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This paper uses publicly available commercial data to determine how the political and legal circumstances of a state influence the production and consumption of firearms. Regression analyses are conducted using data on manufacturers and retailers. The paper finds a statistically significant relationship between the per capita number of establishments and the 2016 presidential vote share in a given state. From this analysis, Vermont is identified as an outlier for retailers and is examined as a case study. The deviation of Vermont from the general relationship establishes two findings: first, that legal protections can insulate retailers from regulation and political risk, bolstering commercial activity; and second, that such legal protections can create a positive consumption culture around guns, supporting demand. In concluding, the paper emphasizes the significance of the findings as they relate to the distinction between regulation and political climate. This study is a starting point for further research on firearm market dynamics and regulation.

The Particular Effects of Political and Legal Circumstances on State Markets for Firearms[*]

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September 16, 2018

Abstract

This paper uses publicly available commercial data to determine how the political and legal circumstances of a state influence the production and consumption of firearms. Regression analyses are conducted using data on manufacturers and retailers. The paper finds a statistically significant relationship between the per capita number of establishments and the 2016 presidential vote share in a given state. From this analysis, Vermont is identified as an outlier for retailers and is examined as a case study. The deviation of Vermont from the general relationship establishes two findings: first, that legal protections can insulate retailers from regulation and political risk, bolstering commercial activity; and second, that such legal protections can create a positive consumption culture around guns, supporting demand. In concluding, the paper emphasizes the significance of the findings as they relate to the distinction between regulation and political climate. This study is a starting point for further research on firearm market dynamics and regulation.

1 Introduction

For decades, the use and regulation of firearms has been the subject of highly divisive political debate in the United States. Indeed, many have come to note that the perpetration of violence using firearms is far too frequent for an industrialized nation. It has, in turn, remained a contentious issue, significant to both the law and the economy in the U.S.

Although presumably measurable in many cases, the efficacy of certain firearm policies has not escaped partisan criticism. This politicization and resultant ambiguity raises a pivotal question for policy-makers and researchers alike: what are the empirical effects of regulation on the production and consumption of firearms in the U.S.? In its attempt to begin answering this question, this paper focuses on the retailing and manufacturing of firearms in the United States, as they relate to politics, culture, and the law.

This study is limited in scope by the immediate availability of information from organizations like the Bureau of Alcohol, Tobacco, and Firearms (ATF). It thus serves as the starting point for a broader and more thorough study of historical market dynamics and particular government policies. Its eventual aim is to study these factors as they relate to more specific controversies, such as those surrounding assault weapons.[1]

Section 2 of the paper provides the necessary background information on the legislative history and market structure of firearms. Section 3 explains the rationale for data selection, then utilizes this publicly available market data to empirically understand its relationship with the political culture in each of the fifty states. An outlier, Vermont, is identified. Section 4 then delves

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[1] Appended to this document are a legal definition of assault weapons, based on the 1994 Federal Assault Weapons Ban (see Appendix B), and a brief review of the existing literature on the economics, criminal use, and regulation of assault weapons (see Appendix C).

deeper into the circumstances of Vermont, leading to two principal implications about the general relationship among retailing, the law, and politics. Section 5 summarizes the findings of the paper and concludes.

2 Background information

2.1 Legislative overview[2]

In 1938, Congress passed the Federal Firearms Act. Among its stipulations is a requirement that all manufacturers, importers, and sellers of firearms have a Federal Firearms License (FFL). The eleven classes of FFL govern commerce of destructive devices, ammunition, and firearms. Of these eleven, the three that are relevant to the market for firearms are Type 01, firearm retailers; Type 02, pawnbrokers selling firearms; and Type 07, firearm manufacturers. Subsection 2.2 elaborates on the classifications of "retailers" and "manufacturers." The 1968 Gun Control Act requires that all interstate gun transfers be conducted through an FFL dealer.

The 1993 Brady Handgun Violence Prevention Act (Brady Act) mandated a nationwide five-day waiting period and background check prior to purchase of a firearm. This waiting period expired in 1998 following the implementation of the National Instant Criminal Background Check System (NICS). The NICS is used by FFL dealers to conduct an immediate background check prior to making a sale. While the Brady Act mandates NICS checks for sales by FFL dealers, most states do not require background checks for private sales — a policy that is often called the "gun show loophole" in political discourse.

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[2] This section focuses solely on the federal, state, and local firearm regulations most relevant to the paper. A more comprehensive summary of historical federal legislation is included in Appendix A.

There are two central pieces of federal legislation relating to assault weapons: the 1989 import ban and the 1994 Federal Assault Weapons Ban. The former prohibited the importation of certain foreign semi-automatic firearms. It was implemented through a permanent reinterpretation of the 1968 Gun Control Act. Still, several brands with foreign roots, such as Beretta USA and Kalashnikov USA, have circumvented the ban and currently manufacture within the United States. The 1994 Federal Assault Weapons Ban imposed a ten-year ban on the manufacturing of certain semi-automatic firearms and large capacity magazines (LCMs) for civilian use.

While the 1994 ban expired in 2004 and was not renewed, there are seven states and three localities which currently ban the manufacturing, sale, and ownership of assault weapons.[3] Four of these states implemented bans in 2004; almost all of these states and localities implemented bans in the period from 1989 to 2004.

2.2 Supply chain

From production to consumption, the U.S. domestic market for firearms is organized into three groups: manufacturers, retailers, and consumers. Beyond these, there exist black market transactions and private exchanges between consumers; however, as Subsection 3.1 elucidates, neither of these groups will be of particular relevance to the paper's empirical analysis.

