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ARTICLE

Modeling the U.S. Firearms Market

The Effects of Civilian Stocks, Legislation, and Crime

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Abstract

We estimate the first econometric model of the national civilian firearms market in the United States (1946–2016), where per capita firearms-related harm is exceptionally high. Solving simultaneous equation models instrumented by natural disasters and steel prices, and employing unique firearms prices and quantities data, we find this market operates normally, except that firearms stocks may generate some new market demand in a positive feedback loop. Save for the Federal Assault Weapons Ban (1994–2004), federal firearms legislation does not influence firearms sales. We find that violent crime, including homicide and mass shootings, boosts domestic sales.

1 | INTRODUCTION

Karp (2018) estimates that the United States, with 1.2 firearms per capita, has a higher rate of firearms ownership than any other country in the world—more than double the rate of war-torn Yemen (0.53) and thrice that of postwar Serbia and Montenegro (both at 0.39). Civilian firearms stocks per se need not be a problem, but the United States also suffers from the highest rates of firearms-related harm in the high-income world. For example, in 2017, the US rate of firearms homicide of 4.5 per 100,000 people was over 13 times that of its equally well-off[1] northern neighbor, Canada (National Center for Health Statistics 2018). Informed by the Second Amendment to the US Constitution, which guarantees its citizens the right to keep and bear arms, the United States also has some of the least restrictive firearms laws globally, resulting in the world's largest civilian firearms market. In 2020, there were approximately 52,700 federally licensed firearms dealer outlets in the United States and a total of about 13.5 million firearms supplied to the domestic market in 2019, about half of which were imports (DOJ/ATF 2021). With the COVID-19 pandemic of 2020, firearms supply exploded to well over 15 million units that year according to the US International Trade Commission (USITC) and Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) data.

Goods designed to multiply the potential for violence can theoretically be expected to provoke overall welfare declines (Hirshleifer 1988). Our study, which models the US firearms market, is therefore justified by an adverse externality argument, an argument to be tested statistically. Although much public discussion in the United States can give the impression that some wish to eliminate the firearms market altogether, economists will give pause, understanding better than most the often deleterious effects of supply-side suppression (e.g., Beletsky and Davis 2017; Moore 2010). Moreover, firearms proponents and opponents agree that with the privilege of firearms ownership comes the responsibility of legitimate and safe use, and they share the goal of reducing firearms-related harm[2]. In theory, then, the design and evaluation of effective firearms legislation should parameterize the firearms market.

Although public health approaches have traditionally dominated the study of firearms (Cook 2018), econometric analysis of the legal firearms market is a prerequisite to making informed policy decisions (Cook and Ludwig 2018). This is true for at least three reasons. First, though most gun crimes are committed with illegally acquired weapons, virtually all firearms in the United States are initially manufactured and sold legally (Fabio et al. 2016). Second, firearms are often viewed as both cause and effect of eroding public security, stimulating demand for private security (Fleitas et al. 2015). By raising perceived or actual levels of insecurity, the supply of firearms may generate its own demand, requiring instrumental variable (IV) models to account for potential endogeneity (meaning circular causation, in this case). Indeed, the availability of firearms on the nonmilitary (i.e., the civilian and law enforcement) market is a function of complex supply chains (Brauer and Muggah 2006) involving domestic manufacture; imports; exports; flows between civilian, law enforcement, and military stocks (Masera 2021); and a dynamic interplay between licit and illicit markets and retail outlets. Third, moral hazard, balloon effects, relative elasticities of supply and demand (i.e., how the quantities supplied to and demanded by the market react to variations in price), and other economic phenomena may affect the efficacy of certain types of policy interventions seeking to reduce firearms-related harm.

As an initial step toward characterizing the US national firearms market, we simultaneously estimate supply and demand curves for the industry, 1946–2016. Credible market studies require reliable data on prices and quantities. We use a combination of publicly available and uniquely derived datasets, including both firearms quantities domestically produced and imported, and prices, that collectively allow us to fully characterize the market by simultaneously predicting supply and demand volumes as a function of price. We pay particular attention to the role that existing civilian firearms stocks, restrictive federal gun legislation, and violent crime play in driving demand. This is the first paper, to the authors' knowledge, that credibly demonstrates that existing stocks likely drive demand at high volumes.

Thereafter, we separately investigate three phenomena not included in the primary analysis due to fewer study years being available to test each:

(i) Industry concentration and potential cartel behavior
(ii) The effect of a technology gap between domestically produced and imported weapons
(iii) Violent crimes against persons (mass shootings and other violent crimes)

We find compelling evidence that existing civilian firearms stocks influence the annual demand flow for new firearms curvilinearly, decreasing overall demand at low levels, while increasing it at high levels. This finding runs counter to the markets of many other durable goods, in which stocks monotonically depress future demand (Saito 2003), but is in keeping with the idea that firearms may be perceived to increase personal security, while generating negative insecurity spillovers for society as a whole. Alternatively, it may indicate that firearms constitute a collectors' market, in which some purchasers demonstrate, in economists' terms, "addictive" purchasing behavior. Further lending credence to the idea that firearms generate their own demand, homicides and mass shootings are also associated with greater purchases. We find that (demand-restrictive) federal firearms legislation does not affect realized demand, except for the time-limited Federal Assault Weapons Ban (FAWB) in effect from 1994 to 2004.

The article is organized as follows. Section 2 reviews the relevant literature on the economics of firearms, as a subset of the larger small arms market. Section 3 discusses our research methods adopted for this study, a simultaneous equation model (SEM) with two exogenous IVs and time series data. Section 4 presents our results, including the effects of certain model controls such as civilian firearms stocks, the role of military veterans in firearms demand, and federal firearms legislation. Section 5 explores three additional influences on the firearms market: industry concentration, crime (mass shootings, other homicides, and other violent crimes), and a technology gap between US and foreign firearms producers. Section 6 sums up and concludes with a discussion, highlighting possible policy lessons.

2 | LITERATURE REVIEW

Despite its large size and prominent role in early American industrialization (Brauer et al. 2017, footnote 2), the US civilian firearms market remains largely uncharacterized from the point of view of economic analysis. One key limitation is data (Muggah and McDougal 2014). Gabelnick, Haug, and Lumpe (2006) note a number of post-9/11 policy developments restricting data accessibility via the Department of Justice's ATF, the Department of Defense, the Census Bureau, and the Customs and Border Protection (CBP) Service, and also demonstrate significant data discrepancies across various US agencies responsible for tracking firearms production, sales, imports, and exports. Brauer (2013b) has noted that, on a national level, we have quantity data for submarkets (e.g., pistols), but not corresponding price data, both of which are indispensable pieces in market characterization. Brauer (2013a), however, proposed a method for estimating yearly price indices for firearms, which was implemented and used here to generate some of the data employed in this study.

The legal US market for firearms comprises four distinct segments: pistols, revolvers, rifles, and shotguns. The pistol market has seen numerous producers enter and exit the market over the 1980–2010 period (and since then), whereas the revolver and shotgun markets were both stable duopolies in the literal sense of comprising just two major manufacturers each (Ruger and Smith & Wesson in the former, Mossberg/Maverick and Remington in the second). The rifle market was diverse, though its top holding company enjoyed over 30% market share spread over several brands (Brauer 2013b). Taken as a whole, the industry has exhibited severe production vacillations over the period 1980–2010 (Brauer 2013b), with generally greatly heightened production in the 2010s and since then (see Figure 1 below). Prior to 2010, mass shootings tended to significantly reduce the equity prices of firearms manufacturers, possibly indicating a risk to producers of tighter legislation. This equity price reduction effect disappears after 2010, however, possibly indicating that worries of such legal crackdowns in the most recent decade have done more to boost demand than to threaten producers (Gopal and Greenwood 2017; Jones and Stone 2015). End user "friendly" state legislation positively influences manufacturers' location decisions, but only as one among other factors which also include relative tax burden, wage profiles, and agglomeration effects (Brauer et al. 2017).

The firearms market in the United States has been described as "mature", "saturated", and even "stagnant" (Diaz 2004), which until 2005 was demonstrably true but not since, as unit sales vastly increased (see Figure 1). The NSSF estimates that the overall economic benefits of the industry have more than tripled over the period 2008–2021 (NSSF 2021). The market came under heavy foreign competition, especially in the pistol segment, starting in the mid-1980s, and yielded considerable market share to foreign brands in the decades since, following trends in many other US manufacturing industries (Brauer 2013b). Beginning in the 1990s and 2000s, the market has relied on a combination of product design innovations (often making their products more deadly; see Diaz 2004; Smith et al. 2015), market demographic expansion (Blair and Hyatt 1995; NSSF 2014, 2015), and demand stoking via vested interests, especially leveraging fear of crises and tightened legislation (see, e.g., Gopal and Greenwood 2017; Langley 1999). For instance, the impending passage of the federal Violent Crime Control and Law Enforcement Act of 1994 spurred the demand for, and production of, AR15

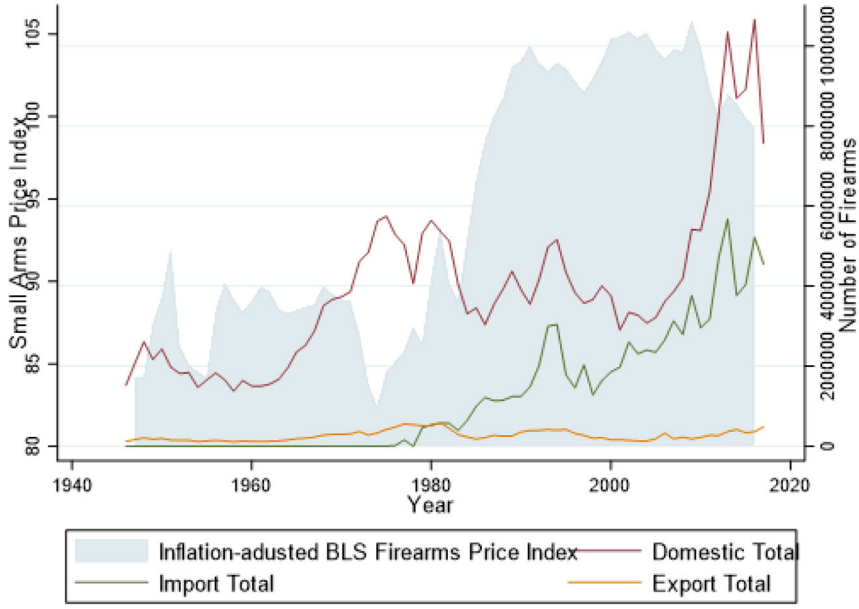

FIGURE 1 Annual domestic firearms production, export, and imports (lines, secondary *y*-axis) and Bureau of Labor Statistics (BLS) price index (area, primary *y*-axis) by year
[Colour figure can be viewed at wileyonlinelibrary.com]
Source: DOJ/ATF (2021) & BLS (2019).

(assault)-style weapons that would soon be banned, creating a pre-passage price depression and a post-passage price surge (Koper and Roth 2002).

There is a small but growing body of evidence on illicit firearms markets. They may operate with considerable transaction costs, resulting in much higher prices than on the legal market (Cook et al. 2007). They also rely on a varied set of pathways from the legal market (Chestnut et al. 2017), most often using near-to-retail diversions to obtain the firearms (Braga et al. 2012). There is substantial interstate trafficking in firearms (Knight 2013) due to the patchwork of legislation at subnational levels (Vernick et al. 2006), and a large quantity of small arms are trafficked annually from the United States into Mexico (McDougal et al. 2015).

