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Michael Coates

Shanna Pearson-Merkowitz
University of Rhode Island, shanna_pearson@uri.edu

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Policy Spillover and Gun migration: The interstate dynamics of state gun control policies

Michael Coates
Ph. D Candidate, University of Maryland, College Park
Azhain@gmail.com

Shanna Pearson-Merkowitz[1]
Associate Professor, University of Rhode Island
shannapearsonuri@gmail.com

Abstract: Objective: In this paper we examine state policy spillover by examining how differences between state gun control policies affect the migration of guns between states with lax regulatory environments for gun purchasing and licensing to states with relatively strict regulatory environments. Method: We test our hypothesis using data from 2007-2013 from the Bureau of Alcohol, Tobacco and Firearms on the presence of criminal guns and from the Brady Campaign on state gun control laws. Results: Our results suggest that a large proportion of criminal guns in states with strict gun control laws were originally purchased in states with fewer regulations. There is a direct correlation between where criminal guns were originally purchased, where criminal guns are uncovered, and the strength of state gun laws. Conclusions: State gun control laws appear to make purchasing a gun through legal frameworks more difficult and shift the "market" for

[1] Direct all correspondence to Shanna Pearson-Merkowitz, University of Rhode Island, Department of Political Science, 80 Upper College Road, Kingston, RI 02881. Email: shannapearsonuri@gmail.com.

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criminal guns to purchasing locations across state borders where purchasing is easier. Gun control laws appear, therefore, to be affected by policy spillover.

In December of 2012, a 23 year-old college student named David Lewisbey was arrested by FBI agents for trafficking 43 firearms to a government informant. Of the incident, Assistant U.S. Attorney Christopher Parente said that Lewisbey would travel to Indiana and purchase a "duffel bag" full of weapons and then sell them on the streets of the "worst neighborhoods of Chicago" (Sweeney & Meisner, 2013). Why would Lewisbey have traveled to Indiana to purchase guns to sell in Illinois? The gun laws in Indiana, compared to those in Illinois, make it very easy to purchase firearms without a background check or any paperwork that would trace the weapons back to the purchaser if they are used in a crime. As a result, it is fairly easy to purchase guns in low regulation Indiana for use or distribution in high-regulation Illinois.

It is a well-established phenomenon that the borders within the United States of America are porous and unrestrictive. While nations can to some extent control the laws of supply and demand by curtailing supply through regulations and tariffs, cities and states share unregulated borders where goods and people flow easily across and between jurisdictions. As a result, states cannot effectively regulate the supply-side mechanisms behind many issues they wish to address. The reality of this situation means that states often experience "policy spillover" where the difference between state policies affect the ability of legislators in each state to effectively implement regulations (e.g. Baicker, 2005; Beard, et al., 1997; Stehr, 2007; Sigman, 2005).

In this article we test a case of potential spillover-effects between states to examine how policy diversity in the arena of gun control impacts where guns are originally purchased and where they are eventually confiscated by police. We employ data on gun control laws from the Brady Campaign and data on the location of gun confiscations and their original purchase location from the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). Our data suggest that in states with strong gun laws there is an increased likelihood that a confiscated gun

will have been originally purchased in a state with weaker gun laws and that a larger proportion of the confiscated guns will have been originally purchased out of state compared to states with weaker gun laws. Our data and findings suggest that policies attempting to regulate the availability of guns are susceptible to policy spillover from other states as a result of the differentiation between state gun control laws around the country.

What we know about gun control policies

Gun control provides an interesting opportunity to examine spillover effects because of the variation between states in gun regulations. Current research on gun control is very limited and finds mixed evidence in terms of the effectiveness of state and local gun control laws. Kleck and Patterson (1993) conducted a meta-survey of 29 studies investigating the effects of gun laws on gun crime. Of the studies, four found that gun control lowers crime, eight had mixed results, and seventeen found no effect. Of the research that investigated state-gun laws, only two found evidence that gun control laws reduced crime while eleven were either inconclusive or found no evidence that gun laws predicted lower gun crime. More recent studies have reinforced these findings. While firearm regulations were found to decrease the incidence rate of suicide among men (Andres & Hempstead, 2011), studies investigating the federal assault weapons ban found either small crime reducing effects (Koper and Roth, 2001) or mixed effects (Lott, 1998). Likewise, Duggan et al. (2011) find that state-level gun show regulations had little effect on state firearm deaths. Ludwig and Cook (2000) investigated background check policies and found small crime-reducing effects. A relatively large literature now exists on concealed carry permits but the effects are likewise mixed (e.g. Kovandzic et al., 2005; Hood & Neeley, 2000; Moody,

2001; Ayres and Donohue, 2003).[2] However, Kwon and Baack (2005) employ a sophisticated measurement of the totality of a state's gun laws, and find that multiple laws directed towards the same end (e.g. gun control) may be effective in reducing gun crime and gun stocks. Even then, however, socioeconomic factors remain the strongest predictors of gun violence.

Policy Spillover and the Case of Gun Control

Various studies have explored the impact of spillover effects impeding or otherwise affecting the effectiveness of state regulations. When states have regulated air pollution, polluting agents have been found to move to a less well-regulated neighboring state. As a result, state level air quality controls are seen as ineffective when there is state-by-state variation in regulations because air pollution simply travels back across the border (Lester, 1986; Lowry, 1992; Sigman, 2005). The same argument has been made in the application of teen drinking laws aimed at curbing drunk driving. Saffer and Grossman (1987) found that when state drinking age laws varied from state to state, teen drunk driving increased in states with higher drinking ages when the drinking age was lower in a neighboring state because the combination of the two policies encouraged driving further in order to consume alcohol. Similarly, Baltagi and Li (2006) find that interstate availability and taxation of liquor leads to a significant amount of out-of-state sales and when states relax availability and/or reduce taxation, own-state sales increase. These findings call into question data that suggest that drinking increases when taxes

[2] There are also several studies on who supports and applies for concealed weapons permits that suggest that those who support these laws do not necessarily apply for them and that concealed permits are held mostly by middle class whites who live in low crime areas (e.g. Hood & Neeley, 2000; Ghent & Grant, 2015).

are increased (or vice versa). Rather, the data suggests that the market simply adjusts by shifting out-of-state but that drinking remains stagnant. In both these cases, environmental regulation and drunk driving prevention, the policies of neighboring states "spilled-over," effectively nullifying the stronger regulations.

