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State Gun Policy and Cross-State Externalities: Evidence from Crime Gun Tracing*

Abstract

This paper provides a theoretical and empirical analysis of cross-state externalities associated with gun regulations in the context of the gun trafficking market. Using gun tracing data, which identify the source state for crime guns recovered in destination states, we find that firearms in this market tend to flow from states with weak gun laws to states with strict gun laws, satisfying a necessary condition for the existence of cross-state externalities in the theoretical model. We also find an important role for transportation costs in this market, with gun flows more significant between nearby states; this finding suggests that externalities are spatial in nature. Finally, we present evidence that criminal possession of guns is higher in states exposed to weak gun laws in nearby states.

Brian Knight
Department of Economics
Brown University
Providence RI 02912

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1 Introduction

A key issue in the design of federations involves the delegation of authority between national, state, and local governments. A common argument against decentralization hinges on the idea that localities may fail to internalize cross-jurisdiction externalities. Under centralization by contrast, political institutions may help to internalize these externalities. A key argument in favor of decentralization, by contrast, involves diversity in preferences, which can be better accommodated under decentralization by tailoring policies according to local preferences.[1]

This paper examines these issues, cross-state externalities and heterogeneous policies, in the context of gun policy in the United States. While the federal government has enacted several gun-related policies, states are also heavily involved in this policy arena, with approximately 300 state laws in place as of 1999 (Ludwig and Cook, 2003). Thus, gun policy is largely decentralized in the United States, and, reflecting the significant heterogeneity in preferences, there is significant diversity in gun restrictions across states.

In response to federal and state restrictions on gun purchases, a secondary market in guns has emerged. In this market, gun traffickers supply guns to prohibited persons, those who cannot, according to federal law, purchase firearms from a licensed gun dealer; this group includes convicted felons and minors.[2] This market is substantial in size, with ATF investigations into trafficking between July 1996 and December 1998 identifying over 84,000 firearms that were diverted into this secondary market (ATF, 2000). Anecdotal evidence suggests that this secondary market is characterized by large price markups and has a significant interstate component, with one trafficker reporting buying guns on the legal market in Virginia, which has relatively weak gun laws, for $150-200 and re-selling them illegally in New York, which has relatively strict gun laws, for $500-600.[3] If the

[1] Among others, see Oates (1972), Oates (1999), Inman and Rubinfeld (1997a), Besley and Coate (1999), and Strumpf and Oberholzer-Gee (2002). In the context of anti-trust policy, see Inman and Rubinfeld (1997b), who focus on the trade-off between economic efficiency and political participation.

[2] See Cook et. al. (2007) for a discussion of this market in the city of Chicago, Illinois.

[3] Mayors Against Illegal Guns (2008).

interstate flow of guns responds to differences in state-level regulations, then gun laws may have significant cross-state externalities.[4]

Thus, gun policy in the United States seems to reflect the costs associated with decentralization, namely cross-state externalities, and these externalities are particularly salient when there is significant diversity in gun regulations across states. In this paper, we provide a theoretical and empirical investigation of these issues. As motivated by our tracing data, which provide information on the source state for crime guns recovered in for each of the 50 states, we begin by building a simple supply and demand model of cross-state gun trafficking. On the supply side, potential traffickers in a destination state choose whether or not to traffic guns, and, conditional on doing so, must choose the source state for purchase. The choice of source state depends upon gun regulations, which increase the cost of trafficking from these states, and transport costs, which are increasing in the distance between the source and the destination state. On the demand side, criminals in the destination state decide, given a price, whether or not to purchase a gun. The key prediction of the model is that increasing the stringency of gun laws in a given source state increases prices and reduces transactions in the secondary market in other states, leading to interstate externalities. A necessary condition for the existence of these cross-state externalities is that trafficking patterns respond to differences in state-level gun regulations. In addition, given that the model includes transportation costs, any externalities are larger in magnitude when the destination and source state are in close proximity.

Our empirical analysis uses tracing data, as described above, to construct a 50-state gun trafficking import-export matrix. Using these data, our primary empirical analysis is based upon a supply-side analysis in which we condition on a trafficker's decision to sell guns in a given destination state. In particular, our empirical specification, which is derived from the theoretical model and is similar to a gravity trade model, relates trade flows between a pair

[4] Indeed, policy-makers in restrictive states have argued that trafficking increases criminal access to guns in their states and have attempted to restrict this source of firearms. Mayor Bloomberg, for example, recently filed a lawsuit against 15 gun dealers in states with weak gun laws after identifying these dealers as sources of crime guns recovered in New York City.

of states to the differences in the stringency of gun laws between those states.[5] Consistent with the predictions derived from the model, we find that guns flow from states to weak gun laws to nearby states with strict gun laws. Thus, the necessary condition for the existence of cross-state externalities is satisfied. Building upon this supply-side analysis, we then incorporate a proxy for criminal possession of guns and conduct an equilibrium analysis, which accounts for both the supply side and the demand side. While this analysis requires a number of additional assumptions, it has the advantage of allowing one to quantify the size of any externalities. The results from this analysis suggest externalities are significant, with weak gun laws being associated with high possession rates by criminals in nearby states. Finally, we examine an alternative indicator for trafficking based upon time-to-crime.