As suggested in the introduction, endogeneity between quantity and price of firearms (as with most other goods) seems plausible. One the one hand, greater quantities of firearms supplied may, all other things equal, generate heightened levels of homicide and other victimization (including suicide) (Anglemyer, Horvath, & Rutherford 2014). Variations in US state laws regulating access to firearms have even had knock-on effects on homicide rates across the southern border in Mexico (Chicoine 2011; Dube et al. 2013). On the other hand, lower levels of perceived or actual public security may also generate heightened demand for firearms as a source of personal protection (McDowall and Loftin 1983), thereby driving up prices and spurring production quantities. The idea that the introduction of more firearms into a society may provoke small arms races has heretofore remained untested to the authors' knowledge. The effects of levels of existing civilian firearms stocks of firearms demand have proven notoriously difficult to estimate, in large part due to lack of data on those stocks. The most reliable national estimates have been produced for the years 2007 by the Small Arms Survey (2011) and 2017 by Karp (2018), which we leverage in combination with yearly unit sales data to infer stock levels. To the extent that firearms are perceived by buyers to improve their personal security while eroding societal security, we might view them as an inverted instance of a tragedy of the commons (Hardin

1968), and demand for them might be expected to follow a convex parabolic shape—decreasing at low levels of stocks and increasing at high levels.

3 | METHODS

3.1 | Empirical Strategy

We exclusively employ ordinary least squared (OLS) models with natural logs of prices and quantities as primary outcomes and regressors—a choice both simple and appropriate to the task. To account for possible endogeneity while estimating firearms quantities produced as a function of prices, we employ a simultaneous 3-stage, 4-model least squares IV approach in which demand-side price is instrumented using measures of the severity of natural disasters and supply-side price is instrumented using cold-rolled steel prices. The supply and demand functions can be represented separately as simultaneous equations (see, e.g., Yobero (2016)):

$$\text{Supply}: \ \text{Ln}Q_t^m = \alpha + \beta \text{Ln}\,(P_t) + G\sum \text{Ln}X_{t-1} + \varepsilon_t^1 \tag{1}$$

$$\text{Demand}: \ \text{Ln}Q_t^m = \delta + \kappa \text{Ln}\,(P_t) + M\sum \text{Ln}Y_{t-1} + \varepsilon_t^2 \tag{2}$$

$$\text{Supply instrument}: \ \text{Ln}\ (P_t) = \gamma + \bar{}\text{Ln}\,(S_{t-1}) + H\sum \text{Ln}X_{t-1} + \varepsilon_t^3 \tag{3}$$

$$\text{Demand instrument}: \ \text{Ln}\,(P_t) = \omega + æ\text{Ln}\,(D_{t-1}) + N\sum \text{Ln}Y_{t-1} + \varepsilon_t^4 \tag{4}$$

where $Q_t^m$is the equilibrium quantity of firearms produced and sold for market m in year t, P_t is inflation-adjusted firearms prices on the US legal market, X_{t-1} is a vector of other potential variables (economic, political) that could determine the sales of firearms in the United States, and Y_{t-1} is a vector of other potential variables (economic, political) that could determine the demand of firearms in the United States. By "market" (m), we mean one of three production categories: (1) domestic production for the domestic market (nonexport production within the United States), (2) domestic production for foreign markets (exports), and (3) foreign production for the domestic market (imports). S_{t-1} in Equation (3) is the real price of cold-rolled steel (US Bureau of Labor Statistics 2020), used in the production of firearms and therefore influencing the price but not directly the quantity produced. D_{t-1} in Equation (4) is a measure of the effects of natural disasters. There is some anecdotal evidence that firearms are in greater demand following natural disasters, when strained law enforcement institutions may struggle to guarantee property rights and enforce contracts (see, e.g., NPR 2006). Such observations would be in line with findings more broadly linking collective security to demand for firearms such as in the city of Detroit for example (McDowall and Loftin 1983). Conversely, the effect of the 2010 earthquake in Haiti was to dampen prices for firearms ammunition in that country, although the resulting massive surge of humanitarian organizations likely also buttressed the general security situation (see McDougal et al. 2018).

Per standard econometric estimations of supply and demand, we use logged outcome and primary predictor variables (see, e.g., Yobero 2016; Zarembka 1968), implying that resulting coefficients may be interpreted as elasticities. We also use lagged predictor variables pertaining to the supply-side to allow for large firms to adjust and adapt to changes, as well as to meet the temporality criterion

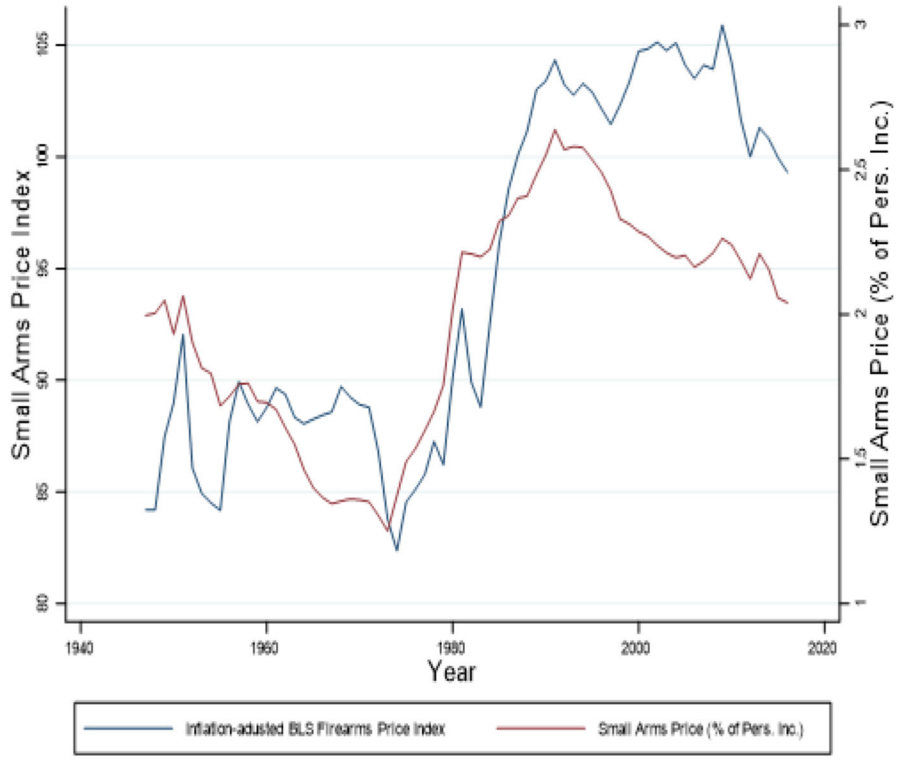

FIGURE 2 Inflation-adjusted small arms price index (primary *y*-axis, 2012 = 100) and small arms price as a percentage of mean personal income (secondary *y*-axis) by year
[Colour figure can be viewed at wileyonlinelibrary.com]
Sources: BLS (2019), the authors.

for demonstrating Granger causality (Gujarati and Porter 2009). We do not attempt to model year fixed-effects, as they would be collinear with many of our other predictor variables.

3.2 | Data

Data for our mediating and outcome variables—inflation-adjusted firearms prices on the US legal market (1947–2017) and quantity of firearms for market *m*, respectively—come from the Department of Commerce's Bureau of Labor Statistics (BLS 2019), the US Department of Justice's ATF (DOJ/ATF 2021), and other data. The BLS price index, when inflation adjusted, is similar, but not identical, to firearms prices as a percentage of personal income (see Figure 2).

Secondary, separate price indices for domestic handguns (1980–2017), domestic long guns (1980–2017), and imported handguns (1989–2017) were reverse computed from the US Treasury's Tax and Trade Bureau (TTB 2019) and the US Department of Justice's ATF data (DOJ/ATF 2021). These are used to test findings in the handgun and long-gun submarkets separately. The TTB gives tax obligations (slightly different from taxes collected) on firearms sales by manufacturer and importer supplying the wholesale or retail chain. As the tax rate is known (e.g., 10% on handguns), one can take, say, US$100 million in handgun tax obligations divided by 0.1 to compute US$1 billion in handgun sales. We divide the figures on total sales volume by the ATF handgun production and Census/USITC import data to get a nominal average handgun price, and then deflate and index (2012 = 100) the result.

TABLE 1 Summary statistics for the major outcome, mediating, and instrumental variables

Variable	N	Mean	S.D.	Min.	Median	Max.	Skewness
Log U.S. Firearms Production for U.S. Market	72	15.06	0.50	14.14	15.12	16.18	−0.01
Log Imported Firearms to U.S. Market	72	8.23	7.08	0.00	13.23	15.55	−0.28
Log U.S. Firearms Exports	72	12.40	0.47	11.62	12.36	13.28	0.11
Log BLS Firearms Price Index	70	4.55	0.08	4.41	4.51	4.66	0.06
Log Brauer Handgun Price Index	38	4.50	0.13	4.06	4.50	4.68	−0.98
Log Brauer Long Gun Price Index	38	4.46	0.14	4.15	4.48	4.77	−0.11
Log Brauer Imported Handgun Price Index	29	4.67	0.10	4.45	4.66	4.90	0.14
Log cold-rolled steel price index (real)	70	5.49	0.32	4.89	5.45	6.11	0.26
Log People Rendered Homeless by Disasters Per 100k	73	0.56	0.98	0.00	0.00	4.59	2.04
Log Disaster-Affected People Per 100k	73	5.87	0.66	4.45	5.91	7.64	−0.04

Abbreviation: BLS, Bureau of Labor Statistics.

Quantity outcomes include domestic production for US markets, exports, and imports. Domestic production for the US market is calculated by subtracting reported exports from total domestic production. Total production already excludes manufactured weapons that go into producer inventories (though wholesalers and retailers may have inventories of their own, for which we have no data). Imports, exports, and total US-made firearms sold on US markets are depicted in Figure 1 against the backdrop of the BLS inflation-adjusted small arms price index. As one might expect, production spikes tend to correlate visually to price depressions and vice versa.[3]

Our demand-side IV candidates pertaining to disasters were obtained from EM-DAT International Disasters Database maintained by the Centre for Research on the Epidemiology of Disasters (CRED) at the School of Public Health, Université Catholique de Louvain. Using the World Bank's country–year data on population and GDP, we created population rates of three variables (number of people affected by disaster, number of people rendered homeless by disaster, and the number of people killed in disasters) and normalized a fourth by GDP (to create a proxy for economic damages as a percentage of GDP). We then created log-normal versions of each of these variables for use in our models. We eliminated two candidates as IVs that were irrelevant to the mediator (i.e., log damages per GDP and log disaster deaths per 100,000 people). For our empirical tests of the remaining two candidates, see "Instrumental Variables" below. See Table 1 for descriptive statistics on these.

We use most of our control variables (see Table 2) to control for demand-side phenomena. Our demand-side control variables cover many commonly accepted influences on demand, whether they impact collective ability to pay (e.g., population and income) or willingness to pay (firearms stocks, political leaning, legal and legislative landscape, security risks, etc.). Only three variables—unemployment rate, conflict intensity, and cumulative conflict intensity—do we deem to affect supply most directly. These do not include our supply-side IV of steel prices (see discussion below), nor the supply-side control of the military diversion effect of the events of September 11, 2001 that we use later as a robustness check. Unemployment rate presumably affects producers by changing the costs of finding and retaining labor. War intensity and cumulative intensity may raise firearms production and capacity more generally, as many US-based firearms manufacturers serve both the military and the nonmilitary markets[4]. Population, real income per capita, and unemployment rate all come from the Federal Reserve Economic Data (FRED II database). Numbers of US veterans were obtained from annual Bureau of Veterans Affairs reports. Presidential party and Republican shares of the US House of Representatives and Senate were obtained from public government records.

