. \tag{13}$$

Then Q_2 occurs where *MSC* = *MB*; that is, where $\lambda b Q^{\gamma} = aQ^{-\alpha}$, so we have

$$Q_2 = [a/\lambda b]^{\frac{1}{(\alpha+\gamma)}} \ . \tag{14}$$

As portrayed in Figure 1, the original deadweight loss from externalities is the area between *MSC* and *MB*, from the equilibrium at Q_0 down to the efficient state at Q_2; that is

$$DWL_0 = \int_{Q_2}^{Q_0} (\lambda b Q^{\gamma} - aQ^{-\alpha})\, dQ = \left\{ \left(\frac{\lambda b}{1+\gamma} \right) Q^{1+\gamma} - \left(\frac{a}{1-\alpha} \right) Q^{1-\alpha} \right\} \Big|_{Q_2}^{Q_0} \ . \tag{15}$$

However, because some taxes are already in place, the current market position is Q_1, and a portion of the deadweight loss has already been eroded; the remaining deadweight loss is

$$DWL_1 = \int_{Q_2}^{Q_1} (\lambda b Q^{\gamma} - aQ^{-\alpha})\, dQ = \left\{ \left(\frac{\lambda b}{1+\gamma} \right) Q^{1+\gamma} - \left(\frac{a}{1-\alpha} \right) Q^{1-\alpha} \right\} \Big|_{Q_2}^{Q_1} \ . \tag{16}$$

The effect of current taxation on efficiency is simply the difference between DWL_0 and DWL_1. Finally, the Pigouvian tax rate that sets $MSC_2 = MB_2$ and thus eliminates deadweight loss is

$$\tau_2 = MEC_2/MPC_2 = \lambda - 1, \tag{17}$$

and the tax revenue (TR_2) generated by the Pigouvian tax is equal to $\tau_2 P_2^S Q_2$, which is calculated as

$$TR_2 = \tau_2 b \left[\frac{a}{\lambda b}\right]^{\frac{1+\gamma}{\alpha+\gamma}}. \tag{18}$$

The following section estimates each of these values empirically, beginning with the actual state of the market at Q_1, P_1^S (or equivalently, MPC_1), τ_1, and P_1^D. We then turn to counterfactuals, quantifying the equilibrium output (Q_0) and price (P_0). Finally, we estimate the marginal external cost per firearm (MEC_1), the output that would occur in a state of market efficiency (Q_2), the deadweight losses that occur at Q_0 and Q_1, and the Pigouvian tax rate that would eliminate all deadweight loss to establish efficiency.

III. Empirical Implementation

Gun Sales

Accurate data on the volume of guns sold in the U.S. are difficult to obtain. In the absence of a national database of sales, we follow Brauer (2013), Brownlee (2025), and Gabriele (2025) in using data from the Federal Bureau of Investigation's (FBI's) National Instant Criminal Background Checks System (NICS) to estimate the number of firearms sold each year. The 1999-2023 data are available at https://www.fbi.gov/file-repository/cjis/nics_firearm_checks_-_year_by_state_type.pdf/view, and are shown in Table 1. Although there were initially more than twice as many background checks for rifles and shotguns, the number of background checks for handguns has exceeded the number for long guns each year since 2014. To estimate sales,

Brauer (2013) multiplied the number of background checks conducted for multiple gun purchases by a factor of 2, added in single handgun and long gun background checks, and then multiplied the total by a factor of 1.1; Brownlee (2025) extends the time series by following the same procedure. In recent years, private sales have increased substantially, as have sales of "other" firearms, which the NICS website defines as "frames, receivers and other firearms that are neither handguns nor long guns (rifles or shotguns), such as firearms having a pistol grip that expel a shotgun shell, or National Firearms Act firearms, including silencers." To account for these changes, we also provide an alternative series based on Gabriele's (2025) procedure, which sums background checks for retail and private sales of handguns, long guns, and other guns, and multiplies the sum by 1.1, then multiplies background checks for multiple purchases by a factor of 2, and adds the two sums. The two methods result in similar, though not identical, time series, as shown in Table 1, where *Sales 1* follows the Brauer (2013) and Brownlee (2025) procedure, and *Sales 2* follows the approach used by Gabriele (2025). The latter begins to exceed the former in 2010 as "other" gun sales rise, and both time series show a peak in 2020, followed by a subsequent decline. Using the *Sales 1* estimates, the number of guns sold in 2023, which we take as our base year, was Q_1= 15.885 million.[5]

[Table 1 here]

Firearm Prices

There have also been remarkably few studies of firearm prices. Marifian and Becker (2020) collected the advertised retail prices of handguns and rifles in two publications during two

[5] As noted below, we use 2023 as the base year because it is the most recent year for which reliable data are available for gun-related homicides and accidents. This also avoids the complications of new state level taxes levied on firearms in 2024 and 2025 by California and Colorado, respectively.

different time periods: *Gun Digest* in 2016, and *Armslist* in August of 2020. Similarly, Moshary *et al*. (2022) obtained prices from the *Gallery of Guns* website for handguns in October and November of 2020 and for long guns between March and May of 2021.[6] The sample sizes, means, and standard deviations (SD) from both studies are reported in Table 2. Because the data were collected at different times, we convert all monetary values into December 2023 dollars, using the Producer Price Index (PPI) for small arms.[7] The PPI weights used as inflation factors are shown in the table, as are the resulting sample means and standard deviations in 2023 dollars.