The paper proceeds as follows. We first present background information on relevant federal and state gun laws. We then describe the relevant literature on guns, gun trafficking, and cross-state externalities. As motivated by our tracing data, we then build a simple supply and demand model of gun trafficking. After describing the data, we then explain the econometric strategy, present the results, and conduct several counterfactual experiments. The conclusion summarizes the results and describes the associated policy implications.

2 Background on gun laws

The Gun Control Act of 1968 is arguably the most significant federal gun control legislation. Among other things, this law requires dealers to have a license, restricts purchases by prohibited persons, including felons and minors, and generally prohibits the interstate sale of firearms. The Brady Bill, passed in 1994, requires dealers to conduct background checks and thus provides an enforcement mechanism for restricting purchases by prohibited persons.

States supplement these federal laws in a variety of ways. For the purposes of this study, which is focused on cross-state gun trafficking, we consider ten laws deemed significant in terms of restricting trafficking, as identified by Mayors Against Illegal Guns (2010). These ten laws are detailed in Table 1A. The first law parallels federal laws on straw purchasing

[5] For a review of the literature in international trade on the gravity model, see Anderson (2011).

and thus provides an additional enforcement mechanism. Straw purchasers are individuals who purchase a gun on behalf of someone else, who is often either a prohibited person or a gun trafficker. The next two laws also parallel federal laws and involve either purchasers who falsify information or dealers who do not conduct the required checks. Fourth, some states also have attempted to close the gun show loophole, under which infrequent sellers are not required to conduct background checks. Fifth, some states require prospective gun purchasers to first acquire a permit to own a firearm, and the application process for this permit typically involves a background check. Sixth, some states allow local authorities discretion to deny concealed carry permits, which are available in some form in every state except Illinois and Wisconsin. Seventh, while convicted felons cannot purchase firearms under federal laws, some states extend this to include those individuals with violent misdemeanors on their record. Eighth, some states require individuals to report lost or stolen guns, attempting to counter the fact that many traffickers allegedly report that their guns have been stolen after investigations have traced a crime gun back to them. Ninth, some states allow local governments to pass firearms restrictions, whereas localities are preempted from doing so in other states. Tenth, some states supplement ATF inspections of gun dealers. See Mayors Against Illegal Guns (2010) for additional information on these state gun laws.

To provide a sense of the cross-state variation in gun regulations, Figure 1 maps an index of state gun laws based upon the total number, from zero to ten, of these gun laws in place, where darker shading indicates more stringent gun laws. As shown, there is significant regional variation, with southern and mountain states tending to have weak gun laws, and with states in the upper Midwest and on the two coasts tending to have stricter gun laws. Despite this regional variation, many state borders are associated with significant changes in gun laws, creating potentially strong incentives for gun trafficking. Illinois, for example, has 8 out of the 10 laws described above and is bordered by three states, Indiana, Missouri, and Wisconsin, with relatively weak gun laws.

As an alternative measure, we also consider an index of laws identified by the Brady Campaign (2009) as key in curbing firearms trafficking. In particular, the Center has assigned a score to each of 11 laws, with a maximum total of 29 points.[6] These laws, as detailed in Table 1B, are focused on regulating dealers, while the laws identified by Mayors Against Illegal Guns are more focused on consumers.

3 Related Literature

The existing literature on gun trafficking within the United States is, similarly to this paper, largely based upon crime gun tracing data. Webster, Vernick, and Hepburn (2001) examine data on guns recovered in 25 U.S. cities and find that cities in states with mandatory registration and licensing systems tended to import more guns from other states. They also find that cities in proximity to states without these laws also tended to import more guns. Cook and Braga (2001) analyze tracing data for guns recovered in Chicago, where background checks were already being conducted prior to 1994, and find a large reduction in guns imported from Brady states, those that were not conducting background checks prior to 1994, after the passage of the Brady Bill. In a study focused on intrastate trafficking, Webster, Vernick, and Bulzacchelli (2009) find that enhanced regulation and oversight of dealers and private transactions is associated with a reduction in gun trafficking. The tracing data used in this paper are based upon a study by Mayors Against Illegal Guns (2010). Their key finding is that states with weak gun laws tend to export more guns than states with stricter gun laws.

We build upon this literature in several ways. Most importantly, by building a theoretical model of gun trafficking, we provide micro-foundations for measurement. In particular, the theoretical model generates an econometric specification that is based upon correlating trade flows between a given pair of states with the difference in the stringency of gun laws between this pair of states. To the extent that traffickers respond to gun laws, then firearms should flow from states with weak laws to states with strict laws. The existing literature, by contrast, has tended to focus on aggregate, jurisdiction-level data. As noted above, for example, Webster, Vernick, and Hepburn (2001) document that cities with strict laws tend

[6] While the original index allows up to 35 points, no states had enacted one of the laws, which increased the score by 6 points.

to import more than cities with weak laws. By not analyzing the source states associated with these imports, however, their test cannot establish that these imports are from states with weak gun laws, as opposed to being from states with strict gun laws. Thus, their results do not establish that traffickers respond to differences in gun laws across states. Similarly, Mayors Against Illegal Guns (2010) find that states with weak gun laws tend to export more than states with strict gun laws. By not analyzing the destination states associated with these exports, however, their test cannot establish that these exports are made to states with strict gun laws, as opposed to being made states with weak gun laws. Given this, their results do not establish that traffickers respond to differences in gun laws across states.