We argue that this is also likely true of guns, particularly those used for violence and criminal activities. When a person wants a gun for the purposes of committing a crime, the availability of guns at the local level may be only partially effective in preventing the crime if the person has the ability to cross state lines. Supply side gun control laws decrease the ease with which someone bent on committing a crime of passion can purchase a firearm, and therefore likely decrease the rate of gun-related crimes and gun-related death by increasing the costs of gun purchasing. For example, "cooling off" laws are intended to help guard against impulsive acts of violence and suicide. Someone in Chicago may be able to simply drive to Indiana to purchase a gun to kill oneself or someone else in a crime of passion. The drive time from downtown Chicago to the closest gun retailer in Indiana is, by our estimate (using Google maps), one hour with no traffic. This means circumventing a "cooling off" law in Illinois would still require a 2 hour-minimum drive for someone to get to the store, purchase a gun, drive back and find their victim. The other choice, of course, would be for the person to purchase the gun on the black market or attain one from an acquaintance who has already legally purchased the weapon.[3]

[3] The theory as presented makes no assumptions about the transference of guns from one state to another through the normal movement of legal gun owners. For example, if someone purchases a firearm in Colorado and later moves to Rhode Island it is possible that the strength of gun laws in one state versus another has little to no bearing on the movement of that weapon. We chose to control for this effect by including a variable of population change, assuming that states with higher rates of population change

Again, this requires locating a black-market dealer or an acquaintance who owns a gun s/he is willing to hand over. While both of these may be viable options, the increased burden of either alternative method could prevent many crimes.

However, guns are also used for protection against criminals, for carrying out criminal activity such as robberies in which a gun may end up being discharged even if that was not the original purpose of the criminal activity, or for murders that are non-impassioned. Supply side gun regulations aim to decrease gun deaths that arise from these crimes as well. However, we argue here that when there is demand for guns, gun purchasing will follow market constraints similar to the ways in which studies have found that alcohol purchases shift as a result of alcohol regulation (e.g. Saffer and Grossman, 1987; Baltagi and Li, 2006): guns that eventually end up in crime scenes are more likely to be purchased in states with less regulatory barriers when a state increases the stringency of its gun control laws (e.g. the supply-market will shift out of state). This is not to say that gun regulations will not decrease gun purchases, or gun crime, but that to the extent gun crime continues, it is likely to follow the market constraints out of state.

The connection between firearms regulation and trafficking has been noted by a few recent studies employing city-level data, single state case studies, or inter-country data. Weil and Knox (1996) in their investigation of the passage of a Virginia gun control law found that the passage of a law limiting firearms purchases to one per month was correlated with a decrease in the number of guns purchased in Virginia which were subsequently used in crimes in the northeastern corridor. While this case supports our assertion about the role of permissive states

receive more firearms simply through their owners moving but the results were not statistically significant and were left out of the final model.

in supplying guns to more restrictive states, the authors did not test if the inverse relationship was also present, and the data is limited to a single state. Webster, et al (2001a) compare 25 cities over the course of a single year and discovered that some of the crime reducing effects of firearm regulations were mitigated in cities near states that lacked similarly restrictive laws. In another study using data from the same cities between 2000 and 2002, the same authors posit that increases in firearms regulations could profoundly lessen intrastate firearm trafficking (2001b). Unfortunately, these two studies examine a limited number of locations and only 2 years of data. Perhaps most importantly for this study, Dube et al. (2013) employ a unique natural experiment to investigate the connection between the expiration of the U.S. Federal Assault Weapons Ban (AWB) and gun violence in Mexico. Their data suggest that Mexican towns near the U.S. boarder experienced increases in homicide and gun related homicide and criminal gun confiscations after 2004 (the expiration of the AWB).

Based on this theory of policy spillover and interstate regulatory dynamics, we expect states with strong gun laws to be more likely to "import" guns from states with weaker laws for use in criminal activity. By contrast, we expect states that have the most relaxed gun laws to "export" more guns to states that have stronger gun laws. Formally stated, our hypothesis is as follows: *As a state's gun control laws increase, the proportion of guns used in crimes originally purchased out-of-state will increase.*

Data and Methodology

To test our hypothesis, we require an indicator of how many guns move between states. Since 1968, the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) has kept records on firearms taken from crime scenes traced to their point of purchase. For years 2006-2013, the ATF has made publically available its reports on traces for each state, including the District of

Columbia and Puerto Rico.[4] Using this data, we calculated our dependent variable as the ratio of exports to imports of guns used in crimes using a ratio of a state's gun "imports" (the guns that were originally purchased out of state but confiscated in state) to "exports" (the guns that were originally purchased in the state but were confiscated in another state). [5] For any two states *k* and

[4] Data for each state is available at the ATF website, here: http://www.atf.gov/statistics/index.html. This count includes the number of guns that were able to be traced to their original purchase state.