Firearms stocks were calculated with a cumulative subtraction algorithm from a recent starting point estimate. We began with a 2017 estimate by Karp (2018) of 393,347,000. We assumed an annual stock depreciation rate of 0%. This unrealistically low number is adopted because the total publicly

TABLE 2 Summary statistics for control variables

Variable	N	Mean	S.D.	Min.	Median	Max.	Skewness
Log Population	72	12.33	0.24	11.86	12.35	12.69	−0.26
Log Military Veterans	73	17.01	0.14	16.65	17.03	17.21	−0.55
Log Civilian Firearms Stocks	72	18.66	0.71	17.34	18.77	19.79	−0.18
Real Income Per Capita	70	3.01	0.45	2.21	3.02	3.66	−0.22
Unemployment Rate	70	5.79	1.61	2.90	5.60	9.70	0.59
Log Real GDP (U.S.$2010)	58	9.02	0.51	8.06	9.08	9.76	−0.22
Presidential Party (Dem = 1)	72	0.49	0.50	0.00	0.00	1.00	0.06
Share Republican: House	72	0.45	0.07	0.32	0.44	0.57	0.13
Share Republican: Senate	72	0.46	0.07	0.32	0.45	0.55	−0.35
Anticipated Firearms Legislation Passage	73	0.04	0.39	−1.00	0.00	2.00	1.82
Log Gun Laws	73	0.93	0.66	0.00	1.10	1.79	−0.44
Federal Assault Weapons Ban	73	0.14	0.35	0.00	0.00	1.00	2.11
UCDP Summed Conflict Intensity	73	2.62	3.10	0.00	2.00	13.00	1.28
UCDP Summed Cumulative Conflict Intensity	73	1.48	1.80	0.00	1.00	7.00	1.24
Herfindahl-Hirschman Index	32	840.22	89.37	689.88	860.79	1030.05	−0.07
Technology Gap	29	0.15	0.20	−0.11	0.07	0.59	0.70
Log Fatal Shootings	35	2.56	1.08	0.00	2.71	4.28	−0.73
Log Violent Crimes	53	13.86	0.58	12.38	14.10	14.47	−1.40
Log Murders	53	9.72	0.30	8.97	9.79	10.11	−1.17

Abbreviation: GDP, gross domestic product; UCDP, Uppsala Conflict Database Program.

reported domestic sales in the United States between 2007 (the year of the previous Small Arms Survey estimate of 270 million; Small Arms Survey 2011) and 2017 cannot collectively account for the difference between those two point estimates: the Small Arms Survey point estimates suggest a stock growth of 123.3 million firearms, but publicly reported domestic sales in the intervening period totaled just 109 million.

Koper and Roth (2002) describe how the anticipated passage of the 1994 FAWB drove up production by foresighted suppliers. Later, as prices rose following the ban's passage, supply dwindled due to the legal restrictions. Existing weapons were "grandfathered" in (meaning allowed under the laws in effect at the time of their purchase) and available for sale and resale during the ban years. To model anticipated legislative changes, we generate an integer variable that is set by default to 0, but adds 1 for each year preceding the passage of a major piece of restrictive US gun control legislation and subtracts one for each year preceding the passage of a major of US legislation relaxation of firearms controls. We also generate a running cumulative variable to proxy for the strength of firearms control laws in any given year. Pertinent laws are listed in Table 3.

The experience of US extraterritorial armed conflict is captured by two variables derived from the Uppsala Conflict Database Program's (UCDP) Armed Conflict Dataset (version 19.1) (Gleditsch et al. 2002; Pettersson et al. 2019). The two original variables describe (a) intensity of each armed conflict in a given year (0–2) and (b) a binary (0,1) variable for cumulative intensity, denoting whether a conflict has equaled or exceeded 1,000 battle-related deaths since its inception. We first expanded this dataset to have the unit of analysis of country–conflict–year rather than conflict–year. We then collapsed the result by country–year, summing the conflict intensity and cumulative intensity scores and yielding the variables we used for this study. Hence, the variable merged into our dataset represents the combined intensities of all conflicts in which the United States took part in a given year.

TABLE 3 Major pieces of federal gun legislation and their effects on the generated firearms control variable

Year	Legislation	Variable Effect
1968	Gun Control Act	1
1968	Omnibus Crime Control and Safe Streets Act	1
1986	Firearm Owners Protection Act	−1
1988	Undetectable Firearms Act	1
1990	Gun-Free School Zones Act	1
1993	Brady Handgun Violence Prevention Act	1
1994	Federal Assault Weapons Ban	1
2004	Federal Assault Weapons Ban (expiry)	−1
2005	Protection of Lawful Commerce in Arms	−1

Several control variables were not included in the main models due to their limited observations, including the Herfindahl–Hirschman Index (HHI, a commonly used quantitative measure characterizing markets along the spectrum from competitiveness to monopoly), technology gap, fatal shootings, total violent crimes, and murders. Nevertheless, we deemed these variables important enough to merit inclusion in tailored spin-off analyses. HHIs were calculated in the usual way (i.e., as the sum of squared market shares s for N market participants i, such that $HHI = \sum_{i=1}^{N} s_i^2$) using ATF-reported quantities of arms sold per producing Federal Firearms Licensee (FFL). However, they will be domestic floor estimates, as (a) multiple FFLs that manufacture arms are subsidiaries of a single holding corporation, and (b) ATF data do not reflect importer market composition. Without in-depth knowledge of shifting corporate ownership structures, it is not possible to produce more accurate HHIs. The technology gap refers to the fact that imported weapons were considered more sophisticated than the US-made competition during the 1980s and 1990s. We model this technology gap simply by normalizing the difference in price indices between imported and domestic handguns by the price index of domestic handguns. Crime figures come from the US Department of Justice's Federal Bureau of Investigation (FBI 2019).

3.3 | Instrumental Variables

We identify four possible IVs measuring the effects of natural disasters for our demand models: variables that might affect the price in the short run, but not the quantity of firearms bought or sold. Although not necessarily exogenous to economic performance (Botzen et al. 2019), the effects of natural disasters may nevertheless be more exogenous than other economic disruptions of national scale and have been used as an IV in previous studies (McDougal et al. 2018; Ramsay 2011). However, their effects on prices and quantities of firearms are theoretically ambiguous: If they raise demand in the context of inelastic supply (or decrease supply in the context of inelastic demand), prices might rise without significant increases in quantity. Conversely, if they raise demand in the context of perfectly elastic supply (or decrease supply in the context of perfectly elastic demand), quantity might change without a corresponding change in price. We therefore test empirically log population killed by natural disasters (in a given year per 100,000 population), log population "affected" by natural disasters (in any way, including being killed, rendered homeless, displaced, etc.), log population rendered homeless, and log economic damages in constant US dollars, for both relevance (to firearms prices) and exogeneity (vis-à-vis quantity of firearms sold) in uncontrolled and controlled OLS regressions. Controlled models include all covariates we later use in our full three-stage least squares (3SLS) regressions. We choose price as the IV mediator because we deem the total quantity of firearms sold

TABLE 4 Prospective instrumental variables assessed for relevance and exogeneity

		Relevance (to price)		Exogenous (to quantity)	
	Prospective instrumental variable	**Uncontrolled**	**Controlled**	**Uncontrolled**	**Controlled**
Demand side	Log Death Due to Disasters	No (+)	**Yes (-)**	**Yes (+)**	**Yes (+)**
	Log People Rendered Homeless by Disasters	**Yes (+)**	No (+)	No (+)	**Yes (+)**
	Log Total Affected by Disasters	**Yes (-)**	No (+)	No (+)	**Yes (+)**
	Log Total Damages Due to Disasters (US$1,000)	**Yes (+)**	No (+)	No (+)	**Yes (-)**
Supply side	Log real price of cold-rolled steel (US$)	**Yes (-)**	**Yes (-)**	No (-)	**Yes (-)**
	Log price of hot-rolled steel (US$)	No (-)	No (+)	No (+)	**Yes (+)**

on US markets to be of greater direct policy importance than prices. Table 4 summarizes Appendix Table 1 and Appendix Table 2, demonstrating that in controlled models, only log deaths due to disasters is both relevant (to price) and exogenous (to quantity). The other three candidates would meet the IV criteria only for a model that used a mediator of quantity to predict price.

Employing uncontrolled and controlled Durbin–Wu–Hausman tests, the residual terms from the first-stage equations are not significant ($p = 0.40$ and $p = 0.34$, respectively) in predicting the outcome of domestic production for the US market (Davidson & MacKinnon 1993). Given the responsiveness of price to log disaster deaths, we use the latter below in predicting price in our SEMs.

We also use the IV of log hot-rolled steel prices for the supply side. We considered both cold- and hot-rolled steel, the former obtained from US Bureau of Labor Statistics (2020) and the latter from US Geological Survey (2012) with imputed data for post-2010 years. As Table 4 shows, hot-rolled steel is both relevant (in controlled models) and exogenous in supply-side models, whereas cold-rolled steel is not found to be exogenous. Steel prices should a priori directly affect the price of firearms production without *directly* affecting the quantity of arms produced. Uncontrolled and controlled manual Durbin–Wu–Hausman tests reveal significant and insignificant residual terms respectively using the hot-rolled steel IV.

4 | BASIC RESULTS

We present uncontrolled and controlled coefficients for the lagged price mediator in SEMs for three logged outcomes:

1. Domestic production of domestically sold firearms
2. Exports of domestically produced firearms
3. Imported production of domestically sold firearms

For each logged quantity outcome, we run 12 models containing the log price predictor: supply and demand, each for six control scenarios. Results are presented in Table 5 (regressions that inform this summary coefficient table are presented in Appendix Table 3, Appendix Table 4, and Appendix Table 5.)

The results indicate that our primary outcome follows the standard microeconomic theory. The price elasticity of supply is positive and significant across all model specifications, indicating that domestic producers are willing to make more firearms as prices rise. Conversely, the price elasticity of demand is negative and significant in all models that include economic or sociodemographic controls, suggesting buyers are less willing to purchase firearms as prices rise. In the fully controlled models, the price elasticity of supply is roughly 3.219 (see Appendix Table 3, model 6): For every 1% rise in price, we can expect a 3.219% rise in quantity demanded. The price elasticity of demand is

TABLE 5 Summary coefficients for firearms price in SEM regressions on various outcomes (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

Outcome	Supply/demand	1 Uncontrolled	2 Demographic controls[1]	3 Economic controls[2]	4 Political controls[3]	5 Legal controls[4]	6 All controls
Domestic production	Supply	**8.791****	**4.412*****	**5.625*****	**3.003****	**8.010*****	**3.239*****
		(3.468)	(0.688)	(0.640)	(1.289)	(0.844)	(0.670)
	Demand	**12.07*****	**−3.893*****	**−5.814*****	**6.789*****	**10.42*****	**−2.561*****
		(4.317)	(1.399)	(1.079)	(1.742)	(3.250)	(0.895)
Exports	Supply	**8.837****	**1.406***	**3.108*****	−0.0766	**6.032*****	**1.372***
		(3.644)	(0.722)	(0.707)	(1.408)	(0.885)	(0.732)
	Demand	**14.55*****	**−8.376*****	**−6.304*****	1.041	−3.569	−0.620
		(4.395)	(2.052)	(1.432)	(1.728)	(2.990)	(1.208)
Imports	Supply	**169.1*****	**90.06*****	**91.08*****	**97.76*****	**109.6*****	**85.95*****
		(31.89)	(6.281)	(5.492)	(13.33)	(7.706)	(5.614)
	Demand	**173.9*****	−21.45	11.45	**127.9*****	**127.1*****	3.812
		(37.94)	(19.29)	(14.57)	(15.59)	(34.31)	(11.72)

Abbreviations: IV, instrumental variable; SEM, simultaneous equation model; UCDP, Uppsala Conflict Database Program.