In addition to focusing on trade flows, our study makes several other contributions to the literature. We highlight spatial considerations, focusing on the idea that externalities are potentially more significant between nearby states than between more distant states.[7] By developing an econometric model from micro-foundations, our analysis also allows us to conduct several counterfactuals relating to reductions in incentives for gun trafficking. Finally, in addition to analyzing tracing data, we also examine the effects of gun trafficking on the possession of guns by criminals.[8]

There is also a related literature on the trafficking of weapons at the international level. DellaVigna and La Ferrara (2010) detect increases in stock prices for arms companies in high corruption countries under an embargo following an increase in conflict in other countries.

[7] Given our focus on spatial considerations and transportation costs, our paper is also related to a literature on cross-border shopping in other policy contexts. Recent contributions include Doyle and Samphantharak (2008) on gasoline taxes, Lovenheim (2008) on cigarettes, and Knight and Schiff (2010) on lottery games. In a study using an empirical strategy similar to that using gun tracing data, Merriman (2010) uses tax stamps on cigarette packs discarded in the city of Chicago and finds that tax rates help to explain the geographic distribution of tax stamps.

[8] Given our use of crime data, our paper is also related to a large literature on guns, gun policy, and crime. Lott and Mustard (1997) and Lott (1998) find that concealed carry laws have led to a reduction in violent crime. Duggan (2001) uses information on the geographic circulation of a popular firearms magazine as a proxy for gun ownership and finds that guns tend to increase crime. Ludwig and Cook (2000) examine trends in crime rates in states with and without background checks prior to the passage of the Brady bill and find that background checks had little or no effects on homicides. Cook and Ludwig (2003) provide evidence that increased gun ownership leads to increased burglary rates. Duggan, Hjalmarsson, and Jacob (2011) find no relationship between gun shows and subsequent crime rates in the states of California and Texas.

This result is consistent with the illegal trading of arms by these companies. Two recent papers examine gun trafficking and violence between the United States and Mexico. Dube, Dube, and García-Ponce (2011) exploit the expiration of the assault weapons ban in the United States during 2004. While California had a state-level ban that made the expiration irrelevant, Arizona and New Mexico did not. The authors show that, relative to California, gun crime in areas in Mexico close to Arizona and New Mexico experienced large increases in gun violence. Chicoine (2011) conducts a similar analysis, in which he compares violence in areas in Mexico with a cartel presence to violence in areas without a cartel presence, before and after the expiration of the assault weapons ban. The results of this analysis also suggest that the availability of assault weapons in the United States increases crime in Mexico.

4 Model of Gun Trafficking

This section develops a simple equilibrium model of interstate gun trafficking. Given our empirical motivation, we keep the model simple and make specific functional form assumptions in many cases. It should be clear, however, that the results are robust to other modeling assumptions.

Consider a set of states. In a given destination state d, there is a pool of N potential traffickers, which are indexed by t. Traffickers supply guns to criminals in d and can purchase domestically ($g_{td} = d$), purchase from another source state ($g_{td} = s \neq d$), or not purchase ($g_{td} = 0$). The non-travel costs associated with purchasing from source state s is given by $-\beta + \gamma r_s - \delta X_s - \eta_s$, where r_s indexes the stringency of the regulatory policy in s, the parameter γ, which is hypothesized to be positive, reflects the sensitivity of these costs to the regulatory policy, and X_s and η_s capture observed and unobserved, respectively, cost differences across states. Travel costs, which equal zero for domestic purchases, are represented by the increasing function $h(t_{ds})$, where t_{ds} represents travel distance. With an additional idiosyncratic component ε_{tds}, a purchase of a gun in source state s by a trafficker that is re-sold in d at a price of P_d yields a surplus equal to:

$$V_{tds} = \beta + \alpha P_d - \gamma r_s + \delta X_s - h(t_{ds}) + \eta_s + \varepsilon_{tds} \tag{1}$$

where α, which is hypothesized to be positive, captures the responsiveness of traffickers to the price in destination state d. The payoff to a trafficker from not purchasing a gun is normalized to equal $V_{td0} = \varepsilon_{td0}$. If ε_{tds} is distributed type-I extreme value, then the probability of a trafficker t from destination state d purchasing in source state s equals:

$$\Pr(g_{td} = s) = \frac{\exp(\beta + \alpha P_d - \gamma r_s + \delta X_s - h(t_{ds}) + \eta_s)}{1 + \sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - h(t_{dk}) + \eta_k)} \tag{2}$$

In terms of the demand size, we assume a pool of n criminals, indexed by c, in destination state d. Criminal c is willing to pay ε_{cd} for a gun, which follows the distribution function F and density f. Thus, given a price P_d, the aggregate demand for guns in state equals $n[1 - F(P_d)]$.

In equilibrium, prices are set such that the aggregate supply of guns to d from all possible source states equals the aggregate demand for guns in d:

$$N \frac{\sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - h(t_{dk}) + \eta_k)}{1 + \sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - h(t_{dk}) + \eta_k)} = n[1 - F(P_d)] \tag{3}$$

where N is the number of traffickers on the supply side and n is the number of criminals on the demand side.