[5] There are several important caveats to this data. The selection process in which guns end up in this dataset may not be random because it is up to the individual police department to request a trace on a gun and the decision making of police as to which guns to trace is unknown. As a result, there may be non-random error but it is impossible to know how much of the dataset is affected, and in what way. However, there is no systematic reason that we can think of that the selection method would necessarily bias our results unless police decide on traces because they believe the gun was purchased in another state. If this were the case, we would expect to see little difference between states in the percentage of guns that come from out-of-state. In addition, one would think that if this was the case, we would see a majority of the traces being from out-of-state, however, in the ATF data most guns are originally purchased from in-state sources. While this is a critical caveat to this study, the data is the best available and novel in its ability to track criminal guns across states. That stated, there are formal constraints on gun traces. The ATF does not trace every gun due to the overwhelming number of confiscated guns in the U.S. and traces are based on priority and urgency (although departments can request a trace simply for data collection purposes). Traces are justified as a priority if the weapon was found or used in an Assault, bank robbery, kidnapping, murder/suicide, rape or a terrorist act or threat of terrorism and the police department needs the trace to hold the suspect, provide probable cause or protect public safety etc. Further, the authors learned after consulting with agents within the ATF that the Department has an internal regulation to only perform traces on weapons that are a part of an ongoing investigation. There is no cost to police departments to

j, we write the (recovered) imports from state *j* to *k* in year *t* as $FA^t_{j,k}$. This includes all of the guns that originated in state *j* but were recovered in state $k \neq j$ in year *t*. We can then define the import ratio for state *j* in year *t* as:

$$IM^t_j = \frac{\sum_{k \neq j} FA^t_{j,k}}{\sum_{j \neq k} FA^t_{k,j}}$$

We also ran our models using several other versions of the dependent variable, for example, a simple percent of guns that came from out of state as well as the inverse (percent of guns sent to other states). These variations did not affect the substance of our results. We prefer the ratio because it can account for both the relationship of imports to exports within one dependent variable. Since our hypothesis is that increasing gun control measures will both decrease exports and increase imports and decreasing gun regulations would increase exports and simultaneously decrease exports, this dependent variable measures both of these factors while also standardizing across states. Despite the strength of the ATF's reports as a unique data source, it has limitations due to ATF reporting format. From 2006-2011 the data for each state only list the 15-16 states that sent the most guns to that state. This means that some states are

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submit a trace request, and requests are usually completed within 4 days. The form to request a trace is two pages long and available online at: https://www.atf.gov/file/11771/download. For these reasons, we are confident that officers are most likely not constrained in tracing weapons they otherwise would because of scarcity of resources, or other systematic reasons that would bias the dataset towards the result we find.

excluded that did "send" guns to another state because they sent fewer guns than 16 other states.[6] This skews the analysis towards larger states which can reliably appear in the top 15 states[7].

Luckily, for years 2012 and 2013 the ATF published gun trace data for the first time which includes the data for every gun traced recovered from a crime scene for every state for all states (not just the top 15 supply states); thus, in this data, we do not lose smaller states and are able to include all the data in our analysis. In order to harness both the benefits of time-series data and the full data that is available in the most recent two years, we run our analysis on both types of data. [8]

Independent Variables. To measure the strength of gun laws on a state-by-state basis, we utilize data from the Brady Campaign to Prevent Gun Violence.[9] Since 2007, the Brady Campaign has collected a "scorecard" for each state based on the strength of the state's gun laws. As the Brady Campaign has evolved, its scorecard has changed so that different types of gun

[6] For example, in the limited dataset for 2012 guns recovered from California that had been purchased in Alabama are not counted because Alabama is not a top 15 supply states for California. Unfortunately, it is the best data available.

[7] Hawaii is excluded from the analysis because it enjoys significant barriers to trafficking that no other state has, namely over 2000 miles of ocean.

[8] The data is also left-skewed. To deal with this, we replicate all of our models utilizing the natural log of the dependent variables. Reviewer Appendix 1 shows the change in the distribution of the dependent variables as a result of converting to a natural log.

[9] Access to each year is limited to special request, but the Brady campaign current scorecard is available here: http://bradycampaign.org/?q=programs/million-mom-march/state-gun-laws

laws are used in the scorecard each year. In addition, the Brady Campaign weights its score based on an evolving standard of which laws are considered more/less important. To deal with this, instead of using the raw score provided by the Brady Campaign, each year of the scorecard was reweighted based on the weighting scheme applied in 2011 (the last year that it issued its score card in this format), and any law from the score which was not tracked over the entirety of the period was dropped. As a result, while the original score was out of 100, the reweighted scores have a maximum of 84. The intended result is that a state should have the same score in 2011 as it had in 2007 if no changes in the law occurred. This method was employed to protect the analysis from being skewed by changes in the scoring standard over time instead of changes in the law. [10] We also created a score where the strength of each law is set equal to 1, in this measurement procedure, no individual law is assumed to have a greater or lesser impact on gun trafficking than any other. We ran our models using all three versions of the score (the original Brady Campaign score as reported for each year, the 2011-base weight score, and an unweighted score). The substantive findings did not depend on which form of the Brady Campaign score we employed. These models are available upon request; we present only the 2011-base weight score here, which we refer to as the *gun control regulation index* in our models.

We also include the per capita number of federal licenses granted to both firearm sales and manufacturing businesses to control for the presence (or lack thereof) of local market

[10] Also, our analysis for 2012-2013 uses the same gun regulation score as 2011 because the Brady Campaign drastically changed its report card format so that now states are not scored on a scale, and instead are given an A-F grade which does not correlate well with the scorecard prior to 2012.

availability. The data on market licenses is only available from the ATF for the years 2010 to 2013. Thus, we report models including this variable only in a model limited to 2010-2013.[11]

A number of control variables are also included in the analysis.[12] The violent crime rate comes from the Federal Bureau of Investigation's (FBI) website.[13] Total population estimates[14] for each state across the six years examined in the study, as well as the level of urbanization, and overall population density come from the U.S Census Bureau.[15] In addition, we include a control for the size, in square miles, of each state.[16] We expect larger states to be less prone to importing guns from other states as the cost of transportation and the likelihood of intervention will be higher. Our expectations for urbanization and overall population density are less unidirectional. On the one hand, we expect states with more densely populated urban areas to have higher demand for guns, but if those guns are originally purchased in-state or out-of-state should be reliant, to an extent, on the strength of the gun laws. Of course it is possible that the laws

[11] We originally included manufacturing and licensing separately as two different independent variables. However, they are highly correlated (.8), so we combined them into a single measure. Including them separately does not change the results.