[Table 2 here]

We pool the summary statistics from the top panel of Table 2 in a simple meta-analysis to determine the mean handgun price, and pool the statistics from the final four rows to obtain a mean price for long guns. From the combined sample of 48,746 handguns, we find a mean price (in 2023 dollars) of $787.81 and a standard error of $2.07, for a 95 percent confidence interval ranging narrowly from $783.67 to $791.95. From the combined sample of 121,665 long guns, we find a mean price of $1,414.41 and a standard error of $2.33, for a 95 percent confidence interval that ranges from $1,409.75 to $1,419.07. While the mean price for each type of firearm appears to be reasonably accurate, and each lies within a narrow confidence interval, long guns account for more than 70 percent of the price data, and were clearly over-sampled relative to handguns in the primary studies. We therefore weight the handgun and long gun means by the proportions of each type of firearm in our national sales estimates during 2023. Comparing handguns to long guns (and including private sales but excluding other guns and multiple sales),

[6] A subsequently published version of the study omitted the summary statistics for prices that were included in Moshary *et al*. (2022).

[7] The PPI is used here rather than the Consumer Price Index (CPI) because inflation rates specific to small arms can be obtained from the PPI but not the CPI. The PPI data are available at the Bureau of Labor Statistics website, https://data.bls.gov/cgi-bin/srgate#. We treat the October-November 2020 data as having been collected in November, the March to May 2021 period as April 2021, and the 2016 data as having been collected at mid-year (July 1).

Table 1 shows that handguns accounted for 60 percent of estimated sales in 2023, while long guns accounted for 40 percent. Thus, the overall weighted average price of a firearm is estimated to be \$787.81(0.6) + \$1,414.41(0.4) = \$1,038.45 before taxes in 2023 dollars; we take this as P_1^S or equivalently, MPC_1.

Taxes and Elasticities

Given the proportions of handgun and long gun sales calculated above, and the FAET rates of 10 and 11 percent on handguns and long guns, respectively, the weighted average federal tax rate on firearms in 2023 was 0.10(0.6) + 0.11(0.4) = 0.104, or 10.4 percent. The average rate of state and local general sales taxes was 6.56 percent (Fritts, 2023). The combined tax rate on firearms across the country therefore averaged 16.96 percent, implying that while sellers received \$1,038.45 per gun, buyers paid an average price of roughly \$1,214.57, about \$176.12 of which represented the combined federal, state, and local tax revenue per gun. Thus we have $\tau_1 = 0.1696$ and $P_1^D = 1{,}214.57 = MB_1$.

This, of course, does not imply that buyers bear the entire tax burden; the economic incidence depends on the price elasticities of supply and demand, of which there have been very few studies. Recently however, McDougal *et al*. (2023) applied instrumental variables to time series data spanning the seven decades from 1946 to 2016 and obtained price elasticities of demand and supply equal to $\varepsilon^D = -2.561$ and $\varepsilon^S = 3.239$, respectively; with these elasticities, $\alpha = 0.39047$ and $\gamma = 0.308737$.[8] And using these elasticities in equation (9) gives the

[8] Other estimations conducted by McDougal *et al*. (2023), using more limited sets of controls, yield somewhat greater price elasticities of both supply and demand. Earlier studies of price elasticities examined only selected types of weapons and/or investigated only the demand side of the market (Bice and Hemley, 2002; Bartley and Williams, 2021). Using excise tax receipts from California, Eisenhauer (2025e) estimates that firearm supply is roughly twice as elastic as demand in the short run and about 2.5 times more elastic than demand in the longer run.

equilibrium output as $Q_0 = 19.875$ million units, while (10) gives the equilibrium price, in the absence of any taxes, as $P_0 = \$1{,}112.83$.[9]

Gun-Related Homicides and Accidental Deaths

Table 3 provides the number of gun-related deaths (including homicides, suicides, and accidents) by year through 2023, as reported by the National Safety Council (2024). In each year, there are far more gun-related suicides than homicides. Because our focus is on externalities, we subtract suicides from all gun-related deaths, to obtain a measure of gun-related homicides and accidents (*HA*) in the fifth column.[10] The sixth column shows the U.S. population in millions (*POP*), and the final column divides homicides and accidents by *POP*, to get external gun-related homicides and accidents per million (*HA/M*).[11] Over the period, gun-related homicides and accidents averaged 47 per million persons annually, though the rate has been substantially higher in recent years, reaching nearly 68 in 2021.