Then, considering an increase in the stringency of gun policies in a given source state s, it can be shown that:

$$\frac{\partial P_d}{\partial r_s} = \frac{\gamma \Pr(g_{td} = s) \Pr(g_{td} \neq 0)}{\alpha \Pr(g_{td} = s) \Pr(g_{td} \neq 0) + \frac{n}{N} f(P_d)} \tag{4}$$

$$\frac{\partial Q_d}{\partial r_s} = \frac{-n f(P_d) \gamma \Pr(g_{td} = s) \Pr(g_{td} \neq 0)}{\alpha \Pr(g_{td} = s) \Pr(g_{td} \neq 0) + \frac{n}{N} f(P_d)} \tag{5}$$

where Q_d is the equilibrium quantity in destination state d. As shown, under the hypothesized signs of the parameters, increasing the stringency of gun laws in source state s leads to an increase in the equilibrium price and a decrease in the equilibrium quantity in the secondary market in state d . Thus, a necessary condition for such cross-state externalities in gun policies is that traffickers respond to differences in gun laws across states ($\gamma > 0$). Given this, the main focus of the empirical analysis involves estimation of the sign and magnitude of this parameter γ.

The model also highlights the role of travel distance in these policy externalities. In particular, we have that the ratio of domestic responses to foreign policy changes ($s \neq d$), relative to responses to domestic policy changes ($s = d$), can be expressed by:

$$E \ln \left[\frac{\partial Q_d / \partial r_s}{\partial Q_d / \partial r_d} \right] = -\gamma(r_s - r_d) + \delta(X_s - X_d) - h(t_{ds}) \tag{6}$$

Thus, under the assumption that travel costs are increasing in travel distance, cross-state externalities, when considered relative to the domestic effects of policies, are more significant when the two states under consideration are in close proximity. Thus, an additional focus of the empirical analysis involves the role of distance in trade flows.

Given the importance of the parameter governing the responsiveness of supply to gun laws (γ) and travel distances, our primary empirical analysis focuses on the supply side via an examination of the flow of guns across states in tracing data. In addition to estimating these key parameters, the supply-side analysis allows us to measure the degree to which state gun laws are weakened by trafficking resulting from weak gun laws in other states. Supplementing this analysis, we then attempt to measure criminal possession of guns, which can be considered as a proxy of equilibrium quantities. This allows us to estimate both supply-side and demand-side parameters and to thus quantify the externalities associated with weak gun laws in other states increasing criminal possession of guns, as highlighted in equation 5.

5 Data and Selection Issues

To shed light on the cross-state externalities associated with gun trafficking, our main data source involves information from crime gun tracing. Although the raw data are not publicly available, the ATF recently released state-level aggregate data for the calender year 2009, and these data were subsequently posted on the website www.tracetheguns.org. For a given destination state, these data include the number of guns recovered from crime scenes that were successfully traced to a given source state. Thus, using these data, one can construct the full 50-state gun trafficking import-export matrix, with about one-third of traced guns originally purchased in other states. Our analysis excludes Hawaii and Alaska but includes the District of Columbia and is thus based upon 49 source and 49 destination states, for a total of 2,401 trade flow observations. In total, about one-third of these traced guns were purchased in other states, suggesting that cross-state externalities are significant.

There are three important selection issues associated with interpreting these tracing data as representative of the pool of guns possessed by criminals. First, not all guns involved in crimes are recovered by the police. One important implication of this is that crimes involving weapons, which are recovered by definition, are likely to be over-represented. Indeed, as shown in Appendix Table 1, weapons offenses represent the largest category, and, within this category, over two-thirds of weapons offenses involve possession crimes. While one could argue that possession crimes are victimless and that there are no cross-state externalities in these cases, there is substantial evidence that those charged with possession crimes represent individuals who are at-risk for criminal activity in general. Indeed, Burruss and Decker (2002) conduct a qualitative analysis of police records involving weapons offenses and find that these violations often occur under violent circumstances. In addition, Bureau of Justice Statistics (2006) reports that, among felony defendants facing weapons charges in large urban counties during 2006, 80 percent of had at least one prior arrest and 65 percent at least one prior conviction.[9] Statistics from New York City also show that those convicted of felony gun possession, when compared to other felons, were more likely to be re-arrested, their re-arrests were more likely to involve violence, and they were four times more likely to be arrested for homicide.[10] Finally, the tracing procedure only allows local police to list a single type of crime. It is possible that many weapons charges were made simultaneously with other charges, and it is natural that police submitting the trace request would list the

[9] While these statistics are based upon felony defendants, individuals may also be charged with misdemeanor offenses. According to arrests data from the state of California during 2009, however, there were 5,771 misdemeanor weapons arrests and 23,908 felony weapons arrests [see http://stats.doj.ca.gov/cjsc_stats/prof09/index.htm]. Thus, 19 percent of weapons-related arrests were misdemeanors and 81 percent were felonies. While these data are limited to as single state, they do suggest that weapons charges are not dominated by misdemeanor offenses.

[10] See http://www.mayorsagainstillegalguns.org/html/local/gun-offender.shtml.

weapons charge, rather than the other crime.

The second selection issue involves the fact that tracing policies vary across jurisdictions, with some jurisdictions submitting all guns recovered for tracing, and others submitting guns only for investigative purposes. One important implication of this second selection issue is that some jurisdictions in states with strict gun laws may first check state-level records, such as purchaser permit databases, before submitting their tracing requests to the ATF. This may lead to states with strict gun laws having an artificially high number of out-of-state traces. As described below, we address this concern by including destination state fixed effects in one of our specifications, and, in this case, the model is identified solely by the distribution of out-of-state traces and the associated gun laws across source states.