[12] To protect against model confusion due to high-multicollinearity, correlations were tested between all independent variables in the analysis, no relationship between the IVs are correlated above .5

[13] Found here: http://www.fbi.gov/stats-services/crimestats

[14] Population estimates are available here: http://www.census.gov/popest/index.html

[15] The urbanization ratio was calculated by comparing the totaled population numbers from the urban clusters page at the census. (http://www.census.gov/newsroom/releases/archives/2010_census/cb12-50.html) with the population listed by the census for 2010.

[16] Info is available at this link: http://www.census.gov/prod/cen2000/phc3-us-pt1.pdf

themselves may just be stricter in places that experience higher levels of gun violence; however, to not inflate the results based on demand for guns we include these measures in our models.

Finally, because of our ability to harness time-series and cross sectional data, we include a lag term. While this is important for empirical reasons, we also believe this is an important control for substantive reasons. Illegal gun sales are not random; there are most likely established sellers and buyers. Thus, there is the chance that illegal markets would not be responsive to changes in gun laws as there are established trade routes.

Bivariate Results

An anecdotal look at our data supports our hypothesis and gives a strong example of the relationship we seek to understand. On its surface, there appears to be a relationship between the strength of local gun laws and the rate of trafficking a state experiences, but certainly not uniformly.

Table 1 shows the top 5 gun exporting states and their 3 largest customers. On a case by case basis, the flow of guns appears to be from states with weak laws to those with stronger ones, with some exceptions. We also see evidence of geographic proximity and region affecting the relationship.

As illustrated by the gun trafficking of David Lewisbey in the introduction of this article, a compelling example can be made of the relationship between Indiana and Illinois: 63.3% of all the guns that were originally purchased in Indiana but that were used in a crime in another state were recovered in Illinois. Indiana is significantly less regulated than Illinois, scoring only a 4 on the regulation scale to Illinois's 26, and the two share a substantial border.

[Table 1 about here]

The lower half of Table 1 presents the top 5 "market" states and their top "suppliers" for 2012. Like the previous table, while there are exceptions, the expectation that states with stronger laws will have guns used in crimes that were originally purchased in states with weaker gun laws once again holds. Connecticut, whose regulation scale scores a 55, is the 3rd strongest in the nation behind California (72) and New Jersey (62). In Connecticut, for every 30 guns recovered at a gun related crime, one gun is exported to a different state's gun related crime. While its regulation score is only slightly lower than its number one supplier, its next two suppliers, which are further away, both have significantly weaker gun laws.

Multivariate Results

Table 2 presents a cross-sectional time series regression analysis for two models built out of two datasets: the first dataset ranges from 2007 to 2013 and the second ranges from 2010 to 2013 and includes a control for the number of firearm manufacturing licenses in the state. Both models, the years where every tracked weapon was reported by the ATF (2007-2013) and those years where the ATF only reported the top sources for each state (2010-2013), employ cross-sectional time series modeling and include a lagged dependent variable, random effects estimates, and clustered standard errors by state. We present both models in their original form and using the logged variables.[17]

[Table 2 about here]

As expected, the lagged dependent variable is statistically significant in three of the four models. The size of the state is also statistically significant which suggests that one of the chief

[17] We also checked to see if the outliers were driving the analysis by dropping these extreme outliers from the data and running the models without them. Dropping the outliers did not change the results.

factors of how guns are trafficked is convenience and that markets are still predominantly regional forces. Also, the state population is correlated with the import ratio indicating that more people results in a larger demand for guns from out of state.

Of paramount importance to this study's hypothesis, however, is that even when controlling for these other variables, the strength of a state's gun laws has a statistically significant impact on the trafficking of firearms across all the specifications in each of the models. Again, these models are consistent across different ways of operationalizing the dependent variable.

Table 3 presents two additional models. In this table, we utilize the data from the ATF on all state-to-state gun flows for the two years in which the full data is available: 2012 and 2013. Unfortunately, with only two years of data we cannot harness the benefits of a cross-sectional time series model. Therefore, we run this data in two ways. In Model A (unconverted independent and dependent variable) and B (variables converted to natural logs) we include both years of data and include a control for the year (1=2013, 0=2012). This model does not include a lag term. The second set of models (C and D), predict only the import ratio for 2013 but include a lag of the import ratio using the 2012 data. Again, the models are run with clustered standard errors for the state and include the full range of control variables. The results of the models in Table 4 largely mirror those for the full time period. Across all of the models, the direction and significance of our key independent variable—the strength of a state's gun laws—supports our hypothesis. States with stricter gun laws are far more likely to have a larger number of guns found at crime scenes that were originally purchased in states with weaker gun laws and that those states "send" fewer guns out-of-state.

[Table 3 about here]

Figure 1 presents the marginal effect of changes in gun regulations on the import ratio using the 2013 data including a lag for the 2012 data. The figure demonstrates the change in trafficking compared with relative levels of regulation. Of particular importance is that the largest correlations of trafficking and regulation appear once regulation has surpassed a fairly high threshold. These findings support Kwon and Baack's (2005) assertion that rather than any individual law being responsible for lowering the prevalence of gun violence, a state's overall gun control regulation climate may be more important.

[Figure 1 about here]

Robustness Tests

We also replicated the models using two different methodological strategies to check for consistency across modeling decisions. These results are available in the supplemental online appendix. First we employed a Standard Trade Model (Krugman & Obstfeld, 2003). In this model, we predicted the natural log of the per capita number of guns imported controlling for the natural log of the per capita number of guns exported (as well as a lag of imports and exports). The gun regulation index remained highly statistically significant and positive.

Second, we replicated Model A of Table 2 using Arellano and Bond (2001) generalized methods of moments (GMM) estimator to control for potential endogeneity (e.g. Roodman 2009). Arellano-Bond estimators are particularly good for models, such as ours, with a large N (49 states) but a low T (7 years). We performed the GMM analysis using both the import ratio as a dependent variable and the dependent variable and controls of the standard trade model. Both of these models support our hypothesis with only minor changes in the size of the coefficient. These results are available in the online supplemental appendix. The main findings of the

models are not changed with the addition of these controls. Given the consistency across modeling strategies, we feel very confident in our results.

