

## Broadening the Perspective on Gun Violence: An Examination of the Firearms Industry, 1990–2015

Victoria M. Smith<sup>1</sup> Michael Siegel, MD, MPH,<sup>1</sup> Ziming Xuan, ScD, SM, MA,<sup>1</sup>  
Craig S. Ross, PhD, MBA,<sup>2</sup> Sandro Galea, MD, DrPH,<sup>2</sup> Bindu Kalesan, PhD, MPH,<sup>3</sup>  
Eric Fleegler, MD, MPH,<sup>4</sup> Kristin A. Goss, PhD, MPP<sup>5</sup>

**Introduction:** Firearm violence injures or kills 100,000 Americans each year. This paper applies the Host–Agent–Vector–Environment model to this issue. Research on firearm violence tends to focus on two elements—the host (i.e., victims of firearm violence) and the environment (i.e., gun policies)—but little attention has been paid to the agent (the gun and ammunition) or the vector (firearm manufacturers, dealers, and the industry lobby).

**Methods:** Using Bureau of Alcohol, Tobacco, Firearms and Explosives data, trends in firearm manufacturing were investigated from 1990 to 2015. Outcome measures included: (1) trends in domestic gun manufacturing by weapon type; (2) trends in production by firearm caliber; and (3) 2015 market share by type of firearm and company. Data were collected and analyzed in 2016.

**Results:** Overall domestic firearms production decreased slightly from 1996 through 2004, and then steadily increased from 1.7% in 2005 to 13.8% in 2013, when >10 million firearms were produced for the domestic market. The increase in total firearm production was driven by the increased production of pistols and rifles. Within the pistol category, increased production was attributable to an increase in higher caliber weapons. Similar trends were observed in gun purchases and recovered and traced crime guns.

**Conclusions:** Trends in firearm manufacturing reveal a shift toward more-lethal weapons, and this trend is also observed in gun purchases and crime gun traces. This may reflect a societal shift in cultural practices and norms related to guns and could inform strategies to reduce firearm violence.  
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### INTRODUCTION

Firearm violence causes more than 36,000 U.S. deaths annually.<sup>1</sup> Although the issue of firearm violence has traditionally been viewed from a criminal justice perspective, it is increasingly seen as a public health problem.<sup>2</sup> One advantage of this perspective is that it enables issues to be viewed using the Host–Agent–Vector–Environment model,<sup>2</sup> which is commonly applied to identify potential solutions to public health problems. In this model, the disease victim is the host; the entity that directly transmits the disease or injury is the agent; the producer or carrier of the agent is the vector; and the historical, cultural, social, economic, and political climate in which disease or injury occurs is the environment. Although this model was originally

intended and used for infectious disease, it has been applied to chronic disease as well. For example, Nord-siek<sup>3</sup> applied this model to the obesity epidemic as early as 1964. More recently, researchers prepared papers on each aspect of the tobacco epidemic,<sup>4</sup> including the host

From the <sup>1</sup>Department of Community Health Sciences, Boston University School of Public Health, Boston, Massachusetts; <sup>2</sup>Department of Epidemiology, Boston University School of Public Health, Boston, Massachusetts; <sup>3</sup>Department of Medicine, Boston University School of Medicine, Boston, Massachusetts; <sup>4</sup>Children's Hospital and Harvard Medical School, Boston, Massachusetts; and <sup>5</sup>Sanford School of Public Policy, Duke University, Durham, North Carolina

Address correspondence to: Michael Siegel, MD, MPH, Boston University School of Public Health, 801 Massachusetts Avenue, 4th Floor, Boston MA 02118. E-mail: mbsiegel@bu.edu.