The third selection issue involves the fact that not all guns submitted for tracing are successfully traced to a source state. In 2009, of the roughly 240,000 guns that were submitted for tracing, only 145,000, or 60 percent, were successfully traced. There are a variety of reasons why a gun may not be traced. First, dealers are only required to keep records for 20 years. Second, in some cases, the serial number on the gun has been obliterated. While we do not have any systematic information on guns that were not successfully traced, there were not significant discrepancies between states in terms of the fraction of guns that were successfully traced (Mayors Against Illegal Guns, 2010).

We supplement these tracing data with information on state gun laws. Our baseline estimates are based upon an index of 10 guns laws, as described above, in Mayors Against Illegal Guns (2010), and we also estimate specifications in which we allow for each law to have an independent effect. To capture the importance of spatial proximity, as suggested by the model, we also incorporate information on the distance between every state, as measured by the number of miles between the geographic centroids of the two states. As control variables, we also include measures of state size, in terms of both square miles and population.

6 Supply Side Analysis

Our primary empirical analysis focuses on role of state gun laws in the flow of guns across states. This analysis tests the simple prediction of the model that trafficking flows between any two states depend upon gun laws in the source state, gun laws in the destination state, and the proximity of the two states.

Since these tracing data do not include information on non-purchases, this analysis focuses exclusively on the supply side and the corresponding theoretical probability that, conditional on supplying a gun to state d ($g_{cd} \neq 0$), a trafficker in destination state d purchases a gun from source state s. This is given by:

$$\Pr(g_{td} = s | g_{td} \neq 0) = \frac{\exp(-\gamma r_s - h(t_{ds}) + \delta X_s + \eta_s + \xi_{ds})}{\sum_k \exp(-\gamma r_k - h(t_{dk}) + \delta X_k + \eta_k + \xi_{dk})} \tag{7}$$

Note that, since this analysis is conditioned on the decision by a trafficker to supply a gun to state d, these key expressions are independent of the price of guns (P_d) in state d. This is helpful from our perspective as we are not aware of any systematic state-level data on prices in this market.

For empirical purposes, we parameterize travel costs as $h(t_{dk}) = \phi 1(t_{dk} > 0) + \theta t_{dk} - \xi_{dk}$. The first term applies only to out-of-state purchases and is intended to capture potential exposure to federal gun laws when re-selling guns across state lines. The second term captures the increase in travel costs associated with increases in travel distance. Finally, ξ_{dk} captures unobserved costs associated with trafficking guns between states s and k.

Then, letting m_{ds} denote the imports from s from d, as represented in the tracing data, assuming a sufficiently large sample of recovered guns, we have that:

$$m_{ds}/m_{dd} = \Pr(g_{cd} = s | g_{cd} \neq 0) / \Pr(g_{cd} = d | g_{cd} \neq 0) \tag{8}$$

Combining equations (7) and (8) and taking logs, we then have the key estimating equation:

$$\ln(m_{ds}) - \ln(m_{dd}) = -\phi - \gamma(r_s - r_d) - \theta t_{ds} + \delta(X_s - X_d) + (\eta_s - \eta_d) + (\xi_{ds} - \xi_{dd}) \tag{9}$$

As shown, under the hypothesis that $\gamma > 0$ and $\theta > 0$, the flow of guns from source state s to destination state d (m_{ds}), relative to in-state purchases (m_{dd}), is increasing in the stringency of gun laws in the destination state, is decreasing in the stringency of gun laws in the source state, and is decreasing in the distance between the source and destination states. Finally, the constant in this regression, which is based upon a comparison of foreign sources to domestic sources, identifies ϕ, which is the cost associated with importing guns from any state, relative to in-state purchases.

Table 2 present our preliminary results from estimation of equation (9) via OLS. In particular, we regress the left-hand side of (9) on distance, in thousands of kilometers, and the difference in the stringency index between the source and destination states. Since the original index varies between 0 and 10, this difference varies between -10 and 10. Standard errors are clustered at the level of both source and destination state.[11]

As shown in column 1, the difference between the source and destination stringency index has the expected sign, with increasing stringency in the source state leading to reduced trade flows and increasing stringency in the destination state leading to increased trade flows, and this coefficient is statistically significant at the 99-percent level. Also, the distance between the two states has the expected coefficient, with increases in distance associated with a reduction in trade flows, and this coefficient is again statistically significant. In terms of comparing these two key coefficients, an increase in the stringency index of one point (i.e. one additional law) in the destination state is equivalent to moving the source state closer by about 230 kilometers. In terms of the other control variables, larger states, in terms of population, are more likely to export and less likely to import. We find no corresponding relationship in terms of state square miles. Finally, the constant is negative and statistically significant, highlighting the fact that around two-thirds of all traced guns were originally sold in the destination state.

While the regression in column 1 restricts source and destination laws to have equal and opposite effects, the specification in column 2 relaxes this restriction. As shown, the two coefficients have the hypothesized signs, with increases in the source stringency index reducing trade flows and increases in the destination stringency index increasing trade flows. In column 3, we relax the assumption that every law in the index of 10 laws has the same effect.[12] As shown, the laws that have the hypothesized negative effect include straw

[11] We have also estimated specifications with two-way random effects (at both the destination-state and source-state level), and the results are similar to those in Table 2.

[12] Each of these laws is measured as source less destination and thus takes on three possible values (-1, 0, and 1).

purchaser liability, required reporting of lost or stolen guns, and local discretion over gun regulations.