Discussion and Conclusion

In this article we evaluate the interstate dynamics of gun control in the United States. We proposed that when states have markedly different approaches to regulating the availability of a good, in this case guns, a single state's attempt to diminish the presence of a good through regulation may shift the market to states with considerably weaker regulations. We find consistent evidence that this is the case in regard to firearms. Regardless of modeling approaches or measurement decisions, our data suggest that states with more restrictive gun laws have a higher share of their confiscated firearms originally purchased in states with weaker gun laws. To put it succinctly, our models suggest that guns are frequently "exported" out of states with weak gun control laws and "imported" into states with stronger gun control laws.

It is well known that state policies "spill over" into neighboring states and countries. States, however, are also suggested to be involved in "competitive federalism" (e.g. Tiebout 1956), in which they attempt to retain residents based on making their policies fit the "demands" of the community. However, a competitive federalism argument might also lead to states intentionally or unintentionally undermining the attempts of neighboring communities to pass and enforce policies that their local citizenry demands. Here we have investigated one such possible context in which this might occur: gun sales.

Most people who have crossed state borders on a road trip can recall driving over a border and being met with a series of stores selling a good that is not available or is more regulated in the neighboring state. Entrepreneurs in New Hampshire have opened alcohol retail

outlets right on the Massachusetts boarder to harness income from Massachusetts residents who face steep alcohol taxes. Likewise, when exiting Maryland into Virginia, you are likely to be met with many stores advertising fireworks that are illegal in Maryland. States in these scenarios benefit economically from their neighbors attempts to regulate supply of goods through harnessing a shifting market. However, they also undermine the residents of the regulated states who wanted laws to decrease the use of the regulated good. In this paper, we propose that the regulations making purchasing a firearm more restrictive also may shift the market to out-of-state suppliers and therefore undermine the state resident's wishes for fewer guns. In terms of competitive federalism, our data suggest that lower regulation states will "win" consistently over states who wish to have regulations because the lower regulated states policies will override the more regulated states. This conclusion calls into question the ability of people to "vote with their feet" and escape an unwanted good if there is variation between state policies. Moreover, for those who support gun control, our findings indicate that while states can make a meaningful dent in the availability of unwanted guns in their state, regional or national gun control legislation would significantly deter the shifting of markets to states easily crossed without border enforcement.

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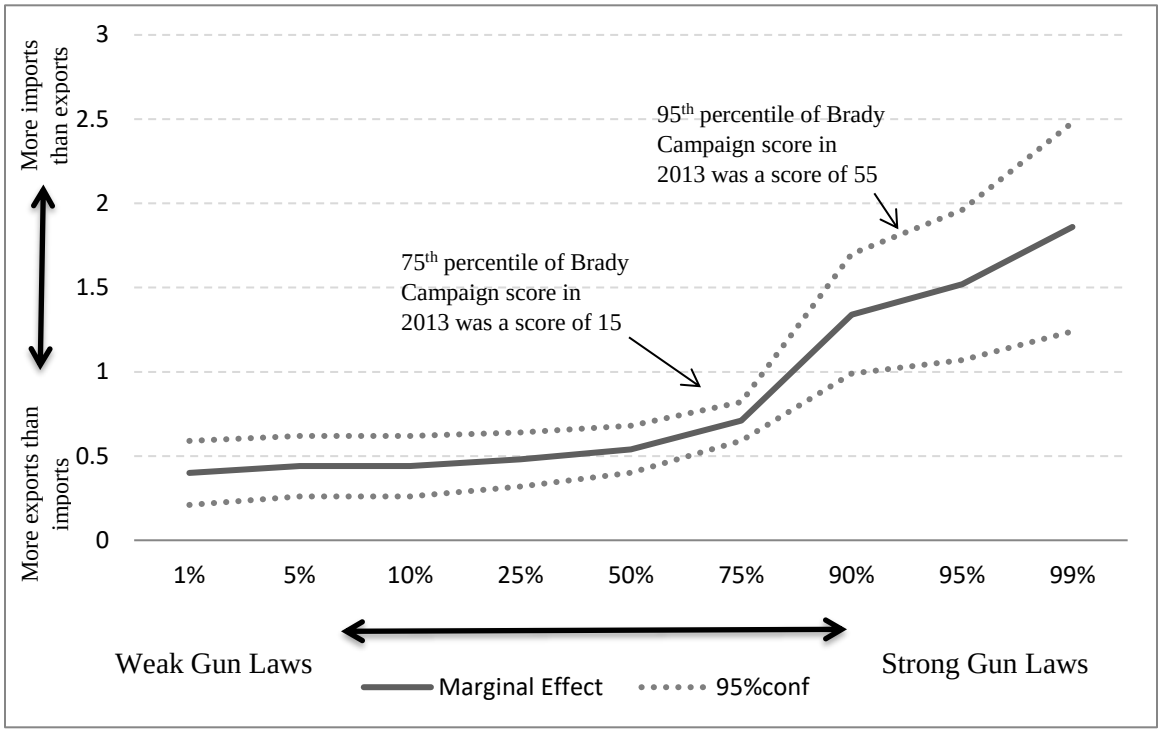
Figure 1. Marginal Effect of Change in Gun Control Index on the Import Ratio: 2013



Note: Y axis is the Import Ratio. The X Axis represents the percentiles for the gun control index. Margins are computed using the margins command in Stata on Model C of Table 5.

Table 1. Importation and Exportation of State Gun Control Markets.