[Table 3 here]

In contrast to firearm-related deaths, data on the number of nonfatal firearm-related injuries are notoriously unreliable. The Web-Based Injury Statistics Query and Reporting System (WISQARS), provided through the Centers for Disease Control and Prevention (CDC), has been widely criticized for being based on relatively small samples of emergency room visits (Barber, 2021). An alternative data series, the National Emergency Department Survey (NEDS) from the Healthcare Cost and Utilization Project (HCUP) underwent a change in survey

[9] These further imply, from (11) and (12), that $a = 787{,}437$ and $b = 6.211$.
[10] The exclusion of suicides is discussed further in the Conclusion. Firearm-related deaths also include a small number of incidents involving law enforcement. Assuming that police only use deadly force when similarly threatened, such incidents presumably involve suspects who were armed; these are included in *HA*.
[11] Population data are available at the U.S. Census Bureau website, https://www.census.gov/topics/population.html.

methodology in 2015, resulting in temporal inconsistency. Similarly, the Gun Violence Archive (https://www.gunviolencearchive.org/) only provides data back to 2014. Consequently, we focus on firearm-related deaths, recognizing this as a limitation that makes the estimates of marginal external cost and deadweight loss conservative.

Marginal External Cost and Deadweight Loss

In a seminal study, Cook and Ludwig (2006) estimated the marginal external cost imposed on society by each additional gun-owning household. Using data from the 200 most populous counties in the country from 1980 to 1999, and initially considering only homicides, they concluded that an appropriate license fee for a gun-owning household would be between $100 and $300 per year. Adding in the costs of nonfatal gun-related injuries raised the estimate by a factor of 6, leading to their conclusion that "the average annual marginal social cost of household gun ownership is in the range of $100 to $1800" (Cook and Ludwig, 2006, p. 379).

While Cook and Ludwig (2006) introduced an innovative model, the annual license fee they describe is fundamentally different from a Pigouvian excise tax. First, such a fee would apply to any household that owned a gun, rather than to the purchase of a gun, and as Cook and Ludwig (2006) acknowledged, the prevalence of gun-owning households is not the same as the prevalence of guns, because most households that own a gun actually own several of them.[12] Moreover, as a matter of implementation, collecting the annual fee would require knowing exactly which households own guns each year. In practice, however, we do not even know the precise fraction of households that own firearms, let alone which particular households own them (Stevenson and Shorter, 2021). Finally, flat fees lose value over time due to inflation; in the two

[12] Berrigan *et al*. (2022) recently estimated that gun owners own an average of five guns each.

decades following the Cook and Ludwig (2006) study, fixed dollar values declined more than 33 percent.[13] Thus, unless regularly updated, a flat license fee would eventually become economically insignificant.

By contrast, as indicated in Figure 1, an *ad valorem* Pigouvian tax is levied on current market transactions—that is, the sale of firearms, rather than the stock of guns—and remains proportional to the retail price, thus keeping pace with inflation. To find the tax rate, we seek the marginal external cost of an additional gun purchase. To that end, we estimate marginal gun-related homicides and accidents (*HA*), monetized by the value of a statistical life (*VSL*):

$$MEC_1 = (\partial HA/\partial Sales)VSL\,, \tag{19}$$

where *Sales* refers to sales of firearms.

To conduct the estimation, we utilize the aggregate time series data in Tables 1 and 3. To control for population changes over time, our dependent variable is the firearm-related homicide and accidental death rate per million persons (*HA/M*), taken from the final column of Table 3. The main independent variable is the volume of gun sales (*Sales*) measured in millions of units. The fundamental regression equation is simply

$$HA/M = \beta_0 + \beta_1 Sales + \sum_{i=2}^{k} \beta_i X_i \tag{20}$$

where each X_i denotes a control variable. From (20), $\beta_1 = \partial(HA/M)/\partial Sales$, and multiplying by the population (in millions) recovers $\partial HA/\partial Sales$ per million guns; then multiplying by the *VSL* in millions of dollars generates the marginal external cost per gun sold, as in (19).

The limited size of the data set permits only a few additional variables. We use the average annual unemployment rate (in percentage) published by the Bureau of Labor Statistics as

[13] From 2000 to 2020, the Consumer Price Index (CPI) rose by slightly more than 50 percent, from 172.2 to 258.8 (https://data.bls.gov/timeseries/CUUR0000SA0?amp%253bdata_tool=XGtable&output_view=data&include_graphs=true).

a control for the state of the economy.[14] Because mental illness has often been considered a contributing factor to gun violence (Bleyer *et al*., 2024), we also control for depression using 1999-2020 data from the Institute for Health Metrics and Evaluation.[15] Summary statistics for these variables are given in Table 4.