Firearm manufacturers — a term used interchangeably with "producers" and "Type 07 dealers" — produce and distribute firearms, predominately to retailers. Manufacturers can make direct sales to consumers, but must do so via an FFL dealer in order to properly conduct a background check. Unless there is a specific ban in place, such as those on assault weapons, manufacturers can sell across state lines.

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[3] These states are CA (1989 and 1999), CT (1993 and 2013), HI (2004), MD (2004), MA (2004), NJ (1990), and NY (2004); localities are D.C., the Chicago area, and parts of Indiana (until 2011).

Retailers, or Type 01 dealers, operate within five subcategories. [4] These include wholesalers, sporting goods stores, department stores, gun stores, and online retailers. Online retailers must be licensed and conduct all interstate transfers through an FFL dealer.

The most predominant consumers of firearms are civilians, law enforcement, and private security markets.

3 Empirical analysis

3.1 Data

There are four particularly useful sources of commercial firearm data that can aid in answering the research question, each of which has its own practical limitations. [5] Upon considering these limitations, the listings of FFL dealers were selected for empirical analysis. What follows in this subsection will outline each of these sources, justify the ultimate choice to use FFL data, and then list the other data sources used.

The first of these four sources is the ATF's Annual Firearms Manufacturing and Export Report (AFMER). The report includes annual quantities of firearms produced in and exported from the United States, disaggregated into five broad categories of firearms. Aside from pistol and revolver caliber, AFMER data cannot be further disaggregated within firearm classes. It would be useful for a time-series analysis of manufacturing through periods of legislative change; however, as was established in Subsection 2.1, most significant and volatile changes to federal regulations

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[4] Due to their typically diverse inventories and low total count, FFL Type 02 dealers (pawnbrokers selling firearms) are excluded from the group of firearm retailers.

[5] It may also be possible to access more disaggregated data, such as an anonymized registry, via a FOIA request; however, these are the most useful sources readily available to the public.

occurred in the period from 1989 to 2004. AFMER data is available online only as far back as 2007, limiting the likelihood that such an analysis would be informative.

The *Blue Book of Gun Values* is a searchable online database of historical firearm prices, disaggregated by model and condition. It is highly comprehensive and contains the information necessary for price-related analyses like, for instance, elasticity calculations. That said, the available data cannot be accessed in aggregate, meaning that individual gun prices must be manually and individually extracted for analysis.

Each month, the FBI publishes the aggregate number of NICS checks conducted in each state. Certain studies have used this data as a proxy for firearm consumption.[6] As alluded to in Subsection 2.2, the use of NICS checks poses a substantial limitation: most states do not require background checks for private gun sales and the size of the black market, while not definitively known, is likely non-negligible. Hence, supply-side data is ostensibly more reliable.

Finally, the ATF makes available a complete listing of FFL dealers each month. This data contains, among other things, the location and license type of each FFL establishment. The FFL data is, though, only available online from 2014 to present, significantly constraining the ability to use it for a time-series analysis over the period of greatest regulatory change. It also provides no information on the specific types of guns being produced and sold.

Of these four sources, the FFL listings provide the most readily accessible disaggregated data on supply-side economic activity. The number of Type 01 and Type 07 dealers in each state is equivalent to the number of retailers and manufacturers, respectively. Thus, recent data is available for each of these verticals, within each state. Despite the lack of long-term historical data

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[6] This particular treatment of the data occurs often in criminology literature.

for time-series analysis, the FFL data allows for a sufficiently detailed evaluation of the present-day relationship between firearm commerce and differences in political and legal circumstances.

In addition to FFL listings, the analysis utilizes two data sources: annual state population totals, as reported by the U.S. Census Bureau, and vote totals for the 2016 Presidential Election, as reported by the Federal Election Commission.

3.2   Initial regression

In establishing the relationship between commerce and regulation, the analysis begins from the following proposition.

Proposition 1: There is a statistically verifiable relationship between the political climate and the prevalence of firearm commerce in a state.

In order to verify this proposition, the study conducts an ordinary least squares regression analysis for retailing and manufacturing. In both cases, the number of establishments per capita is regressed on the Republican vote share in the 2016 Presidential Election.

As stated in Subsection 3.1, the FFL listings contain the necessary information from which to derive the total number of retailers and manufacturers. This number can generally be denoted by Q. More specifically, let the number of Type 01 and Type 07 dealers operating within a given state be represented by Q_{01} and Q_{07}, respectively. Let P represent the 2016 state population. Finally, let V_R represent the number of votes cast for the 2016 Republican nominee in a given state; let V_T represent the total number of votes cast in that state. From these variables, the following are derived:

- $q = Q/P$, the number of retail or manufacturing establishments per capita, and

- $v = V_R/V_T$, the percentage of votes cast for the Republican in the 2016 election.

As with Q, q_{01} and q_{07} denote quantities for Type 01 and Type 07 dealers, respectively. If the relationship between q and v is linear, then the following is true:

$$q = \alpha_0 + \beta_0 v + \varepsilon_0$$

where α_0 and β_0 are constants and ε_0 is the residual. This regression is run using the given data and the results are shown in Tables 2a and 3a and Figures 1a and 2a. The relationship is statistically significant for both Type 01 and Type 07 dealers; however, this fit exhibits heteroscesticity as v increases.

Thus, the relation may be better expressed as an exponential relationship, such that:

$$\log q = \alpha_1 + \beta_1 v + \varepsilon_1$$

where α_1 and β_1 are constant parameters and ε_1 is the residual. This regression is conducted and the results are presented in Tables 2b and 3b and Figures 1b and 2b.