Top 5 Exporting States and Their 'Customers' for 2012 (Import Ratio) | {% of guns exported by the supply state} | [Gun control regulation index]			
Supply State	**#1 'Customer'**	**#2 'Customer'**	**#3 'Customer'**
Indiana (0.27) [4]	Illinois {63.3%} [26]	Kentucky {7.4%} [2]	Ohio {7.2%} [7]
Arizona (0.27) [4]	Tennessee {21.4%} [8]	Illinois {20.9%} [26]	Texas {18.4%} [4]
West Virginia (0.32) [4]	Maryland {26.1%} [43]	Ohio {16.4%} [7]	North Carolina {12.4%} [16]
Mississippi (0.32) [4]	Illinois {27.8%} [26]	Tennessee {21.2%} [8]	Louisiana {16.2%} [2]
Virginia (0.34) [12]	Maryland {21.2%} [43]	New York {20.4%} [52]	North Carolina {14.1%} [16]
Top 5 Market States and Their 'Suppliers' for 2012 (Import Ratio) | {% of local guns provided by supply state} | [Gun control regulation index]			
Market State	**#1 'Supplier'**	**#2 'Supplier'**	**#3 'Supplier'**
Connecticut (28.88) [55]	New York {6.4%} [52]	North Carolina {4.6%} [16]	Florida {3.4%} [5]
New Jersey (25.21) [62]	Pennsylvania {13.2%} [26]	North Carolina {9.4%} [16]	Virginia {9.2%} [12]
Wisconsin (10.45) [3]	Illinois {3.3%} [26]	Indiana {2.1%} [4]	Mississippi {1.9%} [4]
Massachusetts (7.79) [49]	New Hampshire {12.9%} [6]	Maine {7.2%} [7]	Florida {4.5%} [5]
New York (7.74) [52]	Virginia {9.4%} [12]	Pennsylvania {7.6%} [26]	Florida {7.2%} [5]

Note: This data is taken from the limited dataset which includes only the top 15 results for each state.

Table 2. Predicting Gun "Imports" for years 2007-2013, Data Limited to Top 15 "Senders" and "Receivers" For Each State

Dependent Variable=Import Ratio	Model A (2007-2013)	Model B (2007-2013 natural logs)
Lagged Import Ratio	0.695***	0.732***
	(0.024)	(0.041)
Gun Control Index	0.031***	0.124**
	(0.007)	(0.047)
Population (per 100k)	-0.003**	-0.0001
	(0.001)	(0.001)
Size (per 1000 miles^2)	0.001	0.0001
	(0.001)	(0.0004)
Percent Urban	0.816	0.434
	(0.681)	(0.302)
Violent Crime Rate	-0.001*	-0.0001
	(0.001)	(.0003)
Unemployment	-0.030	-0.016
	(0.052)	(.021)
Percent in Poverty	0.031	-0.002
	(0.032)	(0.014)
Prob>f	0.0000	0.0000
R-sq	.897	.759
N	294	294
Cons	-0.239	-0.472*
	(0.578)	(0.278)

Note: *=p<.1 **p<.05 *** P<.01 Natural log models have natural logs for both the import ratio and the regulation index; 49 states are included in the analysis. Only Hawaii is dropped because it has unique physical barriers to trafficking which no other state enjoys, namely 2,300 miles of ocean. There is 7 years of data at this point for a total of 343 observations. We lag a variable which eliminates the 2007 data from the dependent variable because there is no 2006 for lagging purposes.

Table 3. Predicting Gun "Imports" for Years 2012-2013 and 2013 with a Lag for 2012 Only for Accurate Data (All Senders and Receivers)

	2012-2013 Data		2013 Controlling for 2012 Import Ratio	
Dependent Variable=Import Ratio	Model A (2012-2013)	Model B (2012-2013 natural logs)	Model C (2013)	Model D (2013 natural logs)
Lagged 2012 Import Ratio	N/A	N/A	0.063	0.526**
			(0.056)	(0.204)
Gun Control Regulation Index	0.036***	0.426***	0.016**	0.334**
	(0.011)	(0.104)	(0.006)	(0.136)
Population	2.17e-08	2.16e-08**	3.43e-08***	2.35e-08*
	(1.82e-08)	(8.14e-09)	(1.23e-08)	(1.41e-08)
Size	-9.19e-07*	-9.45e-07	3.43e-08	-9.10e-07
	(5.97e-07)	(8.16e-07)	(7.71e-07)	(1.16e-06)
Percent Urban	0.916**	2.666***	0.353	1.124
	(0.353)	(0.657)	(0.426)	(1.069)
Violent crime rate	0.001	0.001	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Unemployment	0.005	-0.073	-0.019	-0.102
	(0.063)	(0.057)	(0.064)	(0.101)
Percent in Poverty	-0.011	0.039	0.025	0.099
	(0.034)	(0.040)	(0.028)	(0.066)
Manufacturing and Licensing	0.023	0.052	0.016	0.057
	(0.027)	(0.054)	(0.408)	(0.069)
Year 2013	-0.504***	-0.576***	N/A	N/A
	(0.170)	(0.112)		
Cons	-0.214	-3.598***	-0.373	-3.214***
	(0.399)	(0.988)	(0.408)	(1.166)
N	98	98	49	49
Prob > F	0.0000	0.0000	0.0000	0.0000
R-Squared	.5124	.6169	.6710	.6194

Note: *=p<.1 **p<.05 *** P<.01 Natural log models have natural logs for both the import ratio and the regulation index. We excluded Hawaii from the models due to distance between the continental United States and Hawaii.