[Table 4 here]

The basic results from ordinary least squares regressions are shown in Table 5. To check robustness, we ran several iterations: linear, lagged, and semi-logarithmic forms, alternatively using *Sales 1* and *Sales 2* to measure gun sales. The top panel of Table 5 shows linear results, the middle panel shows semi-log results, and the lower panel lags *Sales* and *Unemployment*; each regression yields 79 to 82 percent explanatory power. In each iteration, unemployment exerts a negative effect, while the coefficients of gun sales and depression are both positive and statistically significant, suggesting that both firearm availability and depression contribute to gun violence. Where the *Sales* variable is measured in natural log form, we divide $\hat{\beta}_1$ by the average gun sales in millions, and in every case, we multiply $\hat{\beta}_1$ by the mean population in millions (310.02) to recover $\partial HA/\partial Sales$ per million, which is shown in the final column. The results lie in a fairly narrow range from 96 to 116, so we take 100 as a reasonable approximation, indicating that for every one million additional guns sold, there about 100 additional homicidal or accidental gun-related deaths.[16]

[Table 5 here]

[14] The annual unemployment rates can be found at the Bureau of Labor Statistics website, https://data.bls.gov/timeseries/LNU04000000?periods=Annual+Data&periods_option=specific_periods&years_option=all_years.

[15] These data are available from https://www.healthdata.org/. Originally measured in cases per 100,000, we have remeasured depression as cases per 1,000,000 individuals. The slightly shorter time series for this variable than for gun sales causes the loss of several degrees of freedom.

[16] Dividing *HA* from Table 1 by *Sales 1* or *Sales 2* from Table 3 yields a simple average of more than 1,000 gun-related homicides and accidental deaths per million guns sold, more than 10 times the marginal rate, though that calculation does not control for other factors.

In stark contrast to the sparse literature on the price elasticities of firearms, there is a vast body of research on the value of a statistical life, which includes primary studies (Sweis, 2022), reviews of the literature (Robinson and Hammitt, 2016), meta-analyses (Viscusi, 2018), and even a meta-analysis of meta-analyses that incorporated results from 267 primary studies (Banzhaf, 2022). Not surprisingly, the estimates of *VSL* vary considerably. The U.S. Department of Health and Human Services (HHS, 2021), for example, estimated *VSL* in 2020 dollars to lie between $5.3 million and $17.4 million, with a central estimate of $11.4 million. Other recent values are shown in Table 6, along with the base years in which monetary values were reported; to establish a common base year, the inflation factors based on the average Consumer Price Index (CPI) are shown in the fourth column, and the fifth column converts the *VSL* values to 2023 dollars for consistency with Table 2.[17] The wide variation in samples, methodologies, and outcomes make any comparison of these studies difficult, but using the lowest estimate, we can conservatively consider *VSL* to be at least $6.19 million in 2023 dollars.[18]

[Table 6 here]

Following equation (19), the sixth column of Table 6 multiplies the *VSL* in millions of 2023 dollars from the various studies by our estimate of 100 additional gun-related homicidal and accidental fatalities per million additional guns sold, to generate MEC_1; the values range from $619 to more than $1,460. Following (13), these values are used with our estimate of MPC_1 to obtain estimates of λ ranging from 1.6 to 2.4, and MSC_1 ranging from $1,658 to about $2,500. As a conservative example, after converting the $4.98 million *VSL* from Hugonnier *et*

[17] Annual average CPI values are available from the Federal Reserve Bank of Minneapolis at https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-.

[18] Two decades ago, Cook and Ludwig (2006) noted that *VSL* had generally been estimated to range between $3 million and $9 million in the U.S. They used a lower value of $1 million to monetize homicides, arguing that many murder victims were criminals who inherently accepted a high risk of death. The more recent phenomenon of mass shootings suggests that homicide victims are more randomly selected, and argues in favor of using the general *VSL* values for measuring the external cost to society.

al. (2022) into 2023 dollars, $MEC_1 = 619.10$, $MSC_1 = \$1{,}657.55$, and $\lambda = 1.596$. From (14), this implies that Q_2 would be about 10.18 million units, and from (15), this implies a deadweight loss of $3.585 billion at the untaxed equilibrium. But roughly 62 percent, or $2.223 billion, is eroded by existing taxes, so the deadweight loss at present—that is, DWL_1 from equation (16)—is $1.361 billion. In this case, (17) indicates that a Pigouvian tax rate of 59.62 percent (in combined federal, state, and local taxes) would eliminate the deadweight loss entirely. Buyers and sellers would internalize the remaining external costs by paying the tax: sellers would receive an average price of about $905.23, and buyers would pay an average of $1,444.93 per gun. Annual gun sales would decline by more than 5.7 million units (from Q_1 to Q_2) or about 35.9 percent.[19] With larger *VSL* values, the marginal external cost increases proportionately, raising the required Pigouvian tax rate; at the upper end, the tax rate needed to eliminate all deadweight loss exceeds 140 percent.