6.1 Additional specifications

The baseline specification, as reported in Table 2, is identified by two distinct sources of variation. First, to the extent that gun laws matter, then states with strict gun laws should purchase less domestically and import more from other states. That is, the key coefficient on gun laws is identified in part by the correlation between destination state gun laws (r_d) and the propensity to purchase domestically (m_{dd}). Second, to the extent that gun laws matter, then, all else equal, a given destination state should import more from states with weak gun laws. That is, the key coefficient on gun laws is identified in part by the correlation between source state gun laws (r_s) and the propensity to import from that state (m_{ds}). Since, as noted above, not all crime guns are submitted for tracing, it could be that states with strict gun laws first check state-level databases before submitting a gun for tracing, and this may induce an artificial correlation between destination-state gun laws and the propensity to purchase domestically. Given this, we next present a specification with destination state fixed effects. By subsuming all variation that is constant at the level of the destination state, this specification is identified solely by the second source of variation described above. That is, this analysis is identified solely by the distribution of out-of-state traces across source states. As shown in Table 3, which reports results from a fixed effects specification, the results are broadly similar to those in Table 2, with states importing more from other states with weak gun laws than from other states with strict gun laws. Similarly, as shown in column 3, states tend to import more from source states with straw purchaser liability and those that require reporting of lost or stolen guns.

As an additional robustness check, we next estimate a first-differenced specification. In particular, we examine the difference between trade flows, for a given pair of states, from source to destination and trade flows from destination to source:

$$\Delta = [\ln(m_{ds}) - \ln(m_{dd})] - [\ln(m_{sd}) - \ln(m_{ss})]$$

$$= \quad -2\gamma(r_s - r_d) + 2\delta(X_s - X_d) + 2(\eta_s - \eta_d) + (\xi_{ds} - \xi_{dd}) - (\xi_{sd} - \xi_{ss}) \qquad (10)$$

As shown, distance, which is identical in the two equations, drops out of this first-differenced specification. More generally, any measure, whether observed or unobserved, that plays an identical role in source-to-destination and destination-to-source observations, is differenced out in this specification. As shown in column 1 of Table 4, the results are broadly similar to those in Table 2, with guns flowing from states with weak gun laws to states with strict gun laws. The results are similar in column 2, with strict states both importing more and exporting less. Finally, the results in column 3 are similar to those in the baseline specification, although two additional laws, falsifying purchaser information liability and local discretion to deny carry permits, now have a statistically significant effect on trade flows.

One potential alternative explanation for our baseline results involves interstate migration. While we have interpreted our baseline results as reflecting trafficking flows, it is possible that these patterns in the data simply reflect population flows. That is, if owners of firearms are moving from states with weak gun laws to states with strict gun laws, then subsequent diversion of their guns to criminals, via theft, for example, could generate the pattern of tracing observed in the data. To control for interstate migration, we use Census data on 5-year migration rates reported in the American Community Survey between 2005 and 2009. In particular, we create a control variable in which we measure the number of individuals moving from source to destination, relative to individuals who reported living in the destination state in both the current period and five year prior.[13] As shown in Table 5, we indeed do find a positive correlation between gun tracing patterns and migration flows, suggesting that some of the out-of-state guns recovered may be due to migration. After controlling for these flows, however, the role of the gun laws is quite similar and, if anything, suggests a stronger role for gun laws than does the baseline specification.

As an additional robustness check, we next present results using the trafficking index reported by the Brady Campaign. As shown in Table 6, the results are broadly similar to

[13] That is, letting f_{ds} denote the number of individuals moving from source to destination, the control variable is measured as $\ln(f_{ds}) - \ln(f_{dd})$.

those in Table 2, with crime guns flowing from states with strict gun laws to states to weak gun laws. As the index varies from a minimum value 0 to a maximum of 29, the coefficient on the index is smaller, when compared to the coefficient in Table 2, which is based upon an index that varies from 0 to 10. As reported in column 3, store security precautions, ballistic fingerprinting, and mandatory reporting of lost firearms have the expected negative effect on trade flows. States that limit the purchase of handguns to one per month but with two or more exceptions, by contrast, have an unexpected positive effect on trade flows.

A commonly noted problem associated with the multinomial logit model involves unrealistic substitution patterns, which follows from the assumption that the unobserved surplus associated with trafficking (ε_{tds}) are independently distributed across source states.[14] In the context of our application and, as expressed in our baseline specification, an increase in the stringency of gun laws in a given source state leads to an increase in trade flows from every other state that is proportional to the baseline level of imports. It might be more reasonable, by contrast, to allow for imports to increase in a disproportionate manner in states that are similar, say in terms of geography, to the source state experiencing the increase in the stringency in gun laws. To address this issue, we next estimate a nested logit model. In this specification, we allow for ten nests: the domestic market and the nine Census regions, excluding the destination state.[15] Following Berry (1994), we estimate this specification by controlling for the log of the within-group market share on the right-hand side. As shown in Table 7, we do find evidence of a within-group correlation, as expressed in the positive coefficient on the within-group share. After controlling for this within-group share, however, the effects of gun laws are broadly similar to those in our baseline specification.

Note that over 20 percent of observations involve zero trade flows, and, given our log-linear specification, these observations are not included in the baseline results. We have attempted to address this issue in two ways. First, using our baseline specification in Table 2, we add one to all imports. The results from this specification, as shown in Table 8, are

[14] See Berry (1994) and Berry, Levinsohn, and Pakes (1995).