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(smokers),<sup>5</sup> agent (cigarettes),<sup>6</sup> vector (the tobacco industry),<sup>7</sup> and environment (tobacco policies).<sup>8</sup>

Recently, this model has been applied to firearm violence.<sup>9–14</sup> For example, Pinto et al.<sup>9</sup> defined the host (victims of firearm violence), agent (firearms themselves and ammunition), vector (the firearms industry, including arms manufacturers and dealers and the industry lobby), and environment (gun policies, culture, social norms, and political and economic factors) and showed how consideration of each of these factors could lead to a range of potential strategies to reduce firearm violence. There are slight variations on the application of this model to firearm violence, with other authors viewing guns as the vector and ammunition as the agent,<sup>10–12</sup> classifying guns as a combined agent/vector,<sup>13</sup> and adding perpetrators as an additional agent.<sup>14</sup> Regardless of how the model is applied, its value lies in the articulation of a broad range of proximal and distal contributing factors that provide potential leverage at multiple levels to achieve injury prevention goals.

Most of the discussion regarding firearm violence has focused on characteristics of the host (i.e., firearm death and injury rates and the characteristics of victims) and the environment (i.e., gun policies and social determinants of crime), but less attention has been directed toward the agent (the gun and ammunition) or to the vector (firearms manufacturers, their practices, and gun sales). In contrast to the vast literature on cigarettes and tobacco companies, similar data on firearms and firearm manufacturers have rarely been published in the public health literature. Professor Timothy Lytton at Georgia State University recently noted that, “In popular discourse or political discourse, gun violence is often talked about in the context of criminals using weapons.... the real problem in gun violence we should focus on is the firearm industry’s sales, marketing and distribution practices.”<sup>15</sup> This paper begins to address this gap in the literature by examining trends in the volume and types of firearm production and company market shares by firearm types in the U.S. over time, and by examining the correlation between trends in manufactured firearms and purchased firearms, as well as firearms recovered in actual crimes.

Several previous articles in the public health literature have examined trends in the volume and types of firearms produced by the firearm industry. In a 1993 paper in this journal, Cook<sup>16</sup> reported U.S. domestic firearm production by gun type during the period 1965–1990. In a 1996 paper, Wintemute<sup>17</sup> described changes in handgun production and in the caliber of pistols from 1985 to 1994. In a 2002 paper, Wintemute<sup>18</sup> provided data on trends in gun production by weapon type during the period 1976–1999 and listed the leading

manufacturers of semiautomatic pistols during the 1990s. In a 2012 paper, Braga and colleagues<sup>19</sup> reported trends in domestic handgun production during the period 1979–1998. Most recently, a report of U.S. firearms production through 2010 produced by the Small Arms Survey provided data on domestic manufacturing by firearm type from 1942 to 2010 and presented the top manufacturers during the period 1986–2010.<sup>20</sup>

A major limitation of the existing literature is that public health impacts of observed trends in domestic manufacturing are not clear, as these trends have not been directly correlated with trends in purchased firearms and firearms recovered in crime. Given that the existing gun stock is very large,<sup>21</sup> are acute trends in production having an impact on the type of firearms being purchased and used (e.g., the types of guns actually being used in crimes)?

This paper provides information on the descriptive epidemiology of gun manufacture in the U.S. during the period 1990–2015. It examines: (1) trends in overall domestic gun manufacture by weapon types (pistol, revolver, rifle, and shotgun); (2) trends in the caliber of pistols; and (3) current market share by manufacturer for each weapon type. In addition to adding information on more recent trends in the types of firearms being introduced into the domestic market, this paper compares these trends with those in purchased firearms and crime firearms recovered and traced, to confirm whether manufacturing trends would be expected to be reflected in observed public health impacts.

Ultimately, a better understanding of the products on the market may have implications for improving firearms as consumer products, such as fostering changes in design to increase safety or changes in corporate practices to better protect consumers, as has been done for tobacco products.<sup>22</sup> Vernick and Teret<sup>23</sup> have outlined six potential areas in which a better understanding of firearms and firearm manufacturer practices could contribute to the development of novel strategies: (1) implementing safety standards; (2) reducing firearm lethality; (3) implementing surveillance and recall protocols; (4) improving oversight of dealers; (5) ensuring responsible advertising; and (6) enhancing accountability. This paper cannot in itself provide definitive solutions, but it may help inform debate as well as provide a basis for further research.