Indeed, the fit for both retailers and manufacturers is better under this assumption. In both cases, the estimated value of β_1 is statistically significantly greater than 0 — that is, there is a positive linear relationship between the logarithm of the number of per capita establishments and Republican vote share. In general, commercial activity increases exponentially in a state's Republican voting preference. Hence, the regression analysis verifies Proposition 1 in both cases.

3.3   Regression outliers for Type 01 dealers[7]

The result in Subsection 3.2 is likely an expected one, given the evident partisan stances on firearms in the U.S. Furthermore, while the result establishes Proposition 1 as true, it says little about whether this relationship is a consequence of solely the law, solely the political climate, or both. An answer to this question may lie in a closer look at an outlier, if one exists.

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[7] See Appendix D for a more detailed explanation of the procedure used in this subsection, including calculations and the final result.

Examining the residuals of points from the linear fit for Type 01 dealers, the large deviation of Vermont from the fit is noticeable. Of all fifty states, it simultaneously has the seventh highest number of gun retailers per capita and the third lowest Republican vote share. This leads to the following proposition.

Proposition 2: In the case of firearm retail, Vermont deviates from the general relationship established in Proposition 1.

Due to the relatively large deviation of several points from the fit of Type 07 dealers, the same conclusion cannot be confidently made about Vermont manufacturing. Thus, this analysis focuses primarily on Type 01 dealers.

This proposition is validated using the same regression as in Subsection 3.2. Vermont is then tested against a prediction interval as a new data point. The prediction interval for this procedure is calculated as:

$$95\% \, PI = [\hat{q} \pm 1.96\sqrt{se(\hat{q})^2 + RMSE^2}]$$

where $\hat{q}$ represents the predicted value of $\log q_{01}$ at vote share v, $se(\hat{q})$ is its standard error, and $RMSE$ is the root-mean-squared error from the regression. Vermont lies outside of this interval at its 2016 vote share; thus, Vermont is an outlier and Proposition 2 is verified.

3.4 Political climates

In order to contextualize the analysis that follows, the paper groups certain states into three categories of political climate. A state in which Republican vote share was greater than or equal to 60% is deemed a Red State; one in which it was less than or equal to 40% is a Blue State. A Swing State is one in which the vote share was between 49% and 51%. The groupings are comprised of the following states, listed in order of increasing Republican vote share:

- Blue States: HI, CA, VT, MA, MD, and NY.

- Swing States: MN, NH, MI, PA, WI, and FL.

- Red States: IN, LA, MT, KS, UT, NE, TN, AR, AL, KY, SD, ID, OK, ND, WV, and WY.

These intervals are somewhat arbitrary — there are certainly more states, for instance, which might be called "reliably blue" in most political discussions. That said, the analysis does not rely heavily upon this breakdown, so it should suffice for its practical purpose.

4   Discussion[8]

4.1   Investigation of Vermont

Subsection 3.3 established Vermont as an outlier in the general relationship between retail activity and political climate. In attempting to explain this deviation, two possibilities are considered. The first is that the culture of firearm consumption in Vermont, diverging from politically similar states through the popularity of activities like hunting, is propping up demand. The second is that Vermont gun laws are far less stringent than those in states with similar political climates, leading to fewer supply restrictions and thus more firearm commerce. It may be that one or both of these is the cause of Vermont's deviation.

The first of these possibilities is difficult to test explicitly without demand-side data. That said, useful inferences about gun consumption culture can still be drawn from other reasonable indicators. Namely, more widespread popularity of hunting in the state, while not directly measurable from the given information, would point to greater demand. In the absence of consumption data, the rural-urban split of Vermont may point to a greater prevalence of hunting.

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[8] The analyses in this section are intended to provide reasonable explanations for the empirical findings, given available evidence. Conclusions are drawn through discussion and inference.

At the time of the most recent U.S. census, the ten states with the greatest rural population percentages were, in order: ME (61.3%), VT (61.1%), WV (51.3%), MS (50.7%), MT (44.1%), AK (43.8%), SD (43.4%), KY (41.6%), AL (41.0%), and ND (40.1%).[9] Of these ten, six are Red States; two, Alaska and Mississippi, lean Republican; and one, Maine, leans Democrat. Vermont is the only Blue State. This political breakdown is likely not surprising: as Scala and Johnson (2017) demonstrate, a county's position on the urban-rural continuum has been a statistically significant predictor of voting behavior in the past three presidential elections, even after controlling for several demographic and economic factors.

The fact that Vermont is unusually rural given its political leaning suggests that recreational firearm use may differentiate it from politically similar states. This presents a potential explanation for its comparatively high level of commercial activity; however, this conclusion is highly conjectural. Furthermore, it becomes further complicated by the unusual fact that Vermont's population is both majority rural and majority Democrat. This analysis thus looks to the regulatory side for a more well-grounded explanation, then revisits this inference.

A brief examination of firearm legislation in Vermont makes it clear that the level of regulation within the state is minimal. This lack of regulation is in part a consequence of deep-seated constitutional and statutory protections at the state level.

The Vermont Constitution affirms that "the people have a right to bear arms for the defence of themselves and the State."[10] In the 1903 case *State v. Rosenthal*, the Vermont Supreme Court unanimously struck down an ordinance adopted by Rutland city council that required carry

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[9] For the U.S. Census Bureau's data and criteria for rural and urban area classification, see https://www.census.gov/geo/reference/ua/urban-rural-2010.html.
[10] See VT. Const. ch. I, art. 16.

permits, calling it "repugnant to the Constitution." The decision affirmed that "the carrying of firearms for one's defense is a fundamental right of a citizen."