[15] We have also estimated models using the four Census divisions, rather than the nine Census regions, and find broadly similar results.

similar to those in Table 2. Second, using our baseline specification in Table 2, we drop the 13 smallest states in terms of both imports and exports. These states account for over 80 percent of the zero trade flows, and the remaining sample has only 5 percent of observations involving zero trade flows. As shown in Table 9, the results from this specification are similar to those in Table 1.

To summarize, our baseline results are robust to the inclusion of destination state fixed effects, a first-differenced specification, controls for interstate population migration, an alternative index of state gun laws, a nested logit specification, and two methods for handling the large number of zero trade flows in our data.

6.2 Trafficking and Weakening of State Gun Laws

The baseline parameter estimates can be used to estimate the degree to which gun policies are affected by gun laws in other states. To shed light on this issue, we first conduct a counterfactual experiment in which incentives for interstate gun trafficking are eliminated in the sense that all source states adopt the gun laws in place in a given destination state. Under this counter-factual, we then calculate the degree to which states could change their gun laws in order to match the real-world supply conditions. For states with strict gun laws, this exercise first considers an inward shift in the supply curve associated with the reduction of imports as all source states adopt the strict laws of the destination state, followed by an equivalent outward shift in supply as regulatory policies are weakened in all states. By shifting supply back to its original position, equilibrium prices and quantities are unchanged, and this analysis is thus independent of the shape of the demand curve. For states with weak gun laws, by contrast, this exercise first considers an outward shift in supply followed by an inward shift as regulatory policies are strengthened.

More concretely, shutting down the stochastic components of the model and calculating the gun laws in state d in the absence of incentives for trafficking (r'_d) that would match observed supply, we have that

$$\frac{\sum_k \exp(\beta + \alpha P_d - \gamma r'_d + \delta X_k - h(t_{dk}) + \eta_k)}{1 + \sum_k \exp(\beta + \alpha P_d - \gamma r'_d + \delta X_k - h(t_{dk}) + \eta_k)} = \frac{\sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - h(t_{dk}) + \eta_k)}{1 + \sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - h(t_{dk}) + \eta_k)} \tag{11}$$

Solving for these counterfactual gun laws (r'_d), we have that:

$$r'_d = \frac{\ln \sum_k \exp(-\gamma r_k + \delta X_k - h(t_{dk})) - \ln \sum_k \exp(\delta X_k - h(t_{dk}))}{-\gamma} \tag{12}$$

To get some intuition for this index, consider a special case. In particular, if transportation costs, as measured by $h(t_{dk})$, are very large for all source states $k \neq d$, then there are no imports into state d, policies are neither weakened nor strengthened by trafficking, and counterfactual policies are equal to actual policies ($r'_d = r_d$). More generally, counterfactual policies will be weaker than actual policies when a given destination state is exposed to states with weak gun laws and stronger when exposed to states with strict gun laws.

The results from this exercise are reported in Table 10. The results suggest, for example, that New Jersey could have an index of 8.2 were every other state to have the same gun laws in place and still have the same criminal access to guns as they do when their actual index equals 10 and when other states have much weaker gun laws. There are three broad patterns in these results. First, states with strict gun laws, such as New York and New Jersey, tend to have their laws weakened by other states. By contrast, states with weak gun laws, such as Texas and Arkansas, have their laws strengthened by states with stricter gun laws. Second, spatial proximity to states with weak laws matters. Comparing two states with similar laws, Utah and Indiana, for example, we have that laws are weakened in Utah, which is surrounded by states with weak laws and strengthened in Indiana, which borders two states, Illinois and Michigan, with relatively strict laws. Third, state size matters, with small states being more affected by trafficking. Indeed, the largest effects are in the District of Columbia, which has a very small population.

In summary, this supply-side empirical analysis provides support for the two predictions of the model. That is, guns tend to flow from states with weak gun laws to nearby states with strict gun laws, and these results are robust to a number of alternative specifications. Using these parameter estimates, we then demonstrate that gun laws are significantly affected by inter-state trafficking, and any weakening of gun laws is particularly salient in states with strict guns laws, those in close proximity to states with weak guns laws, and in smaller states.

7 Equilibrium Empirical Analysis

Building upon this analysis of the supply side, we next present two specifications that also account for the demand side. The first analysis assumes a fixed price, and the second analysis allows for a general price elasticity of demand. These analyses have the benefit of allowing for the computation of equilibrium criminal possession of guns under various counterfactuals. But, as will be seen below, both of these analyses require additional assumptions from both a specification and identification perspective and also require data on baseline criminal possession of guns at the state level.

7.1 Fixed Price Analysis

Our first specification incorporates information on the demand side but makes the simplifying assumption of a fixed price. That is, all criminals in state d are willing to pay price P_d; this assumption is equivalent to assuming a perfectly elastic demand curve. While prices are assumed to be fixed under this assumption, quantities are determined in equilibrium and are driven by the supply side.