Pigouvian Tax Revenue

Finally, the eleventh column of Table 6 shows the tax revenue that would be generated by the tax rates in the tenth column. Our estimates range from about $5.5 billion to $6 billion. Assuming that state and local taxes remained constant, state and local governments would collect a fraction of the tax revenue, equal to $0.0656/\tau_2$, while the rest accrued to the federal government. For example, if the federal government increased the FAET to 53.06 percent to reach the Pigouvian rate of 59.62 percent in the first row of Table 6 (while state and local sales taxes remained steady

[19] Using the outcomes of a simulation conducted in New York City, Eisenhauer (2025b) estimated that a 35 percent reduction in gun sales could reduce firearm-related murders by about 9.65 percent.

at 6.56 percent), then state and local governments would receive 11 percent of $5.5 billion, or about $605 million, while $4.895 billion would accrue to the federal government.[20]

IV. Conclusion

Certainly, the external costs associated with both deliberate and accidental shootings result from the use of both new and extant guns. From a policy perspective, there is little that can be done about the existing stock of firearms in civilian possession; the absence of a comprehensive federal registry of gun ownership means that neither researchers nor policymakers know exactly who owns a gun, or precisely how many firearms each gun owner possesses (Stevenson and Shorter, 2021).[21] Taxes can, however, be imposed at the point of sale.

Remarkably few studies have attempted to quantify either the marginal social cost or the marginal external cost of guns, the deadweight losses they create, or the Pigouvian tax rates that would induce efficiency in the market. The present study indicates that fully internalizing negative externalities would require combined sales and excise taxes on guns of at least 59.62 percent, with higher estimates exceeding 100 percent. These are well above the existing tax rates that apply to guns, as well as recent legislative proposals to raise them. Indeed, even at the low end, such taxes would exceed those on most other goods that generate negative externalities, such as alcohol, tobacco, gambling, or gasoline (Eisenhauer, 2024, 2025d).

An important caveat is that this analysis takes preferences as fixed, but this assumption may not hold in the presence of Pigouvian policies (Chan, 2024). Kremer and Willis (2016)

[20] Because both $Q_2 < Q_1$ and $P_2^S < P_1^S$, if states and localities held their tax rates constant while the federal government raised its rate, states and localities would collect less tax revenue at Q_2 than they currently collect at Q_1. By contrast, if states or localities raised taxes or established new taxes on firearms but the federal government did not, then states and localities would gain revenue while federal FAET revenues would decline.

[21] Gun buybacks represent one of the few options for reducing the civilian gun stock (Eisenhauer, 2025b).

point out that the announcement of a Pigouvian tax on durables may cause an immediate rush to purchase before the tax takes effect.[22] In contrast, Lucas (2024) suggests that Pigouvian taxation may diminish preferences for the taxed products, and Huang and Xiao (2021) suggest that voters who support Pigouvian taxes may persuade others to accept them as well. If preferences are malleable in these ways, then Pigouvian taxes may have even larger impacts on firearm sales, in which case lower tax rates than those estimated here could potentially eliminate the deadweight loss.

An equally important caveat concerns the treatment of suicides and nonfatal shootings. Because, by definition, suicide represents a self-inflicted harm, we have excluded suicide as an externality. There are, however, several arguments for including suicides among the external costs. First, suicide imposes unexpected financial and emotional losses on families, friends, and employers; indeed, foregone future earnings are an important component in the calculation of *VSL* (Johansson, 2007). Second, the firearm may not be in the possession of its original buyer or true owner at the time of the suicide; guns often change hands through theft, borrowing, straw purchases, and other informal or illegal diversions (Miller *et al.*, 2022). This is especially true among youths who commit suicide by firearm, roughly two-thirds of whom use someone else's weapon (Choi, *et al*., 2017; Barber, *et al*., 2022). Third, if the buyer of the gun was not planning to commit suicide at the time of the purchase, but was subsequently motivated to do so by the convenience of the weapon, then the original transaction ultimately resulted in an unintended consequence (Vitt *et al*., 2018; Sarai *et al*., 2017; Balestra, 2018). Yet, regardless of whether suicides are treated as externalities, nonfatal shooting injuries, armed robberies, and other crimes committed with firearms should be included in the calculation of external costs; these were

[22] Eisenhauer (2025e) reported a spike in gun sales in California in June of 2024, immediately before the state's new excise tax took effect, followed by a subsequent decline in sales.

excluded from the present analysis for lack of reliable data.[23] Thus, the estimates above are conservative, insofar as they include only homicides and accidental shooting deaths.