Vermont allows permitless open carry. As of November 2016, it was one of ten states that did not require a permit to carry a concealed firearm — sometimes called "constitutional" or "Vermont carry."[11] Vermont allows any U.S. citizen to carry without a permit and is the only Blue State that does not require a permit to purchase a handgun.

Vermont's relatively lax regulatory environment has not gone unchallenged. In January 2013, Burlington City Council voted in favor of a ban on assault weapons and LCMs; however, the ban was never enforced. A 1988 Vermont statute states that "no town, city, or incorporated village, by ordinance, resolution, or other enactment, shall directly regulate" firearms.[12] Due to this statute, Burlington's ban would only have been enforceable were the state legislature to approve of the change to firearm regulations.

This brief overview makes apparent that the legislative environment in Vermont is highly favorable to firearm ownership and commerce, even relative to Red States. Thus, it is reasonable to conclude that the lack of current and potential regulatory burden on those selling guns has in some capacity led to a greater prevalence of gun commerce in the state.

Revisiting the previous cultural explanation through the lens of this legal background, another important element of Vermont's circumstances arises. From minimal ownership requirements to lax carry laws, gun regulations affecting residents are few. It follows that the state's lack of restriction of civilian ownership and use of firearms may itself have integrated firearms into the state culture. Even in Burlington, where attempts to regulate civilian use have

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[11] The categorization of certain states as constitutional carry states is sometimes contested, due to varying criteria, like applicability to non-residents and exceptions for localities.
[12] See 24 V.S.A. § 2295.

been staged repeatedly, firearms are permitted on the streets, in restaurants, and in bars. This permeation of gun use throughout Vermont life has very likely normalized the consumption of certain arms, even if others, like assault weapons, have come under criticism.

It makes sense that both of these explanations — a divergent culture around gun consumption and a more favorable regulatory environment — can, together, help explain Vermont's deviation from the general relationship between firearm commerce and political climate. The latter is likely more influential than the former — indeed, it may very well be a main cause of the former. The connection of the two is explored in the following subsection.

This discussion concludes that Vermont is an exception to the general relationship principally because its laws are much more favorable to the selling, ownership, and use of guns.

4.2 Implications for retailers

The purpose of so closely scrutinizing Vermont is primarily to derive a better understanding of how, in general, firearm commerce is affected by regulation and political culture. The case of Vermont sheds light on important distinctions between the effects of existing law and the effects a populace's political leaning. From this study, the paper deduces two implications for retailers. These statements can be thought of as intermediate, testable hypotheses, grounded in the above discussion and empirical analysis. The first deduction is as follows.

(1) State constitutions and judicial precedent can provide protections for both consumers and producers in the market for firearms. From a commercial perspective, these protections reduce political risks for retailers, making investment and operation more attractive.

As was concluded in Subsection 4.1, legally safeguarded freedoms for firearm users are largely responsible for the unexpectedly high number of gun retailers in Vermont. This finding is

extended more generally in statement (1). A brief examination of the circumstances in politically similar states further justifies this deduction.

There are only six states — CA, IA, MD, MN, NJ, and NY — that do not protect the right to bear arms in their state constitutions. Notably, this list includes three of the six Blue States, the other three being Vermont, Massachusetts, and Hawaii. In Massachusetts, as a result of the 1976 case *Commonwealth v. Davis*, the right to use a firearm is interpreted as a collective, as opposed to individual, right. No decision has been made in Hawaii regarding whether gun ownership for self-defense is protected for individuals. The same is true of states that have imposed bans on the production, selling, and ownership of certain firearms. The list of states prohibiting assault weapons is comprised of New Jersey, Connecticut, and all Blue States except Vermont.

In contrast, the case of Vermont demonstrates that, even given a significantly left-leaning political climate, legal circumstances can preserve an unregulated state-wide market. Burlington City Council overwhelmingly voted in favor of an assault weapons ban; nevertheless, statutory and constitutional barriers made the proposition so unlikely that it was abandoned. In its entirety, the analysis of Vermont differentiates the effect of existing law on the firearm market from the effect of popular political opinion.

An important qualification of this argument is that legal protections are influential, but not indestructible. In several instances, firearm-related tragedies or plots have prompted extensive gun control legislation. The Sandy Hook tragedy in Connecticut led to a comprehensive gun control bill in 2013. In 2018, two years after the period of this study, Vermont's Governor signed three gun control bills into law after law enforcement thwarted a planned school shooting in Fair Haven. These examples do not contradict the above finding, but rather qualify it.

The separate legal and political circumstances in Vermont translate into the unique economic circumstances seen in Section 3. The economic rationale behind this is that legal protections have insulated retailers from political risk, reducing the economic costs of current and potential regulation. Retailers have been able to operate with few restrictions and make business decisions with relative confidence that restrictions would not be imposed at the state or local level in the future. Still, while this deduction accounts for the regulatory effects on suppliers, it says little about that on consumers. This component of the economic argument is found in a second deduction, which is stated as follows.

(2) The demand for firearms in a state is a function not only of political climate, but also of the culture surrounding gun consumption. This culture is directly shaped by the ways in which the law permits or prohibits firearm use.

While the number of Type 01 dealers per capita is not a perfect substitute for demand, it is a sufficient proxy for the purposes of this analysis, since most legal purchases within a state are made directly from an in-state retailer. The empirical analysis demonstrated that there is a clear relationship between a state's political climate and the prevalence of firearm retail in that state. Hence, it has already been established that demand, as this analysis defines it, is a function of political climate.