[1]Supply: none. Demand: population, military veterans, estimated firearms stocks, homicide rates, suicide rates.

[2]Supply: unemployment rate. Demand: per capita real disposable income.

[3]Supply: UCDP conflict intensity, cumulative UCDP conflict intensity. Demand: party of the President, Republican share of Senate, Republican share of House.

[4]Supply: None. Demand: anticipated firearms legislation passage, cumulative firearms legal onus, federal Assault Weapons Ban.

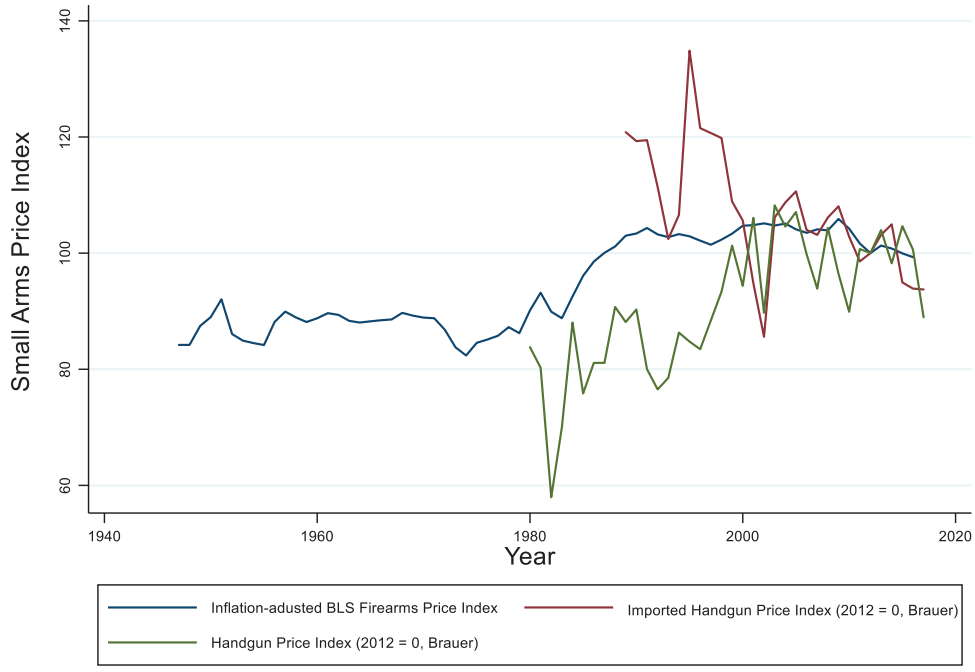

FIGURE 3 Imported (red) and domestic (green) handgun prices indices by year, plotted along with the overall inflation-adjusted Bureau of Labor Statistics (BLS) small arms price index (blue); 2012 = 100 [Colour figure can be viewed at wileyonlinelibrary.com]

approximately −2.561 (see Appendix Table 3, model 6): For every 1% rise in price, we can expect to see a quantity decrease of −2.561%. The same signs (although variously lower statistical significances) are seen in the case of exports, possibly suggesting that US domestic prices are correlated, if imperfectly, with prices on foreign firearms markets. Finally, although foreign supplies appear to respond positively (and dramatically) to higher prices, the elasticity of demand for imports also appears positive (if insignificantly so in the fully controlled model). This might be explained by noting that the BLS small arms price index is a producer price index and entirely dictated by US-made firearms; therefore, rising domestic firearms prices might be expected to drive customers to imports in a substitution effect, and vice versa. This interpretation is contextualized by the fact that imports were initially more technologically sophisticated than US-made firearms and therefore commanded higher prices. In competition with improving US weapons, the price gap eventually closed over the course of the 1980s and 1990s (see Figure 3 and Section 5).

Both logged civilian firearms stocks and its square term were highly significant and exhibited the predicted signs: negative for the former, positive for the latter. These results indicate that demand for firearms is decreasing in civilian stocks at low levels but increasing at high levels. The positive sign of the square terms suggests that higher firearms stocks boost general demand to some extent. Moreover, the nadir of the parabola falls at around $e^{18.9} \cong 161.5$ *million*, well within the range of values for estimated firearms stocks and corresponding to the level of stock in around the year 1986. As stocks have risen monotonically year-on-year, all increases to levels of firearms stocks after that year are estimated to be predictive of heightened future demand (see Figure 4). In the case of the stock elasticity of demand, we use STATA's margins command to estimate a value of 0.078: By the last year of our study period, for every 1% rise in stocks, we observe a corresponding 0.078% rise in firearms demand.

A few other results of our SEM also merit mention. In terms of US production for domestic sale, Appendix Table 3 indicates that, as we had supposed, the unemployment rate is indeed a positive

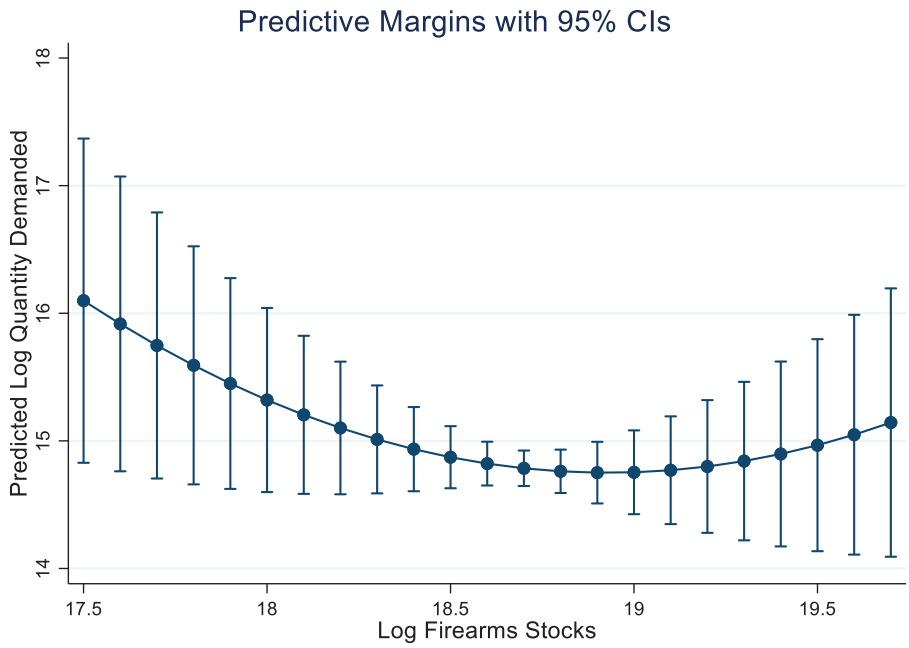

FIGURE 4 Predicted log quantities of firearms demanded as a function of log estimated total firearms stocks, based on Appendix Table 3, model 6 [Colour figure can be viewed at wileyonlinelibrary.com]

and highly significant predictor of quantity supplied. This suggests that higher unemployment rates unsurprisingly make it cheaper to pay worker salaries, and thus fit the general pattern of manufacture moving to lower-cost states (Brauer et al. 2017). Intensity of US conflicts abroad is not associated with greater production for civilian markets but is associated with greater exports, possibly speaking to US-involved conflicts in which allies are gifted or purchase US-made small arms. Homicides and suicides are both significantly associated with heightened future demand in both models in which they figure.

Democratic-party US presidents are generally associated with a boost the quantity demanded by around 9%, presumably due to fears of potential future federal firearms legislation. The share of Republican legislators in the House of Representatives is also positively associated with demand rises. However, effects of legislation itself are mixed. The number of federal firearms laws (i.e., the running total of federal sales restrictions as described above) is not correlated with firearms unit sales, bucking popular presumption. The exception to this is the FAWB, in effect from 1994 to 2004, which is credited by the SEM with a 16.2% decline in domestic firearms sales for US markets. Overall, the models with sociodemographic and economic controls were most highly predictive of demand, explaining 91% and 73% of its variation, respectively.

As a robustness check (not presented), we also included two one-time shocks to the US firearms market, one to supply and the other to demand. The events of September 11, 2001 served as a motivation for many Americans to enlist in the military. We suspected that the enhancement of US military involvement abroad, and the consequent demand for military firearms, would divert production away from the civilian market. The Newtown massacre in December 2012 triggered a wave of purchasing from firearm owners fearing that the policy response would drastically inhibit firearm sales. We generated dummy variables for each of these shocks to begin in the year they occurred (2013 in the case of Newtown, as the events came so close to the end of the year) and diminish by one-third every year thereafter. The September 11 variable, as predicted, is associated with a significant supply decrease of 0.8% ($p = 0.014$). The Newtown massacre variable is associated with increased demand of

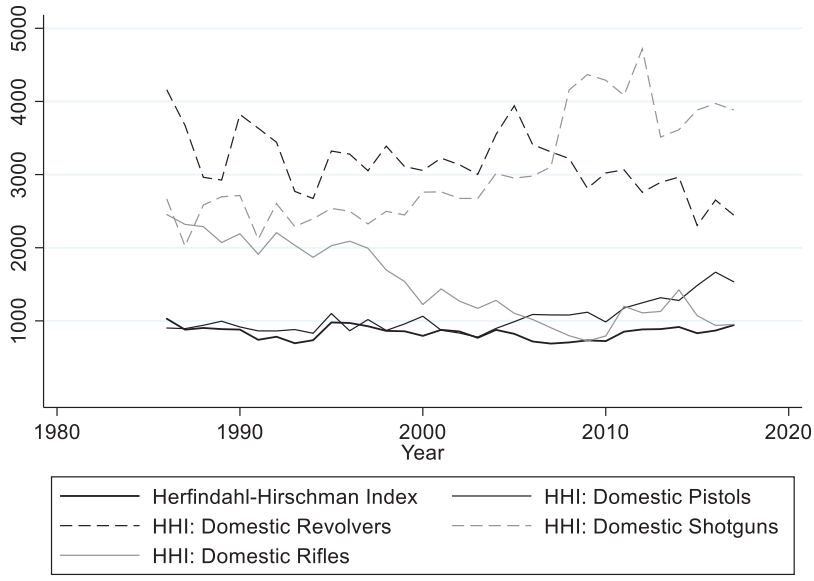

FIGURE 5 Herfindahl–Hirschman Indices (HHIs) for the overall US firearms market and submarkets, 1986–2017
[Colour figure can be viewed at wileyonlinelibrary.com]
Source: the authors.

0.4% ($p = 0.056$). Moreover, the variables' inclusion decreased the p-values associated with our main predictors and boosted R-squared statistics by around 1.5 percentage points, further tightening the model.

5 | OTHER INFLUENCES

Certain factors we could not include in the overall models due to study period limitations on associated data. We therefore chose to deal with three important issues separately. The first two regard industry composition, namely: (1) industry concentration and cartel behavior, and (2) the technology gap between US and foreign firms. The third issue involves the effects, if any, of high-profile mass shootings and other violent crimes, on the firearms market.