## METHODS

### Data Sample

Annual data on domestic firearm production, imports, and exports were gathered from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) for all 50 states for the period 1990–2015.<sup>24,25</sup> These data were used to calculate the trend in total firearms

introduced into domestic commerce by adding the number of manufactured and imported firearms and subtracting the number of exported firearms. Trends in domestic firearm production net of exports by weapon caliber were also examined. For 2015, the market share by volume for the top 20 U.S. manufacturers was determined. An estimate of firearms sold by weapon type was derived from Federal Bureau of Investigation data on the annual number of National Instant Criminal Background Check System checks.<sup>26</sup> Trends in crime guns by type and caliber were obtained from ATF crime gun trace reports.<sup>27</sup> Data were collected and analyzed in 2016.

## Measures

Data on firearm production for the years 1990–2015 were obtained from the U.S. ATF through their Annual Firearms Manufacturing and Export Reports (AFMER).<sup>24</sup> All federally licensed firearm manufacturers are required to report manufacturing and export numbers each year, making AFMER the most comprehensive and accurate source for firearm manufacturing data. These reports stratify each year's firearm production by manufacturer and type of weapon. Weapon types include pistol, revolver, rifle, shotgun, and miscellaneous, where pistols and revolvers are further separated by caliber, or bullet diameter. For pistols, the caliber is recorded in six categories of increasing bullet diameter: (1) up to 0.22 inches; (2) up to 0.25 inches; (3) up to 0.32 inches; (4) up to 0.380 (0.357 inches); (5) 9-mm Parabellum (also 0.357 inches but more powerful than the 0.380); and (6) up to 0.50 inches. Firearm exports account for approximately 5% of overall production. AFMER data exclude production of firearms for military use, but include units manufactured for law enforcement agencies. Firearms categorized as "miscellaneous" were not included in these analyses because this category consists of starter guns, pen guns, and firearm parts that do not constitute a complete, ready-to-use firearm. The ATF provided current AFMER data, but because these data have been updated to correct a small number of errors in reporting, there are minor differences between the totals reported here and those reported in published ATF reports.

Data on firearm imports for the years 1990–2015 were obtained from the annual ATF Report on Firearms Commerce in the U.S.<sup>25</sup> These reports summarize the number of non-military firearms imported, but break these weapons down only by crude type: handgun, rifle, and shotgun. During the study period, the proportion of total firearms introduced into U.S. commerce that were imported varied from 16.9% to 41.4%.

An estimate for annual gun sales by weapon type was derived from the Federal Bureau of Investigation's National Instant Criminal Background Check System data.<sup>26</sup> Because many background checks are associated with permitting rather than purchase, these data are only a rough estimate of the number of firearms sold. However, the current analysis was restricted to background checks listed by the ATF as being associated with the transfer of a handgun or long gun.

Trends in crime guns recovered and traced were obtained from the ATF crime trace data.<sup>27</sup> These data are only available for the period 2006–2015 for weapon type and 2012–2015 for caliber.

## Statistical Analysis

Trends in annual firearm commerce by weapon type (handgun, rifle, and shotgun) were examined by calculating domestically

produced firearms net of exports plus imports. Trends by handgun type (pistol and revolver) and caliber were based on domestically produced firearms net of exports, because imports are not broken down by handgun type or caliber. To calculate the market share by company in 2015, the production net of exports for each company was determined.

Changes in firearm production over time were assessed using a rolling, 5-year, compound annual growth rate, using the formula:  $CAGR = (EV/BV)^{1/5} - 1$ , where EV is the ending value (value in Year 5), and BV is the beginning value (value in Year 1). This value was then converted to a percentage.