Still, considering this reality in conjunction with (1), the deviation of Vermont is not sufficiently explained. Even given the relatively lower regulatory burden, retailers would not be in such abundance if there were not adequate demand driving sales. If demand were solely a function of popular political opinion, then Vermont would not be an outlier. Hence, there must be another explanation for the sustained consumption of firearms in Vermont.

This explanation is, broadly stated, that the culture of firearm use — and thus of firearm consumption — diverges from politically similar states. Subsection 4.1 outlined the two specific

elements of this cultural divergence: the prevalence of hunting and the normalization of civilian use. The explanation of hunting, as a consequence of rural-urban divide, was pursued in Subsection 4.1. It is, for the reasons stated in that subsection, concluded to be a reasonable, partial explanation.

Primarily, (2) focuses on the impact of legal circumstances on gun consumption culture. Subsection 4.1 briefly explains and gives grounds for the proposition that Vermont's legal firearm protections, particularly those affecting civilians, has normalized gun use in the state. Looking again at states that are politically similar, it is clear that Vermont's restrictions on consumers — specifically, requirements to purchase, store, use, and carry a firearm — are substantially more permissive. Vermont's minimum purchase age, as of 2017, was 16. The state requires no purchase or carry permits, no licenses, and no registration at the state or local levels. Each of the other Blue States, in contrast, has restrictions on some or all of these aspects, leaving much more discretion to the government.

The minimal restrictions for civilian purchase and ownership in Vermont have, it follows, engendered a different consumption culture. Just as legal protections make operating more favorable for retailers, continued protections of gun liberties have created convenience for consumers. The widespread public use of firearms has, in a sense, normalized such a use, despite the state's notably left-leaning climate.

Applying this finding more generally, the economic success of retailers in a state is in part a consequence of the stringency of that state's civilian gun laws. Lax restrictions on purchasing, owning, and carrying firearms can normalize and, in turn, prompt widespread ownership of firearms. The prevalence of hunting in a state is also an important factor. These circumstances, as evidenced by the case of Vermont, can support demand for retailers. This leads to the conclusion

reached in (2): while political climate is a significant determinant of demand in a given state market, divergent legislative circumstances can have a distinct impact on demand.

It is important to qualify this demand-side argument so that it is not misinterpreted. For the same reasons as were stated in Subsection 3.1, consumption information is not entirely reliable; consequently, neither are sweeping conclusions about patterns in consumption. The use of Type 01 dealer counts as a proxy for demand is justified for this general statement about state-wide market activity; but it does not answer questions about the types of firearms being purchased, the prevalence of black market and private sales, or the criminal use of firearms.

5   Conclusion

In attempting to better understand the effects of politics and the law on firearm commerce, this study takes a closer look at differences and similarities among states. Through a regression analysis, the paper finds that the prevalence of firearm commerce, both in the case of retailing and in the case of manufacturing, is directly related to political climate. Singling out Vermont, which deviates from this relationship, the paper discusses the circumstances in Vermont that differentiate it from politically similar states. This analysis of the Vermont market for firearms leads to two deductions about the nature of law and politics in state firearms markets, which together establish the direct relationship between commerce and existing constitutional, judicial, and statutory protections.

Through empirical analysis and a more focused investigation of a unique case, the paper finds that, while the particular forces of regulation and popular opinion often work in unison, they are distinct and can work in opposition. This distinction is significant to understanding the role that governments play in the buying and selling of firearms.

As stated in Section 1, this paper serves as a starting point for a more rigorous econometric and statistical examination of the market for firearms and its regulation. This examination is ongoing and will utilize the findings of this paper to inform further research, with the ultimate aim of introducing empirical truths to the often hyper-partisan discourse on firearms in America.

Table 1a: Pairwise correlations for Type 01 dealers

	q_{01}	v
q_{01}	1.0000	
v	0.5506	1.0000
sig.	*0.0000*	

	$\log q_{01}$	v
$\log q_{01}$	1.0000	
v	0.6533	1.0000
sig.	*0.0000*	

Table 1b: Pairwise correlations for Type 01 dealers, excluding Vermont

	q_{01}	v
q_{01}	1.0000	
v	0.6060	1.0000
sig.	*0.0000*	

	$\log q_{01}$	v
$\log q_{01}$	1.0000	
v	0.7225	1.0000
sig.	*0.0000*	

Table 1c: Pairwise correlations for Type 07 dealers

	q_{01}	v
q_{01}	1.0000	
v	0.6060	1.0000
sig.	*0.0000*	

	$\log q_{01}$	v
$\log q_{01}$	1.0000	
v	0.7225	1.0000
sig.	*0.0000*	

Sources: FFL listings, U.S. Census Bureau, Federal Election Commission

Table 2a: Linear regression for Type 01 dealers

No. Obs.	=	150
F(1, 148)	=	64.38
Prob > F	=	0.0000
R^2	=	0.3031
Adj. R^2	=	0.2984
RMSE	=	.00018

q_{01}	Value	Std. Err.	t	$P > |t|$	95% Conf. Interval	
β_0	.00111555	.000139	8.02	0.000	.0008408	.0013902
α_0	-.0003158	.0000752	-4.02	0.000	-.0004644	-.0001673

Table 2b: Log-linear regression for Type 01 dealers

No. Obs.	=	150
F(1, 148)	=	110.20
Prob > F	=	0.0000
R^2	=	0.4268
Adj. R^2	=	0.4229
RMSE	=	.55419