Given the characterization of certain firearms submarkets as being strong duopolies or oligopolies (Section 2 and Brauer 2013b) and observing considerable variation in HHIs for the US firearms market as a whole as well as its submarkets (see Figure 5), we chose to investigate whether such industry supply concentrations are significant enough to influence production quantities. As we have HHIs only for a subset of our study years (1986–2017), including the variable in the original SEM above would have reduced our number of observations from 71 to 31 (a drop of 56%). Accordingly, we re-ran controlled and uncontrolled SEMs both with and without the inclusion of HHIs, restricting the observations utilized in both cases to those in which HHIs exist, for both the overall market and the pistol and rifle submarkets.

The technology gap that existed between US and foreign manufacturers in the 1980s and 1990s is commonly cited as a major factor in driving the steep rise in imported firearms to the United States over that period (Brauer 2013b; see Figure 3). We hypothesize, therefore, that the larger this gap, the fewer US-made firearms would be sold. As we have price indices for both domestically produced and imported handguns sold in the United States for the period 1986–2017 and assuming that price is reflective of quality and technological sophistication in a given year, we are able to construct a proxy

TABLE 6 Coefficients for selected predictors (HHI, technology gap, crimes) in various SEM models estimating quantity of firearms. Derived from Appendix Table 6 through Appendix Table 13

		1	2
Predictor	**Category**	**Uncontrolled**	**Controlled**
HHI	All	0.000324	−0.000655
		(0.000539)	(0.000490)
	Hand guns: pistols	0.00120	**0.00200*****
		(0.00118)	(0.000326)
	Hand guns: revolvers	−0.000173	**−0.000404*****
		(0.000436)	(0.000108)
	Long guns: rifles	**0.000445*****	**0.000496*****
		(0.000111)	(0.000104)
	Long guns: shotguns	4.52e-05	−6.55e-05
		(7.54e-05)	(9.82e-05)
Technology gap	All	−0.218	**−0.557***
		(0.260)	(0.267)
	Handguns	1.683	**−0.610****
		(1.652)	(0.235)
	Long guns	1.863	**−0.654*****
		(1.065)	(0.152)
Crime	Mass shootings	**0.00375***	**0.00298*****
		(0.00162)	(0.000737)
	Violent crimes	**0.447*****	**1.158***
		(0.0699)	(0.537)

Standard errors in parentheses
$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$
Abbreviations: HHI, Herfindahl–Hirschman Index; SEM, simultaneous equation model.

for the technology gap proxy as:

$$TechnologyGa\,p_t = \left(P_{i,t} - P_{d,t}\right)/P_{d,t} \tag{4}$$

where $P_{i,t}$ and $P_{d,t}$ are the price of imported and domestically produced handguns in time t, respectively. We use the same paired-sample methodology described above in our SEM estimations. We have no way of including in these models specific technological developments that likely contribute to higher prices over time, such as the gradual shifts toward magazine-fed rifles and shotguns, recoil dampeners, and electronic safety switches.

Just as with HHIs and the technology gap, we had limited data on violence and crime (aside from general homicide data included in the original models). Two indicators of interest to us were (1) mass shootings (from a dataset collected and maintained by *Mother Jones*, 1982–2016; Follman et al. 2016) and (2) violent crimes in general (Department of Justice, 1960–2012). We ran side by side IV SEMs for each of these variables under uncontrolled and controlled scenarios, restricting uncontrolled model observations by the same criteria that would apply in the controlled scenario (see Appendix Tables 6, 7, and 8).

Table 6 lists the values of coefficients for HHIs (only available for US producers), the technology gap, and log-counts of selected crimes associated with firearms, within SEMs modeling quantity of

firearms. HHI enters the SEM in the supply side due to its presumed effects on competition pricing, whereas the technology gap and crimes enter on the demand side due to their presumed effects on consumer willingness to pay. Coefficient estimates are derived in various submarket categories as shown. Results from the industry concentration analysis show no cartel behavior overall. There is evidence that industry concentration increases supply in the pistols and rifle submarkets, suggesting larger corporations reap economies of scale in those submarkets, but this is not the case for revolvers[5] and shotguns.

There is evidence that the technology gap, as proxied, drives quantity demanded in the overall market, as well as in the handgun and long gun submarkets. In other words, larger gaps are associated with lower sales of domestically produced weapons (see Appendix Tables 9, 10, and 11). As for crime, our basic model already provided evidence that homicides were positively associated with demand. Here, too, we find mass shootings and violent crime to predict greater sales of firearms (see Appendix Tables 12 and 13).

6 | CONCLUSIONS

We have presented a national-level model of the US firearms market, 1946–2016, using an IV simultaneous equation model approach. This study contributes to the understanding and regulation of a complex market. The basic contours of this market conform to microeconomic theory: The price elasticity of supply is positive, that of demand is negative. However, some interesting tidbits emerge from the initial model and subsequent analyses, as follows:

Firearms stocks and crime. Levels of firearms stocks exhibit a convex parabolic relationship with realized demand, suggesting civilian stocks boost demand for more firearms to some extent. This finding accords with the hypothesis that misuse and abuse of firearms generally erode property security (and perhaps feelings of personal safety as well), implying that firearms create their own demand. Indeed, we do find that violent crimes and homicides generally, and mass shootings specifically, drive up demand for firearms. Such a finding is in agreement with theoretical models of conflict in the absence of property security (Caruso 2010), as well as empirical studies of the effects of collective insecurity on firearms demand (McDowall and Loftin 1983). However, we also cannot parse the security effect from the "collector" effect: the idea that the firearms market is characterized by addictive purchasing patterns among a relatively small subset of purchasers (see the "rational addiction" literature). The latter hypothesis also finds empirical support in the phenomenon of serious collectors, the 3% of firearms owners who collectively own roughly half of the nation's stock of civilian weapons (Becket 2016). The finding specific to mass shootings also accords with recent work suggesting that these events drive up prices, and have traditionally driven *down* firearms manufacturers' stock prices—until a post-2010 "new normal" emerged (Gopal and Greenwood 2017; Jones and Stone 2015). To some, such findings may suggest an economic justification for legal restrictions on the sales of firearms paralleling those on sales of harmful and addictive drugs, and for firearms buyback programs and small arms destruction programs in situations of oversupply. Further research is justified in assessing the elasticity of substitution of illegally acquired weapons for legally acquired ones.

Legislation. The (log) "burden" of firearms laws is not correlated with domestically produced firearms sales but is negatively associated with American firearms imports in fully controlled models. If firearms legislation does have a demand-dampening effect, it may also make legal purchase and ownership clearer and easier, or simply not do much besides stoke fears of impending firearms shortages. The major exception to this rule is the US FAWB, signed into law in 1994 by then-President Clinton and allowed to expire 10 years later by then-President Bush, which we credit econometrically with a 16% drop in domestic firearms sales for US markets. These empirical findings may corroborate both seemingly antithetical claims that firearms legislation largely has no significant effect on firearms sales (Polsby 1994) and observations that the FAWB did in fact reduce the total availability of weapons on the market (Chicoine 2011; Dube et al. 2013; Koper and Roth 2002). This result may

imply that firearms legislation only curbs volumes on the market when it involves an outright ban on some category of weapon.

War. We find that US military campaigns abroad have a positive effect on quantity supplied on export markets, whether due to heightened demand of US military contractors and allies, civilians in unstable areas, or some other factor. The fact that US military conflicts do not heighten domestic demand seems to exclude the possibility of military-industrial demand driving economies of scale.

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CONFLICT OF INTEREST STATEMENT

This study received no outside funding, and the authors have no known conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

PEER REVIEW

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ENDNOTES

[1] Canada's per capita gross domestic product (GDP) is somewhat lower than that of the United States, at around US$49K to the United States' US$62.6K, although it also generally offers a higher degree of social welfare and lower rates of poverty and inequality (as measured by Gini coefficients: 33.3 in 2017 as against the United States' 41.2) (World Bank, 2022). Both countries are considered "developed" with similar expenditures on education (both around 5% of GDP), similar average times spent in school (~16 years), similar rates of urbanization (both around 82-83%), and both providing 100% of their urban population with access to improved drinking water and sanitation facilities (IndexMundi, 2022).

[2] For instance, a prominent "anti-gun" group, Everytown USA, is not in fact "anti-gun" but has gun violence prevention as is mission. Similarly, the firearms industry association, the National Shooting Sports Foundation (NSSF), has for many years promoted firearms safety and suicide prevention among its members. These two, and many additional, organizations clash not over the goal of reducing firearms-related violence, but over the normative extent of firearms-related legislation.

[3] The Federal Bureau of Investigation (FBI) runs background checks on most new sales of firearms, raising the question of whether statistics on such background checks might represent good proxies for sales. They do not; background checks are problematic proxies for sales and are considered inappropriate as such by the firearms research community generally. The FBI itself states that background checks are not equivalent to unit sales. This is due to many reasons, including the facts that (a) not all background checks are approved for sale, (b) many sales do not require background checks (e.g., those under the famous "gun show loophole"), (c) successful background checks may initiate sales of more than one firearm at a time, and (d) some background checks are run as routine rechecks. The state of Kentucky, for instance, rechecks every permit every month, but this of course does not mean that every such permit holder purchases a new firearm every month. For these reasons, the firearms industry's NSSF (the agent with the foremost interest in assessing demand) adjusts the FBI's background check data; its methodology is similar to ours (first developed in Brauer, 2013a).

[4] The US military does not tend to issue spot orders to fill any immediate demand needs. That said, it is true that current and cumulative external conflict increases wear and tear and leads to replacement needs, even if stretched out over time (Stiglitz and Bilmes, 2012). These conflict events and periods may also be associated with higher security sensitivity and fear transmission in the general US population (e.g., after the events of 9/11) and therefore with a hypothetical uptick in the civilian market. All in all, it seems at least plausible that this variable may play a role in supply decisions.

[5] It is worth noting that import shares of revolvers (31%) are much lower than those for pistols (41%).

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APPENDIX: REGRESSION TABLES

TABLE A1 Relevance test of prospective IVs predicting firearms price

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VARIABLES	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**
	Controls	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**
Demand side	Log Death Due to Disasters	0.0155	**−0.0114***						
		(0.0134)	(0.00605)						
	Log People Rendered Homeless by Disasters			**0.0137*****	0.000156				
				(0.00158)	(0.00158)				
	Log Total Affected by Disasters					**0.0105*****	−0.00114		
						(0.000984)	(0.00179)		
	Log Total Damages Due to Disasters (US$1,000)							**0.0103*****	−0.000355
								(0.00312)	(0.00130)
	Observations	70	68	70	68	70	68	70	68
	R-squared	0.016	0.872	0.507	0.865	0.508	0.866	0.259	0.865

(Continues)

TABLE A1 (Continued)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VARIABLES	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**	**Log Inflation-adjusted BLS Firearms Price Index**
	Controls	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**
Supply side	Log cold-rolled steel price index (deflated)	**−0.199*** **	**−0.0542** **						
		(0.0136)	(0.0266)						
	Log hot-rolled steel price index (deflated)			−0.000639	**−0.0912*** **				
				(0.0450)	(0.0255)				
	Observations	70	69	70	69				
	R-squared	0.606	0.784	0.000	0.817				

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable.