## RESULTS

The number of firearms manufactured in the U.S. for domestic commerce ranged between 3 and 5 million per year between 1990 and 2005, but then grew exponentially, from 3.2 million firearms in 2005 to a peak of 10.3 million in 2013 (Table 1, Figure 1). The 5-year rolling compound annual growth rate in overall domestic firearms production was negative from 1996 through 2004, and then steadily increased from 1.7% in 2005 to 13.8% in 2013, before dropping to 7.0% in 2015. This increase in firearm manufacturing was primarily attributable to increased production of pistols and rifles. After declining from 1990 to 2005, annual pistol production increased by more than fourfold from 2005 to 2015 (from 0.8 million to 3.6 million), peaking in 2013 at 4.4 million. Whereas the number of manufactured shotguns and revolvers remained stable throughout the study period, rifle production increased nearly threefold from 1.4 million in 2005 to a peak of 4.0 million in 2013.

Within the pistol category, the dramatically increased production observed since 2005 was attributable primarily to 0.380 and higher caliber pistols (Table 2, Figure 2). Between 2004 and 2015, production of 0.380 pistols increased from 68,319 to 819,103 (a 12-fold increase), production of 9-mm pistols increased from 209,650 to 1,531,065 (a sevenfold increase), and production of pistols >9 mm increased from 304,551 to 767,471 (a 2.5-fold increase). Between 1990 and 2015, the production market share within the pistol category nearly doubled for 0.380 pistols (from 12.5% to 23.0%), increased by nearly 18 percentage points for 9-mm pistols (from 25.4% to 43.0%), and increased by seven percentage points for pistols >9-mm caliber (from 14.8% to 21.6%).

Trends in total U.S. firearm commerce (domestic production for domestic use plus imports) followed a similar pattern to domestic production itself, with a large increase in handgun and rifle production since 2005, but only a small increase in shotgun production (Appendix Table 1, Appendix Figure 1, available online).

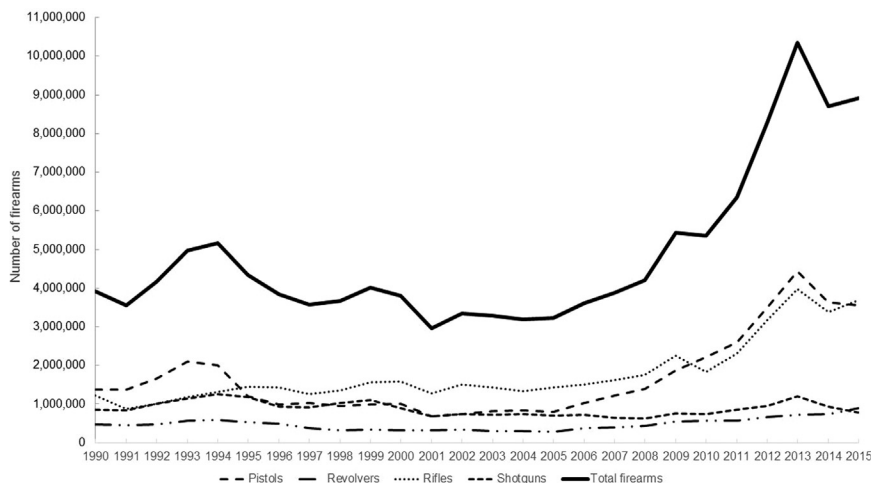
**Table 1.** Domestic Firearm Production (Net Exports), by Type, U.S., 1990–2015