Supplemental Appendix Table 1. Brady Campaign Gun Regulation Scores

To measure the strength of gun laws on a state-by-state basis, we utilize data from the Brady Campaign to Prevent Gun Violence. Since 2007, the Brady Campaign has collected a "scorecard" for each state based on the strength of the state's gun laws. As the Brady Campaign evolved, its scorecard changed so that different types of gun laws were used in the scorecard each year. In addition, the Brady Campaign weights its score based on an evolving standard of which laws are considered more/less important. To deal with this, *we tested three different values which measure gun strength*: (1) the raw score as provided by the Brady Campaign for each state and each year. (2) Each year reweighted based on the weighting scheme applied in 2011 (the last year that it issued its scorecard in this format) and dropping any laws not tracked over the entirety of the years measured. (3) An unweighted score in which each law in the 2011 weighted standard is calculated as 1, no individual law is assumed to have a greater or lesser impact on gun trafficking than any other. As a result, while the original score was out of 100, the reweighted scores have a maximum of 84. Our preferred measure is the weighted 2011 standard because the intended result is that a state should have the same score in 2011 as it had in 2007 if no changes in the law occurred. This method was employed to protect the analysis from being skewed by changes in the scoring standard over time instead of changes in the law. We ran our models using all three versions of the score (the original Brady Campaign score as reported for each year, the 2011-base weight score, and an unweighted score). Here we show the difference between the scoring mechanisms for a subset of laws to show how the scoring changes based on the Brady Campaign's weights. Again, the substance of the results was unchanged regardless of if we used a weighed measure or an unweighted measure. Here we have chosen 6 gun laws to exemplify the difference in the measures. In total there were 40 or so gun laws tracked by the Brady campaign. The actual number of laws per year increases overtime however we kept only those tracked every year for our measure. For information on all laws or how we converted each law to match the Brady Campaign's weights, please contact the authors.

Gun Regulation	**Weighted Score (2007 Standard)**	**Weighted Score (2011 Standard)**	**Unweighted**
Universal Background Checks	17	17	1
One Handgun/month purchase limit	10	5	1
Fingerprinting required for permit	2	3	1
Safety training required for permit	2	3	1

Under 16/17 access prevention	5	2	1
Integrated locks sold on all guns (childproof)	3	5	1
State with all of these gun laws gun regulation score would be:	**39**	**35**	**6**

Supplemental Appendix Table 2. Standard Trade Models and GMM Models and for 2007-2013 Data

	Standard Trade Model	GMM Models	
	(Model A) Dep Var=Log Number of Guns Imported	(Model B) Dep Var=Import Ratio	(Model C)[+] Dep Var=Log of Number of Guns Imported
Lag of Log of Number of Imports	0.89***	--	0.87***
	(0.02)		(0.02)
Log of Number of Exports	0.02	--	0.03
	(0.02)		(0.02)
Lag of Log of Number of Exports	0.04**	--	0.06**
	(0.02)		(0.02)
Lagged Import Ratio	--	0.28**	--
		(0.14)	
Gun Control Regulation Index	0.002**	0.08**	0.004***
	(0.0009)	(0.04)	(0.02)
Population	2.85e-09	--	--
	(2.19e-09)		
Size	-9.00e-08	-1.19e-06	-2.92e-08
	(7.44e-08)	(2.76e-06)	(8.02e-08)
Percent Urban	0.17**	0.96	0.18**
	(0.066)	(1.86)	(0.09)
Violent crime rate	0.0001**	-0.001	0.0002**
	(0.00001)	(0.001)	(0.00001)
Unemployment	-0.006	0.03	-0.01**
	(0.006)	(0.09)	(0.00)
Percent in Poverty	-0.001	-0.13	0.002
	(0.003)	(0.10)	(0.005)
Cons	0.14***	1.50	0.03
	(0.07)	(1.47)	(0.06)
N	294	294	294
Prob > F	0.00	0.00	0.00
R-Squared	0.97	n/a	n/a

*=p<.1 **p<.05 *** P<.01

[+] Standard Trade Model GMM

Supplemental Appendix Table 3. Model in Table 1 with Regional Controls

Dependent Variable=Import Ratio	(2007-2013)
Lagged Import Ratio	0.230
	(0.165)
Gun Control Regulation Index	0.094***
	(0.023)
Population	-1.46e-07***
	(4.24e-08)
Size	3.84e-06***
	(1.40e-06)
Percent Urban	6.69***
	(1.87)
Violent Crime Rate	-0.003***
	(0.001)
Unemployment Rate	0.037
	(0.069)
Percent in Poverty	0.128**
	(0.055)
South	1.33***
	(0.503)
Northeast	2.71***
	(1.01)
Midwest	2.05***
	(0.580)
Wald chi ^{2}	110.34
Prob>f	0.0000
R-sq	0.4384
N	294
cons	-6.05***
	(2.01)