$\log q_{01}$	Value	Std. Err.	t	$P > |t|$	95% Conf. Interval	
β_1	4.381753	.4174071	10.50	0.000	3.556906	5.306601
α_1	-10.78381	.2256803	-47.78	0.000	-11.22978	-10.33784

Sources: FFL listings, U.S. Census Bureau, Federal Election Commission

Table 3a: Linear regression for Type 07 dealers

No. Obs.	=	150
F(1, 148)	=	34.94
Prob > F	=	0.0000
R^2	=	0.1910
Adj. R^2	=	0.1855
RMSE	=	2.8e-06

q_{07}	Value	Std. Err.	t	$P > |t|$	95% Conf. Interval	
β_0	.0001266	.0000214	5.91	0.000	.0000842	.0001689
α_0	-.0000207	.0000116	-1.70	0.076	-.0000436	2.17e-06

Table 3b: Log-linear regression for Type 07 dealers

No. Obs.	=	150
F(1, 148)	=	47.11
Prob > F	=	0.0000
R^2	=	0.2415
Adj. R^2	=	0.2363
RMSE	=	.6703

$\log q_{07}$	Value	Std. Err.	t	$P > |t|$	95% Conf. Interval	
β_1	3.4652	.5048533	6.86	0.000	2.467548	4.462852
α_1	-12.0601	.2729599	-44.18	0.000	-12.5995	-11.5207

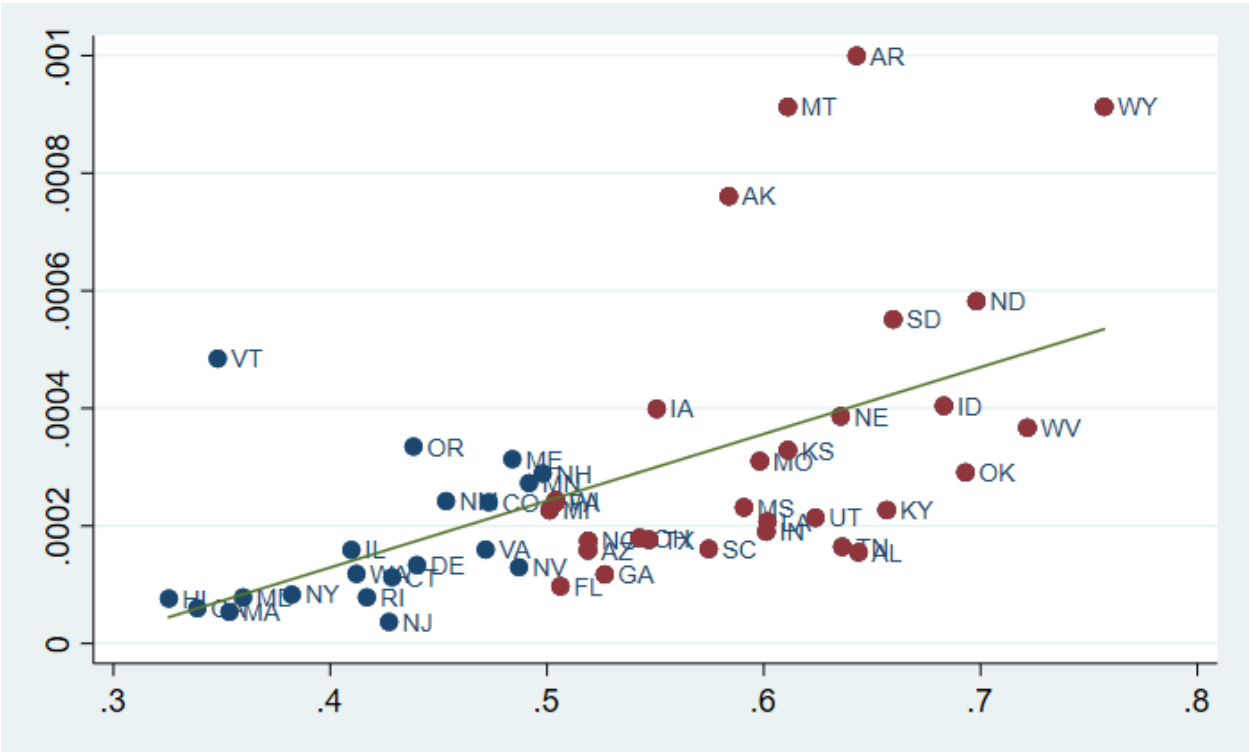Sources: FFL listings, U.S. Census Bureau, Federal Election Commission

Figure 1a: Linear Regression for Type 01 Dealers
The scatterplot shows the OLS regression of q_{01} on v. The vertical axis shows the number of Type 01 dealers per capita. The horizontal axis shows Republican vote share. Note the increasing size of the residuals as v increases.