Year	Pistols	Revolvers	Rifles	Shotguns	Total firearms	Pistols, 5-year CAGR, %	Rifles, 5-year CAGR, %	All firearms, 5-year CAGR, %
1990	1,371,427	470,495	1,211,664	855,970	3,909,556	—	—	—
1991	1,378,252	459,466	883,482	828,426	3,549,626	—	—	—
1992	1,669,537	469,413	1,001,833	1,018,204	4,158,987	—	—	—
1993	2,093,362	562,292	1,173,694	1,148,939	4,978,287	—	—	—
1994	2,004,298	586,450	1,316,607	1,254,924	5,162,279	7.9	1.7	5.7
1995	1,195,284	527,664	1,441,120	1,176,958	4,341,026	-2.8	10.3	4.1
1996	987,528	498,944	1,424,315	925,732	3,836,519	-10.0	7.3	-1.6
1997	1,036,077	370,428	1,251,341	915,978	3,573,824	-13.1	1.3	-6.4
1998	960,365	324,390	1,346,959	1,036,520	3,668,234	-13.7	0.5	-6.6
1999	995,446	335,798	1,569,685	1,106,995	4,007,924	-3.6	1.7	-1.6
2000	1,004,351	318,960	1,583,097	898,442	3,804,850	0.3	2.1	-0.2
2001	677,434	320,143	1,284,551	679,874	2,962,002	-8.1	0.5	-3.7
2002	743,016	347,070	1,515,535	741,384	3,347,005	-5.0	2.4	-1.8
2003	826,986	309,364	1,430,433	726,078	3,292,861	-3.6	-1.8	-3.9
2004	837,017	294,099	1,336,077	733,623	3,200,816	-3.6	-3.3	-3.4
2005	807,237	274,399	1,433,560	709,313	3,224,509	3.6	2.2	1.7
2006	1,021,544	382,067	1,500,659	714,618	3,618,888	6.6	-0.2	1.6
2007	1,222,718	391,334	1,618,257	645,600	3,877,909	8.1	2.5	3.3
2008	1,387,349	431,753	1,747,502	630,663	4,197,267	10.6	5.5	5.6
2009	1,870,063	547,526	2,256,912	752,755	5,427,256	18.3	9.5	11.0
2010	2,212,226	559,673	1,831,831	743,092	5,346,822	16.7	4.1	8.1
2011	2,598,256	572,857	2,318,207	862,401	6,351,721	16.3	7.5	10.4
2012	3,488,865	667,357	3,172,451	949,010	8,277,683	20.3	12.7	14.5
2013	4,441,726	725,282	3,979,568	1,203,072	10,349,648	18.9	12.0	13.8
2014	3,636,048	744,047	3,379,931	935,433	8,695,459	10.4	13.0	10.2
2015	3,557,199	885,259	3,691,799	777,273	8,911,530	6.5	9.8	7.0

Source: Bureau of Alcohol, Tobacco, Firearms and Explosives. Annual Firearms Manufacturers and Export Reports, 1990-2015.<sup>24</sup> CAGR, compound annual growth rate.

In 2015, Sturm, Ruger & Co. (Ruger) held the largest market share in the number of firearms produced at 18.7%, followed by Smith & Wesson at 16.5% and Remington at

12.8% ([Appendix Table 2](#), available online). The top five firearm manufacturers alone (including Sig Sauer and Maverick Arms) held 59.0% of the market, with the top

**Figure 1.** Domestic firearm production by type of weapon, 1990–2015.

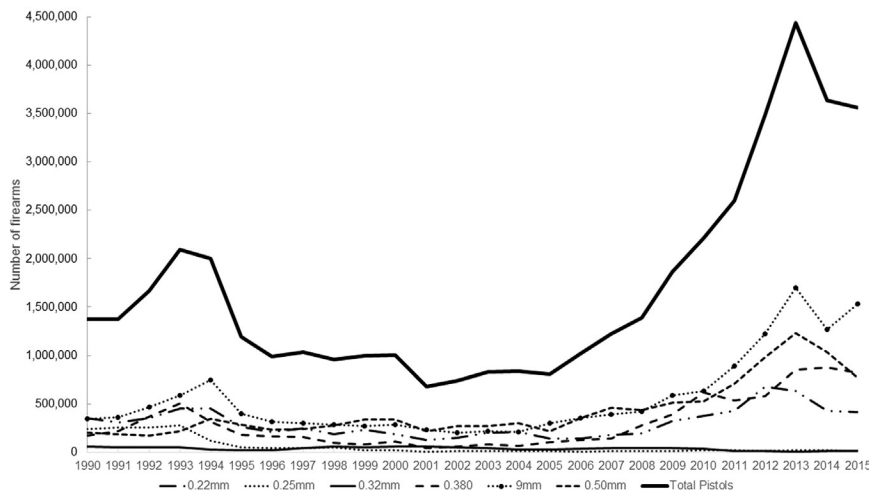
**Table 2.** Domestic Pistol Production (Net Exports), by Caliber, U.S., 1990–2015