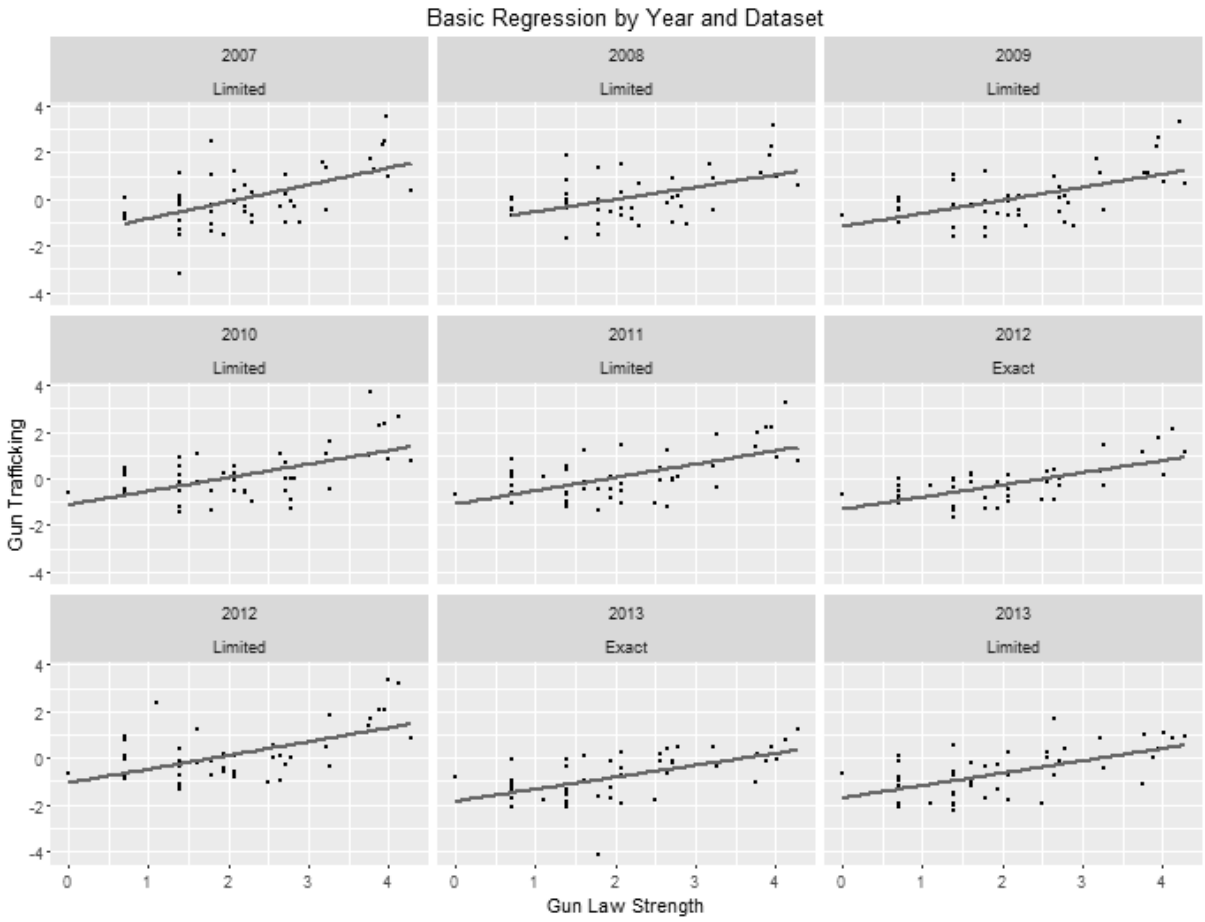
*=p<.1 **p<.05 *** P<.01

Supplemental Appendix Table 4. Model in with Pop Change Variable

Dependent Variable=Import Ratio	(2007-2013)	(2007-2013 logged)
Lagged Import Ratio	0.696***	~
	(0.025)	
Gun Control Index	0.025***	~
	(0.007)	
Lagged Import Ratio (logged)	~	0.733***
		(0.039)
Gun Control Index (logged)	~	0.124***
		(0.041)
State Size	0.0001	0.0001
	(0.001)	(0.0004)
Percent of Urbanization	0.360	0.409
	(0.736)	(0.277)
Violent Crime	-0.001	-0.0002
	(0.001)	(0.0003)
Unemployment	-0.027	-0.014
	(0.060)	(0.021)
Percentage in Poverty	0.0004	-0.002
	(0.034)	(0.013)
Population Change	-2.429	1.056
	(7.636)	(1.954)
Constant	0.364	-0.466**
	(00.588)	(0.232)
Observations	294	294
R^2	0.868	0.758
F Statistic (df = 9; 284)	0.00	0.00

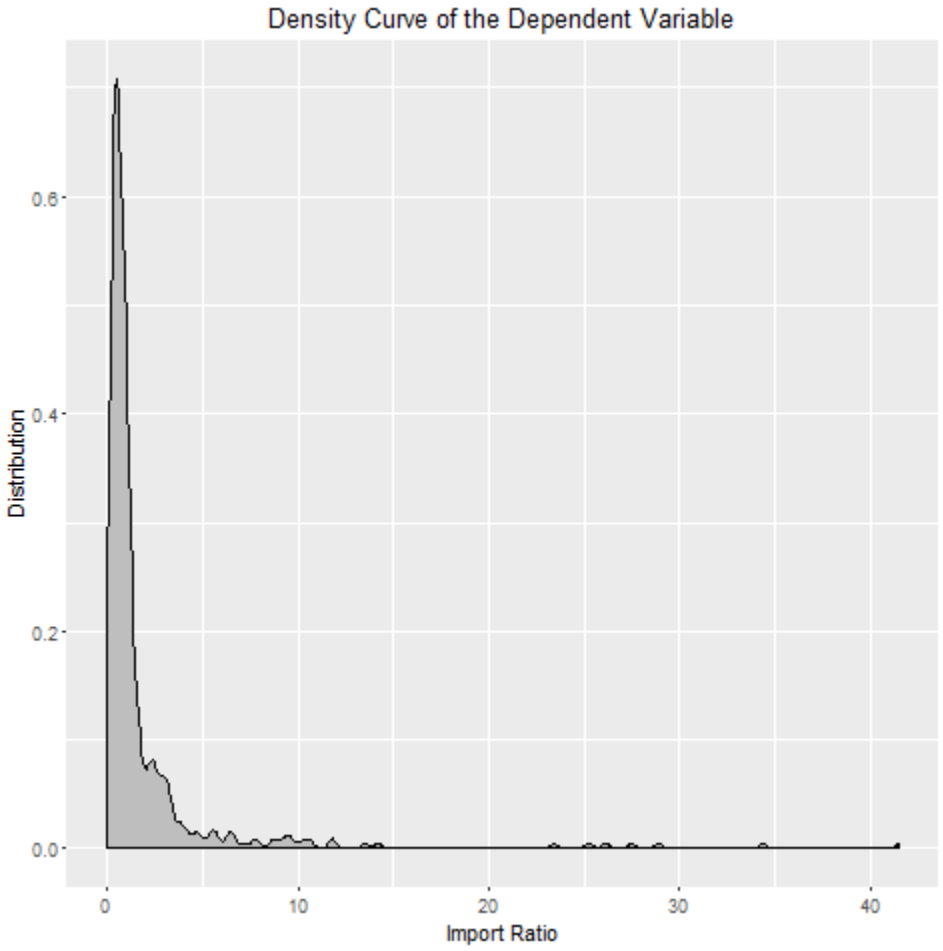
*=p<.1 **p<.05 *** P<.01

Supplemental **Appendix Figure 1. Bivariate relationship between Gun Control Regulation Index and Percent of Guns Imported from other States**



Note: Y Axis is percent of guns imported from other states, the X axis is the strength of a state's gun laws.

Supplemental Appendix Figure 2. Distribution of Dependent Variable



Supplemental Appendix Figure 3. Distribution of Logged Dependent Variable