Figure 1b: Log-Linear Regression for Type 01 Dealers
The scatterplot shows the OLS regression of $\log q_{01}$ on v. The vertical axis shows the logarithm of Type 01 dealers per capita. The horizontal axis shows Republican vote share. Note the significant deviation of Vermont from the line of best fit.
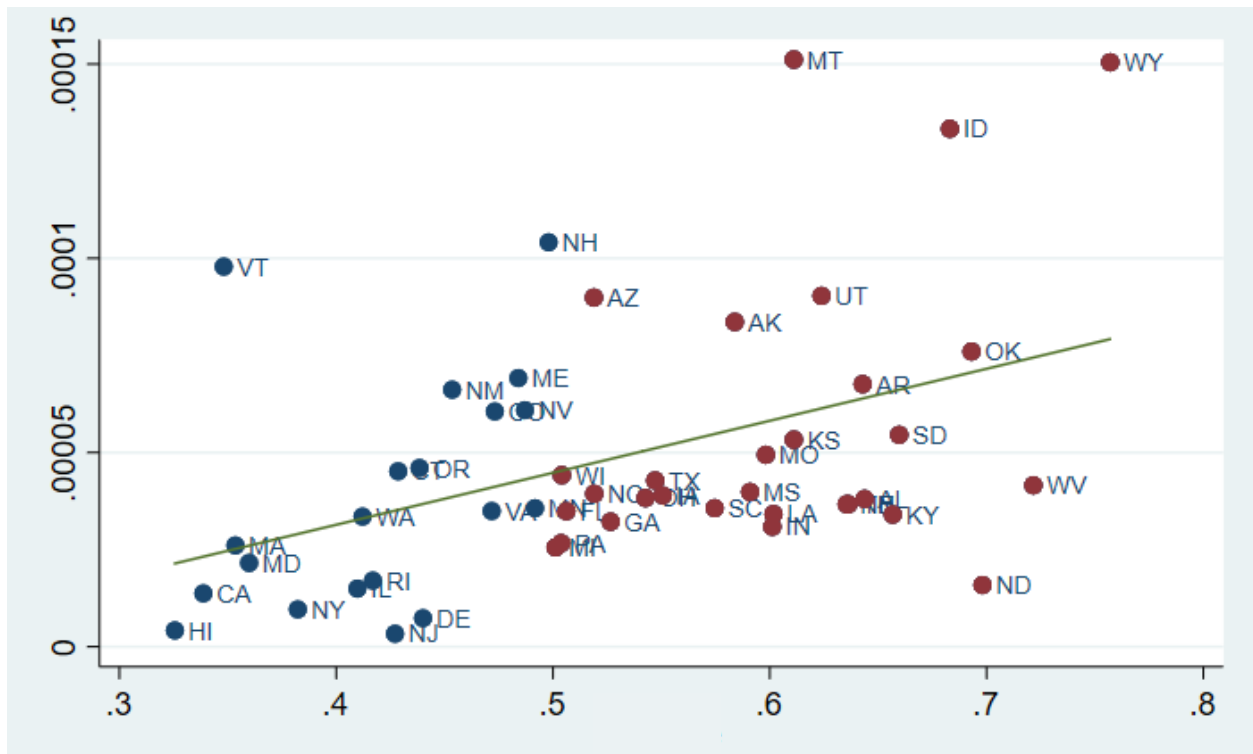
Figure 2a: Linear Regression for Type 07 Dealers
The scatterplot shows the OLS regression of q_{07} on v. The vertical axis shows the number of Type 07 dealers per capita. The horizontal axis shows Republican vote share. Note the increasing size of the residuals as v increases.
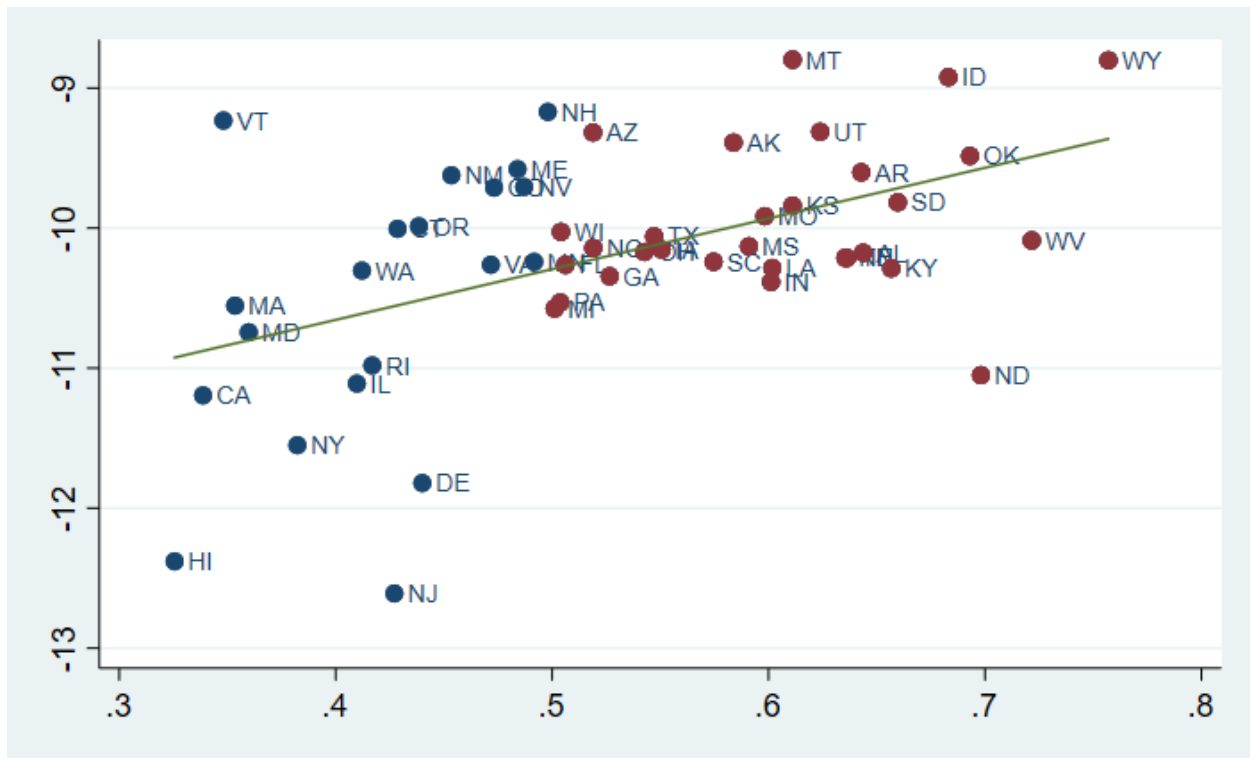
Figure 2b: Log-Linear Regression for Type 07 Dealers
The scatterplot shows the OLS regression of $\log q_{07}$ on v. The vertical axis shows the logarithm of Type 07 dealers per capita. The horizontal axis shows Republican vote share. There is an improvement in homoscedasticity from Figure 2a, but the issue is not resolved to the same extent as for Type 01 dealers.