TABLE A2 Exogeneity test of prospective demand-side IVs predicting log domestic total firearms production

VARIABLES	(1) Log Domestic Total	(2) Log Domestic Total	(3) Log Domestic Total	(4) Log Domestic Total	(5) Log Domestic Total	(6) Log Domestic Total	(7) Log Domestic Total	(8) Log Domestic Total
Controls	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**
Log Death Due to Disasters	0.0899	0.0124						
	(0.0762)	(0.0350)						
Log People Rendered Homeless by Disasters			**0.0612*** **	0.00953				
			(0.0116)	(0.00786)				
Log Total Affected by Disasters					**0.0614*** **	0.00970		
					(0.00824)	(0.00709)		
Log Total Damages Due to Disasters (US$1,000)							**0.0588*** **	−0.00198
							(0.0150)	(0.00947)
Observations	72	69	72	69	72	69	72	69
R-squared	0.014	0.925	0.278	0.927	0.453	0.928	0.225	0.925
Log cold-rolled steel price index (deflated)	**−0.705*** **	**0.881*** **						
	(0.128)	(0.271)						
Log hot-rolled steel price index (deflated)			**0.892*** **	0.273				
			(0.180)	(0.203)				
Observations	70	69	71	70				
R-squared	0.213	0.459	0.181	0.360				

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Abbreviation: IV, instrumental variable.

TABLE A3 Log-log SEM estimations of domestic production of firearms for the US market on log prices under five control specifications (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1) No Controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Log Inflation-adjusted BLS Firearms Price Index = L,	**8.791****		**4.412*****		**5.625*****		**3.003****		**8.010*****		**3.239*****	
	(3.468)		(0.688)		(0.640)		(1.289)		(0.844)		(0.670)	
Log Inflation-adjusted BLS Firearms Price Index		**12.07*****		**−3.893*****		**−5.814*****		**6.789*****		**10.42*****		**−2.561*****
		(4.317)		(1.399)		(1.079)		(1.742)		(3.250)		(0.895)
Log US population in ('000s)				**3.814*****								1.168
				(1.073)								(1.648)
Log Number of Military Veterans				0.451								**0.817***
				(0.532)								(0.469)
Log Estimated Total Firearms Stocks				**−28.85*****								**−25.01*****
				(5.416)								(5.968)
c.lstocks#c.lstocks				**0.760*****								**0.661*****
				(0.141)								(0.159)
Log Homicide rate per 100k = L,				**0.884*****								**0.709*****
				(0.163)								(0.203)
Log Suicide rate per 100k = L,				**1.397****								**1.419****
				(0.591)								(0.583)
Unemployment Rate = L,					**0.0482*****						**0.117*****	
					(0.0178)						(0.0298)	
Log Per Capita Real Disposable Personal Income, US$2009						**1.730*****						0.860
						(0.177)						(0.549)
Sum UCDP War Intensity = L,							−0.0965				0.123	

(Continues)

TABLE A3 (Continued)

	(1) No Controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
							(0.0953)				(0.0919)	
Sum UCDP Cumulative War Intensity = L,							0.162				−0.167	
							(0.179)				(0.161)	
Party of the President (Dem = 1 / Rep = 0)								−0.0263				**0.0905****
								(0.0683)				(0.0394)
Republican Share of House of Rep's								0.761				**1.130****
								(0.733)				(0.511)
Republican Share of Senate								**−2.129***				−0.925
								(1.161)				(0.593)
Anticipated Firearms Legislation Passage										−0.0257		0.0287
										(0.122)		(0.0439)
Log Firearms Laws = L,										−0.0504		0.0638
										(0.264)		(0.101)
Federal Assault Weapons Ban in Effect = L,										**−0.469*****		**−0.162****
										(0.173)		(0.0786)
Constant	−24.90	**−39.83****	−5.007	**246.4*****	**−10.80*****	**36.27*****	1.409	**−15.16****	**−21.36*****	**−32.18****	−0.419	**227.1*****
	(15.76)	(19.63)	(3.126)	(41.40)	(2.910)	(4.420)	(5.843)	(7.516)	(3.838)	(14.52)	(3.041)	(48.24)
Observations	69	69	69	69	68	68	69	69	69	69	68	68
R-squared	−1.079	−2.418	0.037	0.914	−0.101	0.737	0.137	−0.303	−0.796	−1.110	0.325	0.937

Standard errors in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A4 Log-log SEM estimations of US exports on disaster-affected population under five control specifications: (1) no controls, (2) demographic controls, (3) economic controls, (4) political controls, (5) all previous controls (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1) No controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Log Inflation-adjusted BLS Firearms Price Index = L,	**8.837****		**1.406***		**3.108*****		−0.0766		**6.032*****		**1.372***	
	(3.644)		(0.722)		(0.707)		(1.408)		(0.885)		(0.732)	
Log Inflation-adjusted BLS Firearms Price Index		**14.55*****		**−8.376*****		**−6.304*****		1.041		−3.569		−0.620
		(4.395)		(2.052)		(1.432)		(1.728)		(2.990)		(1.208)
Log US population in ('000s)				0.547								1.544
				(1.731)								(2.231)
Log Number of Military Veterans				−0.364								**1.357****
				(0.870)								(0.635)
Log Estimated Total Firearms Stocks				−14.72								**−18.63****
				(9.011)								(8.081)
c.lstocks#c.lstocks				**0.416***								**0.500****
				(0.235)								(0.216)
Log Homicide rate per 100k = L,				**1.358*****								**1.044*****
				(0.272)								(0.275)
Log Suicide rate per 100k = L,				−0.138								1.215
				(0.907)								(0.789)
Unemployment Rate = L,					**0.0341***						**0.130*****	
					(0.0204)						(0.0328)	
Log Per Capita Real Disposable Personal Income, US$2009						**1.372*****						−0.827
						(0.230)						(0.743)

(Continues)

TABLE A4 (Continued)

	(1) No controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Sum UCDP War Intensity = L,							0.0160				**0.247****	
							(0.106)				(0.103)	
Sum UCDP Cumulative War Intensity = L,							−0.0459				**−0.467*****	
							(0.199)				(0.180)	
Party of the President (Dem = 1 / Rep = 0)								−0.0179				**0.144*****
								(0.0692)				(0.0534)
Republican Share of House of Rep's								−0.198				**1.252***
								(0.736)				(0.691)
Republican Share of Senate								−0.904				−0.958
								(1.146)				(0.803)
Anticipated Firearms Legislation Passage										**0.287*****		0.0577
										(0.111)		(0.0594)
Log Firearms Laws = L,										**0.793*****		0.137
										(0.243)		(0.137)
Federal Assault Weapons Ban in Effect = L,										**−0.567*****		**−0.296*****
										(0.157)		(0.107)
Constant	**−27.77***	**−53.75*****	**6.000***	**177.4****	−1.935	**36.91*****	**12.76****	8.178	**−15.02*****	**27.97****	5.439	**143.6****
	(16.56)	(19.98)	(3.282)	(69.53)	(3.207)	(5.894)	(6.382)	(7.440)	(4.024)	(13.35)	(3.326)	(65.30)
Observations	69	69	69	69	68	68	69	69	69	69	68	68
R-squared	−2.286	−6.332	−0.025	0.564	−0.183	0.353	0.000	0.006	−1.012	0.685	0.191	0.862

Standard errors in parentheses
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$
Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A5 Log-log SEM estimations of foreign imports on disaster-affected population under five control specifications (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1) No controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Log Inflation-adjusted BLS Firearms Price Index = L,	**169.1*****		**90.06*****		**91.08*****		**97.76*****		**109.6*****		**85.95*****	
	(31.89)		(6.281)		(5.492)		(13.33)		(7.706)		(5.614)	
Log Inflation-adjusted BLS Firearms Price Index		**173.9***** (37.94)		−12.45 (12.95)		11.45 (14.57)		**127.9***** (27.99)		**127.1***** (27.31)		3.112 (18.72)
Log US population in ('000s)			**−91.60*****								**−61.86*****	
			(14.91)								(21.70)	
Log Number of Military Veterans			−10.56								−0.883	
			(7.403)								(6.165)	
Log Estimated Total Firearms Stocks			**199.9*****								63.03	
			(75.48)								(78.54)	
c.lstocks#c.lstocks			**−4.207****								−0.595	
			(1.963)								(2.095)	
Log Homicide rate per 100k = L,			1.454								**4.431***	
			(2.267)								(2.679)	
Log Suicide rate per 100k = L,			−11.45								**−13.10***	
			(8.177)								(7.675)	
Unemployment Rate = L,					**0.865*****						**1.406*****	
					(0.225)						(0.250)	
Log Per Capita Real Disposable Personal Income, US$2009						**12.94*****						−11.87
						(2.399)						(7.219)

(Continues)

TABLE A5 (Continued)

	(1) No controls		(2) Sociodemography		(3) Economics		(4) Politics		(5) Legislation		(6) All Controls	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Sum UCDP War Intensity = L,							−0.228				0.758	
							(1.079)				(0.763)	
Sum UCDP Cumulative War Intensity = L,							−0.317				**−2.236***	
							(1.988)				(1.337)	
Party of the President (Dem = 1 / Rep = 0)								−0.0433				0.419
								(0.872)				(0.520)
Republican Share of House of Rep's								**−20.44****				**−16.50****
								(9.432)				(6.724)
Republican Share of Senate								9.649				6.142
								(11.75)				(7.807)
Anticipated Firearms Legislation Passage										−0.932		−0.396
										(1.268)		(0.578)
Log Firearms Laws = L,										−0.111		**−2.788****
										(2.785)		(1.332)
Federal Assault Weapons Ban in Effect = L,										**−3.379***		0.897
										(1.794)		(1.037)
Constant	**−760.2*****	**−782.2*****	**−401.2*****	−823.7	**−410.9*****	−82.90	**−435.2*****	**−568.7*****	**−489.9*****	**−569.1*****	**−389.5*****	−133.8
	(144.9)	(172.5)	(28.55)	(577.5)	(24.80)	(59.53)	(60.41)	(66.69)	(35.02)	(153.3)	(25.50)	(634.1)
Observations	69	69	69	69	68	68	69	69	69	69	68	68
R-squared	−0.654	−0.759	0.628	0.909	0.692	0.814	0.613	0.323	0.471	0.347	0.766	0.951

Standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A 6 Comparisons of IV SEMs for the total US firearms market with and without the introduction of an overall HHI, 1986–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand
Log Inflation-adjusted BLS Firearms Price Index = L,	−5.737		−3.163		**−6.225*** **		**−10.97*** **	
	(3.125)		(3.878)		(1.865)		(2.662)	
Log Inflation-adjusted BLS Firearms Price Index		**−17.57*** **		**−10.16** **		**−9.995*** **		**−6.920** **
		(3.625)		(3.146)		(2.728)		(2.377)
Herfindahl-Hirschman Index = L,			0.000324				−0.000655	
			(0.000539)				(0.000490)	
Log US population in ('000s)						**−45.31*** **		**−47.93*** **
						(6.544)		(6.145)
Log Number of Military Veterans						0.388		0.549
						(0.460)		(0.414)
Log Estimated Total Firearms Stocks						**−5.475***		**−5.862** **
						(2.316)		(2.081)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k						0.431		0.323
						(0.329)		(0.299)
Log Suicide rate per 100k						**−3.064** **		**−2.703** **
						(1.169)		(1.045)
Log Per Capita Real Disposable Personal Income, US$2009						−0.787		−1.341
						(1.329)		(1.219)
Party of the President (Dem = 1 / Rep = 0)						**0.214*** **		**0.197*** **
						(0.0559)		(0.0510)

(Continues)