Year	Up to 0.22	Up to 0.25	Up to 0.32	Up to 0.380	Up to 9mm	Up to 0.50	Total
1990	351,456	239,345	56,297	172,051	348,679	203,599	1,371,427
1991	306,088	252,370	55,007	215,595	358,228	190,964	1,378,252
1992	352,621	253,955	50,916	371,095	468,182	172,768	1,669,537
1993	452,509	277,306	52,268	508,469	586,039	216,771	2,093,362
1994	449,495	119,769	25,972	313,915	750,693	344,454	2,004,298
1995	260,059	51,025	19,220	182,801	398,472	283,707	1,195,284
1996	206,485	41,156	20,709	166,089	319,696	233,393	987,528
1997	250,983	43,103	43,623	154,046	303,212	241,110	1,036,077
1998	184,836	50,936	62,338	98,266	284,374	279,615	960,365
1999	229,852	24,393	52,632	81,881	270,298	336,390	995,446
2000	184,577	23,198	60,527	108,523	287,329	340,197	1,004,351
2001	123,374	5,697	57,823	41,634	229,821	219,085	677,434
2002	146,221	10,009	54,000	59,476	205,197	268,113	743,016
2003	200,300	14,023	43,471	79,788	220,576	268,828	826,986
2004	211,913	10,140	32,444	68,319	209,650	304,551	837,017
2005	139,178	10,471	29,028	107,416	301,189	219,955	807,237
2006	141,653	9,627	39,205	126,939	352,646	351,474	1,021,544
2007	180,419	11,395	43,914	138,484	392,263	456,243	1,222,718
2008	195,653	14,622	40,487	278,945	421,746	435,896	1,387,349
2009	320,892	15,107	47,395	390,895	586,548	509,226	1,870,063
2010	374,505	21,722	39,792	616,310	631,028	528,869	2,212,226
2011	427,571	19,182	13,890	537,063	888,379	712,171	2,598,256
2012	675,736	9,853	11,248	582,645	1,226,756	982,627	3,488,865
2013	635,744	18,578	6,591	852,727	1,697,509	1,230,577	4,441,726
2014	427,370	19,097	10,499	873,168	1,270,425	1,035,489	3,636,048
2015	413,230	11,567	14,763	819,103	1,531,065	767,471	3,557,199

Source: Bureau of Alcohol, Tobacco, Firearms and Explosives. Annual Firearms Manufacturers and Export Reports, 1990-2015.<sup>24</sup>

20 manufacturers holding a combined 87.2% market share. Ruger and Smith & Wesson were the predominant pistol manufacturers in 2015 (combined 49% market share), and Remington and Ruger were the predominant rifle manufacturers (combined 39% market share).

Manufacturing trends were reflected both in National Instant Criminal Background Check System background check trends and in crime gun recovery patterns. Estimated firearm sales remained relatively steady from 1999 to 2006, but rose dramatically starting in 2007,



**Figure 2.** Domestic pistol production by caliber of weapon, 1990–2015.

peaking in 2013 (Appendix Figure 2, available online). Crime trace data revealed an increase in recovered pistols between 2006 and 2015, with little change in rifles and a decline in revolvers and shotguns (Appendix Figure 3, available online). An analysis of recovered crime guns by caliber, which is available only for the period 2012–2015, revealed a decline in smaller caliber weapons and an increase in 0.380, 9-mm, and high caliber weapons (Appendix Table 3, available online).

## DISCUSSION

To the best of the authors' knowledge, this is the first paper in the public health literature to examine trends in firearm manufacturing by weapon type, caliber, and company subsequent to 1999. There was a dramatic increase in domestic firearm production starting in 2005 and peaking in 2013, driven by the increased production of pistols and rifles. In particular, there was a marked increase in production of large caliber (0.380 and higher) pistols. The gun manufacturing market share is concentrated among a small number of companies, with the top five manufacturers holding 59% of the market in 2015.