Yet another notable caveat is that there are practical limits to taxation. If set too high, a firearm tax could create a new deadweight loss. Moreover, a tax rate perceived to be excessive could potentially induce buyers and sellers to move transactions underground to black markets, where they are neither taxed nor regulated (Eisenhauer, 2025c). If the Pigouvian tax rate exceeds the market's tolerance for taxation, then efficiency is unattainable.

Although we have utilized the best available data, the empirical results are subject to the limitations on the comprehensiveness and quality of the data set, and ultimately represent an embryonic evaluation of social policy. Future replications would benefit from further refinements such as a longer time series and the inclusion of nonfatal shootings, armed robberies, and other external costs. As noted above, there is also limited information on the price elasticities of firearm supply and demand, and further confirmation of these parameters would be valuable. Nonetheless, this initial analysis highlights the failure of existing tax rates to fully induce internalization of the negative externalities associated with firearms.

Finally, while we have conducted this study for the U.S., where gun-related violence is most pronounced (Grinshteyn and Hemenway, 2019), the methodology could readily be applied to other countries, or alternatively, sub-national jurisdictions, where suitable data are available.

[23] Song *et al*. (2022) estimated that nonfatal firearm injuries cost about $30,000 per victim annually. Royan *et al*. (2025) estimated the mean inpatient hospital cost at $43,392 for nonfatal gun-related assaults and $34,444 for nonfatal shooting accidents.

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Figure 1. Pigouvian Taxation with Negative Externalities