A Overview of federal firearm legislation

The following table provides a brief summary of historical federal firearm legislation in the U.S.:

National Firearms Act (1934)	- Taxed the manufacture and transfer of firearms - Mandated registration of weapons such as machine guns, short-barreled rifles and shotguns, heavy weapons, explosive ordnances, silencers, and disguised or improvised firearms
Federal Firearms Act (1938)	- Required that all manufacturers, importers, and sellers of firearms have a Federal Firearms License (FFL) - Prohibited sale of firearms to convicted felons
Gun Control Act (1968)	- Prohibited interstate firearm transfers except among FFL dealers - Revised and partially repealed by the Firearm Owner Protection Act
Firearm Owners Protection Act (1986)	- Loosened restrictions on gun sales, including reopening of interstate sales of long guns (on limited basis), legalization of USPS ammunition shipments, and the "safe passage" provision - Banned the sale of machine guns manufactured
Undetectable Firearms Act (1988)	Criminalized, in most cases, the manufacture, sale, and receipt of firearms with a metal content of less than 3.7 ounces
Brady Act (1993)	Mandated nationwide five-day waiting period and background check prior to purchase; waiting period expired in 1998 following implementation of NICS
Federal Assault Weapons Ban (1994-2004)	Imposed a 10-year ban on manufacture of certain semi-automatic firearms and large capacity magazines for civilian use; defined assault rifle as semi-automatic rifle capable of accepting a detachable magazine and having at least two specified characteristics
Protection of Lawful Commerce Act (2005)	Prevented firearms manufacturers and FFL dealers from being held liable for negligence when crimes are committed by users of their products

B   Definition of assault weapon

An assault weapon is typically defined by both function and features. The 1994 Federal Assault Weapons Ban defined assault weapons as semi-automatic shotgun or a semi-automatic pistol or rifles with a detachable magazine, plus two or more of the following features:

Pistol	- Ammunition magazine attaches outside grip - Threaded barrel - Heat shroud attached to barrel - Unloaded weight exceeding 50 ounces - Semi-automatic version of automatic gun
Rifle	- Folding or telescoping stock - Pistol grip that protrudes - Bayonet mount - Flash hider or threaded barrel - Grenade launcher
Shotgun	- Folding or telescoping stock - Pistol grip that protrudes - Fixed magazine capacity over 5 rounds - Accepts detachable magazine

C   Existing literature on assault weapons

A large proportion of research on assault weapons (AWs) is concerned with criminology, but there are still several key studies that focus on the economics.

Koper et al (2004) assessed the impact of the 1994 ban, finding that its success in reducing use of the banned guns was mixed, and that many non-banned substitutes were purchased during the period. Several other studies also tie sales to changes in government sentiment and mass

shootings. As was shown to be the case following the Sandy Hook tragedy by Jones and Stone (2015), it is commonly thought that mass shootings cause a surge in firearm sales.

On the application of statistical analysis purely for the sake of understanding trends in AW sales, there is a small base. Killicoat (2007) proposed a cross-country time-series price index of Kalashnikov assault rifles as a function of income, motivation, regulation, and supply costs. Additionally, Koper et al (2004) found, through a less rigorous analysis, that discussion of the 1994 ban triggered speculative pre-ban price increases, largely driven by sentiment among assault rifle collectors.

D   Procedure for determining outlier

As stated in Subsection 3.3, the calculation for the 95% prediction interval is as follows:

$$95\% \, PI = [\hat{q} \pm 1.96\sqrt{se(\hat{q})^2 + RMSE^2}]$$

In order to calculate this interval and test Vermont against it, the following values are used, as found in Table 2b and calculated from vote share data:

v	$=$	0.3481357
$\log q_{01}$	$=$	-7.632838
$RMSE$	$=$	0.55419
$\bar{v}$	$=$	0.52969229
$var(v)$	$=$	0.01175206
n	$=$	150

The value of $\hat{q}$, the predicted value of $\log q_{01}$ at $v = 0.3481357$, is calculated using the equation for the regression fit, as in Table 2b.

$$\hat{q} = \alpha_1 + \beta_1 v$$

$$\approx -9.258$$

The squared standard error of $\hat{q}$, denoted $se(\hat{q})$ is calculated as follows:

$$se(\hat{q})^2 = RMSE^2 * \sqrt{\frac{1}{n} + \frac{(v - \bar{v})^2}{(n-1)var(v)}}$$

$$= 0.0078$$

Now, the prediction interval can be calculated using the above equation. The result is:

$$95\% \, PI = [-10.358, -8.158]$$

The value of $\log q_{01}$ for Vermont is -7.633, which lies outside of this interval. Thus, it is a statistical outlier.

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