The main implication of these findings is that there has been a large increase, especially since 2005, in the share of firearms produced that are of higher caliber and therefore greater lethality. In addition, the growing production of 0.380 pistols, which are generally compact, suggests a shift toward more-concealable weapons as well. Thus, firearm production has moved toward products designed to be more powerful and more concealable. This is evidenced by the shift from revolvers to pistols as well as the shift toward higher caliber pistols and smaller designs (the 0.380 pistol) that retain high power. Though a pistol's stopping power, or wounding potential, is also related to bullet speed, ammunition shape, and ammunition jacketing, it is generally the case that the power of these pistols increases as the categories progress because bullet diameter is strongly related to stopping power.<sup>28–35</sup>

Koper<sup>29</sup> classified handgun calibers larger than 0.32 as being high stopping power handguns and noted that the 0.32 caliber dividing point is standard in the firearm literature.

Several studies have documented a connection between the lethality of weapon type and caliber and firearm injury frequency and severity.<sup>28–35</sup> Reedy and Koper<sup>30</sup> found that compared with revolvers, semiautomatic pistols result in a greater number of fired shots and a greater number of victims. Zimring<sup>35</sup> reported that larger caliber handguns are associated with a higher risk of fatal injury. Koper<sup>28,29</sup> reported an association between increased use of higher caliber weapons and increases in firearm homicide.

Although these data reflect trends in the overall entry of firearm types and calibers into the market, they are consistent with national trends in the recovery of crime guns. These trends are also consistent with an analysis of crime guns traced by the Chicago Police Department between 2001 and 2016, which revealed a decline in recovery of 0.22 caliber weapons (from 12.5% to 10% of recovered firearms), with an increase in 9-mm (from 18% to 29%) and 0.40 caliber weapons (from 2% to 13%) during the study period; both increases started in 2006.<sup>36</sup>

There is also empirical evidence that recent gun production trends have implications for crime because they reflect increasing numbers of guns or different types of guns making their way into the hands of high-risk possessors. Braga et al.<sup>19</sup> have shown that acute changes in retail sales have the potential to impact crime guns: Handguns sold at retail in a given year were over-represented by a factor of nearly five times in crime guns recovered the following year. Several studies have found a correlation between changes in the rate of retail gun sales and changes in rates of firearm homicide in subsequent years.<sup>37–39</sup>

The finding that firearm manufacturing is highly concentrated among a small number of companies is important because it suggests that the market may be driven by the practices of just a handful of companies. Therefore, changes in firearm design, safety, and marketing by these few companies could substantially affect the entire gun supply. For example, if just one or two companies could be convinced to begin producing “smart guns”—firearms that can only be operated by an authorized user—it is likely that such an innovation would spread through the market quickly.

By closely examining the firearm industry and its manufacturing practices, this paper builds on efforts to reframe gun violence as a societal public health problem rather than simply individual crimes, advancing a public health approach to the problem of firearm violence.

## Limitations

This study has five central limitations. First, the ATF does not list imported firearms by handgun type or caliber. Thus, the estimates of total firearm commerce include only the crude categories of handguns, rifles, and shotguns. Second, the AFMER data include firearms produced for law enforcement agencies. Thus, it cannot be assumed that the observed trends are strictly related to civilian use. Third, the AFMER data do not provide any information about ammunition magazine capacities. Fourth, not all agencies provide guns to the ATF for tracing, which is voluntary, and tracing practices may change over time. Thus, changes in the composition of trace guns may reflect differences in tracing procedures over time in addition to differences in the actual

composition of crime guns. Finally, this paper did not examine demand-side factors that may be contributing to increased firearm production and sales. Such an examination is beyond the scope of this analysis, but should be explored in future research.

## CONCLUSIONS

Despite these limitations, the findings of this study have significant implications for finding working solutions to the problem of firearm violence. Further research is needed to determine whether industry marketing is contributing to a change in the demand for firearms and the cultural perception of guns in society.

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## SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2017.05.002>.

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