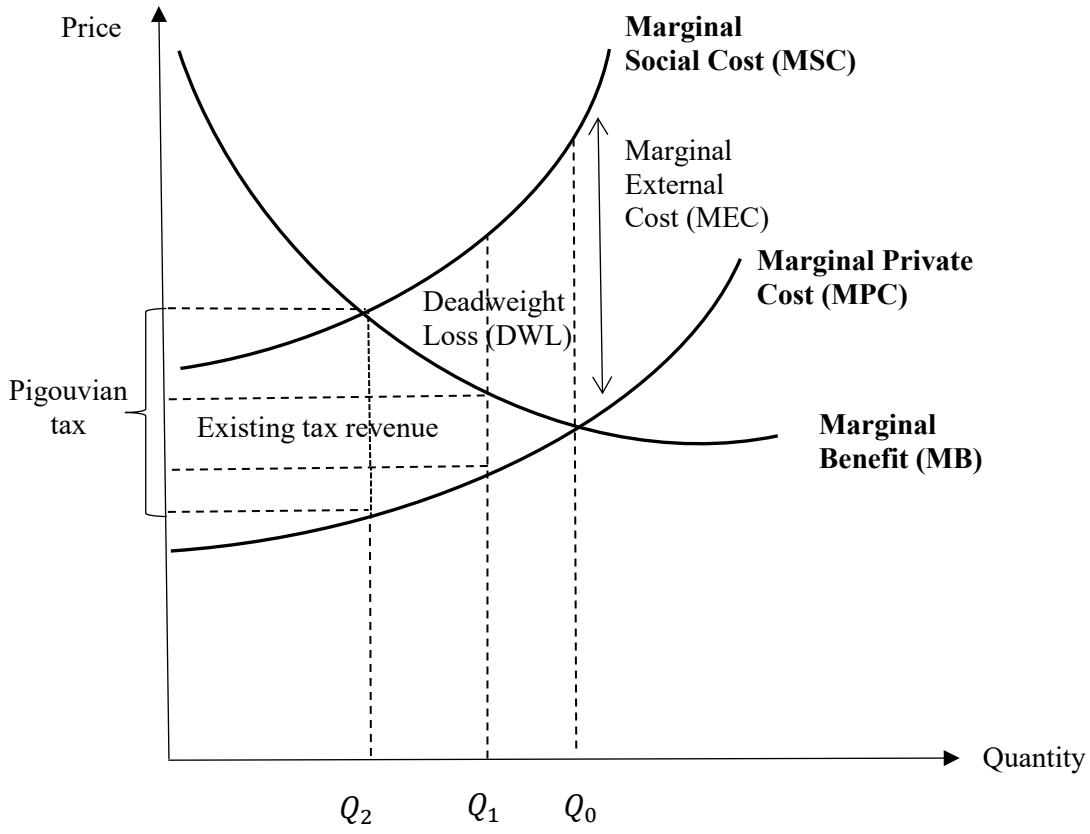


Table 1. Estimates of Gun Sales 1999-2023

Year	Handgun (HG)	Long Gun (LG)	Other	Multiple	Private Sales			Sales 1	Sales 2
					HG	LG	Other		
1999	2,536,738	5,217,451	0	103,743	0	0	0	8,757,843	8,737,094
2000	2,191,879	4,779,978	0	95,777	0	0	0	7,879,752	7,860,597
2001	2,167,213	4,943,375	0	97,132	0	0	0	8,035,337	8,015,911
2002	1,845,112	4,409,311	0	93,069	0	0	0	7,084,617	7,066,003
2003	1,851,078	4,383,057	0	99,236	0	0	0	7,075,868	7,056,021
2004	1,990,460	4,506,847	0	101,985	0	0	0	7,371,405	7,351,008
2005	2,241,740	4,584,462	0	109,750	0	0	0	7,750,272	7,728,322
2006	2,441,325	4,789,591	0	130,117	0	0	0	8,240,265	8,214,242
2007	2,635,629	4,570,697	0	324,401	0	0	0	8,640,641	8,575,761
2008	3,331,199	4,907,967	0	187,079	0	0	0	9,474,656	9,437,241
2009	3,689,604	4,978,641	23,208	235,685	0	0	0	10,053,577	10,031,968
2010	3,678,001	4,842,184	52,761	180,609	0	0	0	9,769,543	9,791,459
2011	4,301,389	5,445,966	70,137	219,618	0	0	0	11,205,250	11,238,477
2012	5,682,963	6,866,225	162,823	230,270	0	0	0	14,310,701	14,443,752
2013	6,387,502	7,128,798	212,776	241,360	385	409	68	15,398,922	15,585,652
2014	6,199,243	5,543,371	268,263	225,475	1,720	1,341	103	13,412,920	13,666,395
2015	7,333,808	5,479,441	329,499	242,375	7,181	5,804	472	14,627,799	14,956,576
2016	8,085,498	5,988,511	586,137	257,723	14,561	11,042	1,038	16,048,401	16,670,912
2017	7,226,979	5,234,757	399,993	236,167	23,776	19,328	1,658	14,227,477	14,669,474
2018	6,576,111	4,916,533	494,299	257,088	26,348	23,136	3,085	13,207,502	13,757,639
2019	6,802,167	4,744,298	543,538	256,524	21,534	17,100	3,141	13,265,464	13,858,004
2020	11,897,521	7,132,864	854,836	393,814	29,390	20,201	4,933	21,799,814	22,721,348
2021	9,999,061	6,497,192	771,902	328,658	131,426	61,318	13,289	18,868,926	19,878,923
2022	8,784,415	5,633,657	722,331	313,841	131,686	58,741	13,834	16,550,329	17,506,812
2023	8,288,826	5,514,099	720,051	319,236	138,125	60,686	12,764	15,885,537	16,846,478
Mean	**5,126,618**	**5,321,571**	**248,502**	**211,229**	**21,045**	**11,164**	**2,175**	**11,957,713**	**12,226,643**

Note: Sales 1 follows the methodology of Brauer (2013), and Sales 2 is similar to Gabriele (2025).

Table 2. Firearm Prices

Study	Gun Type	Source	Sample Dates	Sample Size	Mean ($)	SD ($)	PPI Wt.	Mean (2023 $)	SD (2023 $)
Marifian & Becker (2020)	Handgun	*Armslist*	Aug. 2020	33,362	657	381	1.021	670.79	389.00
	Handgun	*Gun Digest*	2016	1,882	602	615	1.060	638.25	652.04
Moshary *et al*. (2022)	Pistol	*Gallery of Guns*	Nov. 2020	8,724	1,307	306	1.017	1,329.67	311.31
	Revolver	*Gallery of Guns*	Nov. 2020	4,778	663	279	1.017	674.50	283.84
Marifian & Becker (2020)	Rifle	*Armslist*	Aug. 2020	14,455	776	568	1.021	792.29	579.92
	Rifle	*Gun Digest*	2016	2,605	712	2,683	1.060	754.88	2,844.58
Moshary *et al*. (2022)	Rifle	*Gallery of Guns*	Mar/May 2021	80,863	1,661	584	1.013	1,681.81	591.31
	Shotgun	*Gallery of Guns*	Mar/May 2021	23,742	943	598	1.013	954.81	605.49