TABLE A6 (Continued)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						−1.009		−0.402
						(0.707)		(0.729)
Republican Share of Senate						−1.445		−1.266
						(0.914)		(0.932)
Anticipated Firearms Legislation Passage						0.0733		**0.102****
						(0.0386)		(0.0359)
Log Firearms Laws						**0.433***		**0.515****
						(0.204)		(0.182)
Federal Assault Weapons Ban in Effect						0.147		0.125
						(0.0974)		(0.0854)
Unemployment Rate = L,					**0.101*****		**0.0912****	
					(0.0298)		(0.0293)	
Sum UCDP War Intensity = L,					0.110		0.0753	
					(0.0670)		(0.0660)	
Sum UCDP Cumulative War Intensity = L,					**−0.283***		−0.210	
					(0.128)		(0.125)	
Year	**0.0260*****	**0.0261*****	**0.0248*****	**0.0233*****	**0.0432*****	**0.666*****	**0.0374*****	**0.709*****
	(0.00482)	(0.00448)	(0.00453)	(0.00428)	(0.0101)	(0.128)	(0.00986)	(0.114)
Constant	−10.16	**44.50***	−20.01	15.83	**−42.75***	**−593.6*****	−8.491	**−656.0*****
	(13.91)	(19.16)	(20.79)	(18.51)	(20.27)	(139.6)	(23.66)	(124.0)
Observations	31	31	30	30	31	31	30	30
R-squared	0.549	0.504	0.494	0.698	0.661	0.970	0.692	0.973

Standard errors in parentheses

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Abbreviations: BLS, Bureau of Labor Statistics; HHI, Herfindahl–Hirschman Index; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A7 Comparisons of IV SEMs for the US handguns submarket with and without the introduction of pistol and revolver HHIs, 1986–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand
Log Handgun Price Index (2012 = 0, Brauer) = L,	−12.70		−11.05		−1.866		−1.185	
	(7.932)		(7.624)		(1.246)		(0.683)	
Log Handgun Price Index (2012 = 0, Brauer)		**−20.42*****		**−13.68*****		0.0337		0.132
		(3.488)		(1.900)		(0.412)		(0.387)
HHI: Domestic Pistols = L,			0.00120				**0.00200*****	
			(0.00118)				(0.000326)	
HHI: Domestic Revolvers = L,			−0.000173				**−0.000404*****	
			(0.000436)				(0.000108)	
Log US population in ('000s)						**−35.18*****		**−29.77****
						(9.206)		(9.316)
Log Number of Military Veterans						0.278		0.0104
						(0.535)		(0.535)
Log Estimated Total Firearms Stocks						−0.842		−0.217
						(1.985)		(2.189)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						0.243		0.537
						(0.261)		(0.348)
Log Suicide rate per 100k = L,						0.790		0.983
						(1.267)		(1.280)
Log Per Capita Real Disposable Personal Income, US$2009						0.802		1.480
						(1.972)		(2.143)

(Continues)

TABLE A7 (Continued)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Party of the President (Dem = 1 / Rep = 0)						**0.326*** **		**0.328*** **
						(0.0598)		(0.0620)
Republican Share of House of Rep's						0.797		0.942
						(0.646)		(0.721)
Republican Share of Senate						**−2.239****		**−2.662****
						(0.728)		(0.985)
Anticipated Firearms Legislation Passage						**0.0921***		**0.111***
						(0.0462)		(0.0487)
Log Firearms Laws = L,						0.271		0.134
						(0.169)		(0.187)
Federal Assault Weapons Ban in Effect = L,						**−0.199****		−0.143
						(0.0770)		(0.0837)
Unemployment Rate = L,					**0.149***		**0.100****	
					(0.0655)		(0.0383)	
Sum UCDP War Intensity = L,					**0.238***		−0.0779	
					(0.109)		(0.0742)	
Sum UCDP Cumulative War Intensity = L,					−0.389		0.207	
					(0.224)		(0.151)	
Year	0.136	**0.176*** **	0.0946	**0.126*** **	**0.0367***	**0.390****	−0.0222	**0.313***
	(0.0697)	(0.0284)	(0.0807)	(0.0171)	(0.0163)	(0.144)	(0.0122)	(0.152)
Constant	−199.4	**−245.4*** **	−125.5	**−175.6*** **	−51.53	**−318.0***	**62.81****	−242.0
	(104.4)	(43.62)	(128.4)	(28.10)	(31.62)	(151.1)	(24.25)	(161.7)
Observations	32	32	31	31	31	31	30	30
R-squared	−1.254	−5.770	−0.609	−1.858	0.541	0.976	0.845	0.978

Standard errors in parentheses
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$
Abbreviations: HHI, Herfindahl–Hirschman Index; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A8 Comparisons of IV SEMs for the US long gun submarket with and without the introduction of an overall HHI, 1986–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Log Longgun Price Index (2012 = 0, Brauer) = L,	1.664		0.327		0.413		0.809	
	(1.021)		(0.833)		(0.478)		(0.421)	
Log Longgun Price Index (2012 = 0, Brauer)		**4.710*** **		**5.677*** **		**1.455*** **		0.345
		(1.073)		(1.468)		(0.351)		(0.269)
HHI: Domestic Rifles = L,			**0.000445*** **				**0.000496*** **	
			(0.000111)				(0.000104)	
HHI: Domestic Shotguns = L,			4.52e-05				−6.55e-05	
			(7.54e-05)				(9.82e-05)	
Log US population in ('000s)						−16.46		**−18.01***
						(9.350)		(8.729)
Log Number of Military Veterans						0.321		0.956
						(0.577)		(0.522)
Log Estimated Total Firearms Stocks						**4.369***		3.377
						(2.046)		(2.111)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						0.301		−0.0954
						(0.299)		(0.350)
Log Suicide rate per 100k = L,						0.409		1.145
						(1.320)		(1.221)
Log Per Capita Real Disposable Personal Income, US$2009						**4.384***		**4.724***
						(1.871)		(2.011)
Party of the President (Dem = 1 / Rep = 0)						**0.302*** **		**0.272*** **
						(0.0624)		(0.0600)

(Continues)

TABLE A8 (Continued)

	(1)		(2)		(3)		(4)	
	No HHI		HHI		No HHI		HHI	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						**1.733****		**1.898****
						(0.613)		(0.675)
Republican Share of Senate						**−2.795*****		**−2.546****
						(0.719)		(0.960)
Anticipated Firearms Legislation Passage						**0.0963***		0.0707
						(0.0429)		(0.0413)
Log Firearms Laws = L,						0.247		0.298
						(0.174)		(0.178)
Federal Assault Weapons Ban in Effect = L,						−0.0874		−0.102
						(0.0786)		(0.0796)
Unemployment Rate = L,					**0.0541***		0.0552	
					(0.0262)		(0.0336)	
Sum UCDP War Intensity = L,					0.0896		0.0686	
					(0.0584)		(0.0530)	
Sum UCDP Cumulative War Intensity = L,					**−0.247***		**−0.222***	
					(0.117)		(0.109)	
Year	0.0115	−0.0179	**0.0434*****	**−0.0316***	**0.0373*****	−0.0146	**0.0677*****	0.0250
	(0.00914)	(0.0109)	(0.00751)	(0.0155)	(0.00873)	(0.148)	(0.0104)	(0.145)
Constant	−15.63	29.56	**−74.39*****	**52.61***	**−61.86*****	137.6	**−125.2*****	88.56
	(14.29)	(17.61)	(14.58)	(25.04)	(17.61)	(155.1)	(21.63)	(155.3)
Observations	32	32	31	31	31	31	30	30
R-squared	0.440	−1.116	0.769	−1.868	0.619	0.912	0.784	0.942

Standard errors in parentheses

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Abbreviations: HHI, Herfindahl–Hirschman Index; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A9 Comparisons of IV SEMs for the US firearms market with and without the introduction of a technology gap proxy, 1989–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No Tech Gap		Tech Gap		No Tech Gap		Tech Gap	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Log Inflation-adjusted BLS Firearms Price Index = L,	**−50.03*****		**−36.24*****		**−15.65*****		**−14.82*****	
	(12.50)		(9.833)		(2.229)		(2.195)	
Log Inflation-adjusted BLS Firearms Price Index		**−47.75*****		**−42.85*****		−7.541		−9.088
		(5.540)		(5.134)		(6.191)		(5.744)
U.S.-Foreign Technology Gap Proxy				−0.218				**−0.557***
				(0.260)				(0.267)
Log US population in ('000s)						−8.718		−5.323
						(4.524)		(4.600)
Log Number of Military Veterans						0.433		0.755
						(0.589)		(0.578)
Log Estimated Total Firearms Stocks						2.038		1.924
						(1.533)		(1.463)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						−0.0186		0.531
						(0.282)		(0.374)
Log Suicide rate per 100k = L,						1.766		1.184
						(1.763)		(1.665)
Log Per Capita Real Disposable Personal Income, US$2009						3.338		1.815
						(2.116)		(2.165)
Party of the President (Dem = 1 / Rep = 0)						**0.189****		**0.257*****
						(0.0643)		(0.0679)

(Continues)

TABLE A9 (Continued)

	(1)		(2)		(3)		(4)	
	No Tech Gap		**Tech Gap**		**No Tech Gap**		**Tech Gap**	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						−0.261		−0.343
						(1.500)		(1.401)
Republican Share of Senate						**−2.476****		**−2.403****
						(0.883)		(0.843)
Anticipated Firearms Legislation Passage						0.0599		0.0124
						(0.0820)		(0.0791)
Log Firearms Laws						0.230		−0.343
						(0.312)		(0.389)
Federal Assault Weapons Ban in Effect						−0.0161		0.148
						(0.0963)		(0.115)
Unemployment Rate = L,					**0.0776****		**0.0762****	
					(0.0245)		(0.0244)	
Sum UCDP War Intensity = L,					−0.00787		−0.0147	
					(0.0577)		(0.0573)	
Sum UCDP Cumulative War Intensity = L,					0.0739		0.0863	
					(0.0957)		(0.0951)	
Constant	**247.3*****	**236.7*****	**183.3*****	**214.0*****	**87.27*****	**98.08***	**83.42*****	65.83
	(57.97)	(25.68)	(45.58)	(23.79)	(10.36)	(38.19)	(10.20)	(41.14)
Observations	28	28	28	28	28	28	28	28
R-squared	−2.093	−1.211	−0.494	−0.654	0.763	0.957	0.767	0.958

Standard errors in parentheses

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model.

TABLE A10 Comparisons of IV SEMs for the US handguns market with and without the introduction of a technology gap proxy, 1989–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No Tech Gap		Tech Gap		No Tech Gap		Tech Gap	
VARIABLES	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand
U.S.-Foreign Technology Gap Proxy				1.683				**−0.610****
				(1.652)				(0.235)
Log Handgun Price Index (2012 = 0, Brauer) = L,	−8.394		**−17.05*****		−1.731		−1.737	
	(11.06)		(2.924)		(1.203)		(1.195)	
Log Handgun Price Index (2012 = 0, Brauer)		**−10.60*****		1.029		0.428		−0.0917
		(2.670)		(3.525)		(0.454)		(0.519)
Log US population in ('000s)						**−9.718***		−4.411
						(4.340)		(3.847)
Log Number of Military Veterans						−0.153		0.400
						(0.549)		(0.536)
Log Estimated Total Firearms Stocks						**3.649****		2.001
						(1.318)		(1.198)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						0.408		0.394
						(0.364)		(0.306)
Log Suicide rate per 100k = L,						**2.652****		**3.480*****
						(0.917)		(0.828)
Log Per Capita Real Disposable Personal Income, US$2009						1.553		0.582
						(2.081)		(1.722)
Party of the President (Dem = 1 / Rep = 0)						**0.254*****		**0.262*****
						(0.0625)		(0.0514)
Republican Share of House of Rep's						0.842		1.046

(Continues)

TABLE A10 (Continued)

	(1)		(2)		(3)		(4)	
	No Tech Gap		Tech Gap		No Tech Gap		Tech Gap	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
						(0.733)		(0.618)
Republican Share of Senate						**−2.978****		**−2.307****
						(0.925)		(0.803)
Anticipated Firearms Legislation Passage						**0.150****		0.0986
						(0.0574)		(0.0567)
Log Firearms Laws = L,						−0.0633		−0.0511
						(0.255)		(0.209)
Federal Assault Weapons Ban in Effect = L,						**−0.186***		**−0.217****
						(0.0851)		(0.0718)
Unemployment Rate = L,					**0.157***		**0.153***	
					(0.0654)		(0.0651)	
Sum UCDP War Intensity = L,					**0.230***		0.219	
					(0.114)		(0.113)	
Sum UCDP Cumulative War Intensity = L,					−0.356		−0.321	
					(0.238)		(0.238)	
Year	0.0958	**0.111*****	**0.164*****	**0.0567*****	0.0293		0.0260	
	(0.0892)	(0.0219)	(0.0265)	(0.0120)	(0.0197)		(0.0196)	
Constant	−139.1	**−159.8*****	**−236.5*****	**−104.0*****	−37.34	55.00	−30.71	14.20
	(130.1)	(33.81)	(42.00)	(31.45)	(39.20)	(35.55)	(39.13)	(31.32)
Observations	29	29	29	29	28	28	28	28
R-squared	−0.039	−0.538	−3.170	0.381	0.545	0.978	0.545	0.985

Standard errors in parentheses
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$
Abbreviations: IV, instrumental variable; SEM, simultaneous equation model.

TABLE A11 Comparisons of IV SEMs for the US long guns market with and without the introduction of a technology gap proxy, 1989–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No Tech Gap		Tech Gap		No Tech Gap		Tech Gap	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
U.S.-Foreign Technology Gap Proxy				1.863				**−0.654*****
				(1.065)				(0.152)
Log Longgun Price Index (2012 = 0, Brauer) = L,	2.298		0.826		0.504		0.536	
	(1.778)		(1.711)		(0.554)		(0.521)	
Log Longgun Price Index (2012 = 0, Brauer)		**32.81*****		25.08		**1.619*****		**1.360*****
		(6.692)		(24.22)		(0.313)		(0.249)
Log US population in ('000s)						**−17.26*****		**−11.74****
						(4.409)		(3.692)
Log Number of Military Veterans						0.203		0.859
						(0.584)		(0.477)
Log Estimated Total Firearms Stocks						**4.374****		**2.350***
						(1.351)		(1.113)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						0.568		**0.661***
						(0.385)		(0.309)
Log Suicide rate per 100k = L,						0.0222		1.327
						(0.989)		(0.797)
Log Per Capita Real Disposable Personal Income, US$2009						**4.344***		**3.876***
						(2.101)		(1.701)
Party of the President (Dem = 1 / Rep = 0)						**0.297*****		**0.321*****
						(0.0649)		(0.0518)

(Continues)

TABLE A11 (Continued)

	(1)		(2)		(3)		(4)	
	No Tech Gap		Tech Gap		No Tech Gap		Tech Gap	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						**2.068****		**2.126*****
						(0.735)		(0.585)
Republican Share of Senate						**−3.309*****		**−2.515****
						(0.953)		(0.766)
Anticipated Firearms Legislation Passage						**0.155****		**0.130****
						(0.0522)		(0.0415)
Log Firearms Laws = L,						0.212		0.395
						(0.260)		(0.207)
Federal Assault Weapons Ban in Effect = L,						−0.0313		−0.117
						(0.0882)		(0.0707)
Unemployment Rate = L,					**0.0545***		0.0531	
					(0.0278)		(0.0277)	
Sum UCDP War Intensity = L,					0.0898		0.0868	
					(0.0604)		(0.0605)	
Sum UCDP Cumulative War Intensity = L,					**−0.254***		**−0.248***	
					(0.122)		(0.122)	
Year	0.00265	**−0.361*****	0.0171	−0.190	**0.0380*****		**0.0375*****	
	(0.0184)	(0.0821)	(0.0175)	(0.290)	(0.0109)		(0.0109)	
Constant	−0.803	**590.1*****	−23.18	282.5	**−63.73****	**120.3*****	**−62.87****	**77.77***
	(29.17)	(135.9)	(27.76)	(473.7)	(21.58)	(35.90)	(21.60)	(30.34)
Observations	29	29	29	29	28	28	28	28
R-squared	0.274	−66.983	0.517	−41.331	0.567	0.902	0.566	0.942

Standard errors in parentheses

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Abbreviations: IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A12 Comparisons of IV SEMs for the US firearms with and without the introduction of Mother Jones mass shootings, 1986–2017 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No Mass Shootings		Mass Shootings		No Mass Shootings		Mass Shootings	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Mother Jones Mass Shootings: Fatalities = L,				**0.00375***				**0.00298*****
				(0.00162)				(0.000737)
Log Inflation-adjusted BLS Firearms Price Index = L,	**−4.205***		**−5.034****		**−5.022*****		**−4.138****	
	(1.728)		(1.806)		(1.420)		(1.346)	
Log Inflation-adjusted BLS Firearms Price Index		**−9.150*****		**−9.115*****		**−6.791*****		**−4.801*****
		(1.842)		(1.936)		(1.251)		(0.911)
Log US population in ('000s)						**−32.70*****		**−27.75*****
						(8.675)		(6.734)
Log Number of Military Veterans						0.811		0.445
						(0.525)		(0.391)
Log Estimated Total Firearms Stocks						−2.059		−2.209
						(2.385)		(1.825)
co.lstocks#co.lstocks						0		0
						(0)		(0)
Log Homicide rate per 100k = L,						**0.580***		0.299
						(0.266)		(0.199)
Log Suicide rate per 100k = L,						−0.751		0.424
						(1.084)		(0.861)
Log Per Capita Real Disposable Personal Income, US$2009						2.990		**2.831***
						(1.562)		(1.211)
Party of the President (Dem = 1 / Rep = 0)						**0.282*****		**0.252*****
						(0.0615)		(0.0445)

(Continues)

TABLE A12 (Continued)

	(1)		(2)		(3)		(4)	
	No Mass Shootings		Mass Shootings		No Mass Shootings		Mass Shootings	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						**1.148***		0.805
						(0.544)		(0.431)
Republican Share of Senate						**−2.936*****		**−1.993****
						(0.887)		(0.655)
Anticipated Firearms Legislation Passage						0.0524		**0.0662***
						(0.0414)		(0.0302)
Log Firearms Laws						0.268		**0.373****
						(0.162)		(0.119)
Federal Assault Weapons Ban in Effect						0.0579		0.0366
						(0.0894)		(0.0655)
Unemployment Rate = L,					**0.0762***		**0.0849****	
					(0.0315)		(0.0303)	
Sum UCDP War Intensity = L,					0.0564		0.0923	
					(0.0725)		(0.0702)	
Sum UCDP Cumulative War Intensity = L,					−0.213		**−0.278***	
					(0.136)		(0.132)	
Year	**0.0258*****	**0.0387*****	**0.0293*****	**0.0341*****	**0.0478*****	**0.373****	**0.0492*****	**0.317****
	(0.00578)	(0.00549)	(0.00573)	(0.00509)	(0.0105)	(0.139)	(0.0101)	(0.112)
Constant	**−16.91***	**−19.86***	**−20.03***	−10.75	**−57.42****	−273.3	**−64.36*****	−225.1
	(7.765)	(8.317)	(8.012)	(8.742)	(18.01)	(150.8)	(17.75)	(122.2)

Standard errors in parentheses

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model, UCDP, Uppsala Conflict Database Program.

TABLE A13 Comparisons of IV SEMs for the USfirearms market with and without the introduction of log violent crimes, 1960–2012 (IV_{demand} = log disaster deaths, IV_{supply} = log steel prices)

	(1)		(2)		(3)		(4)	
	No Violent Crime		Violent Crime		No Violent Crime		Violent Crime	
VARIABLES	Supply	Demand	Supply	Demand	Supply	Demand	Supply	Demand
Log (sum) violent_crimes				**0.447*** **				**1.158***
				(0.0699)				(0.537)
Log Inflation-adjusted BLS Firearms Price Index = L,	**−3.876***		**−7.792*** **		**−4.864*** **		**−4.750*** **	
	(1.595)		(1.604)		(0.925)		(0.914)	
Log Inflation-adjusted BLS Firearms Price Index		**−5.742*** **		**−6.228*** **		**−2.292***		**−4.995****
		(1.644)		(1.222)		(1.029)		(1.597)
Log US population in ('000s)						0.750		−11.18
						(9.648)		(10.53)
Log Number of Military Veterans						0.255		0.0699
						(0.634)		(0.592)
Log Estimated Total Firearms Stocks						−10.81		**−24.01***
						(7.979)		(9.653)
c.lstocks#c.lstocks						0.239		**0.587***
						(0.200)		(0.247)
Log Homicide rate per 100k = L,						0.786		0.0627
						(0.404)		(0.491)
Log Suicide rate per 100k = L,						1.638		0.102
						(1.158)		(1.290)
Log Per Capita Real Disposable Personal Income, US$2009						0.354		−0.996
						(1.212)		(1.251)
Party of the President (Dem = 1 / Rep = 0)						0.101		0.103
						(0.0736)		(0.0675)

(Continues)

TABLE A13 (Continued)

	(1)		(2)		(3)		(4)	
	No Violent Crime		Violent Crime		No Violent Crime		Violent Crime	
VARIABLES	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**	**Demand**
Republican Share of House of Rep's						0.197		0.244
						(0.830)		(0.767)
Republican Share of Senate						−0.0932		−0.414
						(0.976)		(0.914)
Anticipated Firearms Legislation Passage						0.0496		0.0246
						(0.0556)		(0.0524)
Log Firearms Laws						0.237		0.108
						(0.144)		(0.146)
Federal Assault Weapons Ban in Effect						−0.109		−0.0361
						(0.121)		(0.117)
Unemployment Rate = L,					**0.0511***		**0.0524***	
					(0.0232)		(0.0231)	
Sum UCDP War Intensity = L,					**0.271*****		**0.272*****	
					(0.0795)		(0.0795)	
Sum UCDP Cumulative War Intensity = L,					**−0.523*****		**−0.524*****	
					(0.137)		(0.137)	
Year	**0.0293*****	**0.0376*****	**0.0475*****	**0.0269*****	**0.0391*****	0.0623	**0.0385*****	0.204
	(0.00775)	(0.00785)	(0.00785)	(0.00646)	(0.00506)	(0.0911)	(0.00502)	(0.108)
Constant	**−25.50****	**−33.34*****	**−43.76*****	**−16.14***	**−40.58*****		**−40.02*****	
	(8.713)	(8.656)	(8.956)	(7.494)	(6.595)		(6.559)	
Observations	53	53	53	53	53	53	53	53
R-squared	0.532	0.552	0.447	0.752	0.688	0.904	0.688	0.920

Standard errors in parentheses
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$
Abbreviations: BLS, Bureau of Labor Statistics; IV, instrumental variable; SEM, simultaneous equation model.