Table 3. Gun-Related Homicides and Accidents, 1999-2023

Year	Gun-Related Homicides	Gun-Related Suicides	Total Gun-Related Deaths	Gun-Related Homicides & Accidents (HA)	Population in millions (POP)	Gun-Related Hom & Acc Per Million (HA/M)
1999	10,828	16,599	28,874	12,275	279.04	43.99
2000	10,801	16,586	28,663	12,077	282.16	42.80
2001	11,348	16,869	29,573	12,704	284.97	44.58
2002	11,829	17,108	30,242	13,134	287.63	45.66
2003	11,920	16,907	30,136	13,229	290.11	45.60
2004	11,624	16,750	29,569	12,819	292.81	43.78
2005	12,352	17,002	30,694	13,692	295.52	46.33
2006	12,791	16,883	30,896	14,013	298.38	46.96
2007	12,632	17,352	31,224	13,872	301.23	46.05
2008	12,179	18,223	31,593	13,370	304.09	43.97
2009	11,493	18,735	31,347	12,612	306.77	41.11
2010	11,078	19,392	31,672	12,280	309.32	39.70
2011	11,068	19,990	32,351	12,361	311.56	39.67
2012	11,622	20,666	33,563	12,897	313.83	41.09
2013	11,208	21,175	33,635	12,460	315.99	39.42
2014	11,008	21,386	33,594	12,208	318.30	38.34
2015	12,979	22,018	36,247	14,229	320.64	44.36
2016	14,415	22,938	38,658	15,720	322.94	48.66
2017	14,542	23,854	39,773	15,919	324.99	48.96
2018	13,958	24,432	39,740	15,308	326.69	46.84
2019	14,414	23,941	39,707	15,766	328.24	48.02
2020	19,384	24,292	45,222	20,930	331.58	63.12
2021	20,958	26,328	48,830	22,502	332.10	67.76
2022	19,651	27,032	48,204	21,172	334.02	63.39
2023	17,927	27,300	46,728	19,428	336.81	57.68
Mean	**13,360**	**20,550**	**35,229**	**14,679**	**310.02**	**47.11**

Note: Total gun-related deaths include a small number of deaths involving law enforcement and others involving unknown circumstances.

Table 4. Summary Statistics

Variable	Minimum	Maximum	Mean	SD
Homicides & Accidents per million	38.34	67.76	47.11	7.78
Gun sales in millions (Sales 1)	7.08	21. 80	11.96	4.09
Gun sales in millions (Sales 2)	7.06	22.72	12.23	4.42
Unemployment rate (annual average)	3.60	9.60	5.71	1.83
Depression (cases per million)	477.67	576.48	489.60	20.16

Table 5. Regression Results

Constant	Sales 1	Sales 2	Unempl	Depress	R^2	Implied $\partial HA/\partial Sales$ per million
-44.588***	0.357**		-1.281***	0.190***		
(13.882)	(0.158)		(0.308)	(0.030)	.796	110.62
-44.009***		0.344**	-1.268***	0.189***		
(13.804)		(0.147)	(0.305)	(0.030)	.799	106.60
Constant	**Ln(Sales 1)**	**Ln(Sales 2)**	**Unempl**	**Depress**	R^2	**Implied $\partial HA/\partial Sales$ per million**
-55.172***	3.890**		-1.292***	0. 201***		
(13.476)	(1.815)		(0.313)	(0.029)	.791	100.86
-54.860***		3.788**	-1.281***	0.201***		
(13.387)		(1.717)	(0.310)	(0.029)	.793	96.05
Constant	**Lag(Sales 1)**	**Lag(Sales 2)**	**Lag(Unempl)**	**Depress**	R^2	**Implied $\partial HA/\partial Sales$ per million**
-26.831*	0.373*		-1.386***	0.155***		
(14.617)	(0.179)		(0.321)	(0.028)	.812	115.53
-26.511*		0.364**	-1.372***	0.154***		
(14.437)		(0.167)	(0.317)	(0.028)	.816	112.86

Note: The dependent variable is HA/M from Table 3. Standard errors are in parentheses. Significance levels are 10 percent (*), five percent (**), and one percent (***).

Table 6. Value of a Statistical Life, Marginal External Cost, Deadweight Loss, and Pigouvian Tax

Study	Base Year	*VSL* ($ mil)	CPI Wt.	*VSL* (2023 $ mil)	MEC_1 (2023 $)	MSC_1 (2023 $)	DWL_0 (2023 $ bil)	DWL_1 (2023 $ bil)	Pigouvian Tax	
									Rate (%)	Revenue (2023 $ bil)
Hugonnier *et al*. (2022)	2017	4.980	1.24	6.191	619.1	1,657.55	3.585	1.361	59.62	5.50
Sweis (2022)	2020	7.200	1.18	8.477	847.7	1,886.15	5.932	2.763	81.63	5.91
Banzhaf (2022)	2019	7.960	1.19	9.485	948.5	1,986.99	7.061	3.475	91.34	6.00
Viscusi (2018)	2015	8.072	1.29	10.378	1,037.8	2,076.23	8.100	4.145	99.94	6.04
Banzhaf (2022)	2019	8.880	1.19	10.582	1,058.2	2,096.62	8.342	4.302	101.90	6.05
Kniesner & Viscusi (2024)	2022	12.000	1.04	12.492	1,249.2	2,287.65	10.682	5.852	120.29	6.07
HHS (2021)	2020	11.400	1.18	13.422	1,342.2	2,380.64	11.862	6.648	129.25	6.05
Viscusi (2018)	2015	11.380	1.29	14.631	1,463.1	2,501.52	13.432	7.718	140.89	6.01

Note: *VSL* is the value of a statistical life; CPI is the consumer price index; *MEC* is marginal external cost; *MSC* is marginal social cost; and *DWL* is deadweight loss. Subscripts 0 and 1 denote the untaxed equilibrium and current states of the market, respectively.