Under this assumption and the parameterization of travel costs used above, we have that the equilibrium probability that a trafficker purchases a gun in source state s and re-sells in destination state d is given by:

$$\Pr(g_{td} = s) = \frac{\exp(\beta + \alpha P_d - \gamma r_s + \delta X_s - \phi 1(t_{ds} > 0) - \theta t_{ds} + \eta_s)}{1 + \sum_k \exp(\beta + \alpha P_d - \gamma r_k + \delta X_k - \phi 1(t_{dk} > 0) - \theta t_{dk} + \eta_k)} \tag{13}$$

Let σ_{d0} denote the number of criminals not possessing a gun and let $m'_{ds} = m_{ds}(1 - \sigma_{d0})$. Then, assuming a sufficiently large sample of recovered guns and recalling that the observed surplus from not trafficking a gun is normalized to zero, we have the key estimating equation:

$$\ln(m'_{ds}) - \ln(m_{d0}) = \beta + \alpha P_d - \gamma r_s + \delta X_s - \phi 1(t_{ds} > 0) - \theta t_{ds} + \eta_s + \xi_{ds} \tag{14}$$

By comparing imports from state s into destination state d to the decision to not traffic, this specification now depends upon the price of a gun (P_d). Since this price is fixed by assumption, however, it can be estimated by a destination state fixed effect. This is helpful since we do not have any data on prices in the secondary market. Also, the parameter δ is identified in this estimation by comparing the number of guns imported from other states to the number of guns purchased domestically.

As should be clear, this analysis requires state-level information on criminal possession of guns. As a proxy, we incorporate FBI data on types of weapons used in robberies by state during calendar year 2009. Averaging across states, around 40 percent of robberies involve a gun, ranging from 19 percent in New Hampshire to 61 percent in Georgia.

The underlying assumption driving this proxy is that criminal decisions to commit robberies are independent of gun possession, and criminals commit robberies with guns should they possess a gun and with another weapon otherwise. Of course, there may be reasons to believe that this is not the correct model of criminal behavior. If criminals are more likely to commit crimes when they have access to a gun, then this measure may lead us to over-state the effects of gun laws on criminal possession of guns. Even so, it should be clear that there are significant cost for residents associated with this increase in crime.

Table 11 presents the results from this analysis. As shown, the inclusion of information on criminal access to guns changes the results only slightly, with the parameter estimates in column 1 similar to those in the baseline results in Table 2. In column 2, which relaxes the assumption that every law in the index of 10 laws has the same effect, the results are again similar to those in Table 2.

Using these parameters, we next compute criminal possession of guns under a counterfactual scenario in which incentives for trafficking are eliminated. In particular, we consider a scenario in which domestic policies are fixed and are adopted in every other state as well. For example, from the perspective of New York states, every state adopts 10 out of 10 gun laws in the index, thereby eliminating incentives for traffickers to travel to states with weak gun laws in order to purchase guns. Under this counterfactual, we then re-compute criminal possession of guns and compare this to the baseline criminal possession of guns, as predicted by our model. As shown in Table 11, the effects are again most significant in states with strict guns laws, in close proximity to states with weak gun laws, and in small states. From a proportional perspective, the largest declines are in DC, Rhode Island, and New Jersey. Possession rates increase in states with weak gun laws, as disincentives for trafficking from other states are eliminated. West Virginia, for example, has very weak gun laws and is surrounded by states with stricter guns laws. Thus, criminal possession in this state increases from 20 percent to 23 percent when all states adopt West Virginia's gun laws.

7.2 Full equilibrium analysis

Finally, we present a specification in which we estimate both supply-side and demand-side parameters. Importantly, this specification allows for the possibility that demand is perfectly inelastic. In this special case, increasing the stringency of gun laws in other states will increase prices but will not reduce equilibrium quantities even if trafficking flows respond to differences in policies. Thus, in this special case, there are no cross-state externalities in the sense that a weakening of gun laws in a given state does not increase criminal possession of guns in other states.

In particular, we assume that, given a price P_d, criminal c in destination state d purchases a gun with the following probability:

$$\Pr(g_{cd} = 1) = \frac{\exp(\nu_d - \rho P_d)}{1 + \exp(\nu_d - \rho P_d)} \tag{15}$$

where ρ, which is hypothesized to be positive, captures the responsiveness of criminal purchasing decisions to prices, and ν_d represents unobserved demand for guns in state d. Again, if demand is perfectly inelastic ($\rho = 0$), then an increase in the stringency of gun laws may increase prices but will not reduce possession rates.

For tractability considerations, we next assume that the number of criminals (n) is equal to the number of traffickers (N). In this case, equating supply, as expressed by the left-hand side of equation (3), and demand in equation (15), one can solve for equilibrium possession rates as follows:

$$\ln\left[\frac{\Pr(g_{cd}=1)}{1-\Pr(g_{cd}=1)}\right] = -\frac{\beta}{\alpha+\rho} - \frac{\rho}{\alpha+\rho}e_d + \frac{\alpha}{\alpha+\rho}\nu_d \quad (16)$$

where $e_d = -\ln\sum_k \exp(-\gamma r_k - h(t_{dk}) + \delta X_k + \eta_k + \xi_{dk})$ is an effective stringency index of the regulatory policy in d, accounting for both domestic and foreign gun laws.[16] As shown, a regression of possession rates on the effective stringency index uncovers a combination of demand-side (ρ) and supply-side (α) parameters. Under the hypotheses that $\rho > 0$ and $\alpha > 0$, criminal possession of guns in equilibrium is declining in the effective stringency index.

To provide some interpretation for the effective stringency index, consider first the special case where $h(t_{dk})$, which can be interpreted as the cost of importing from any state, is very large and, shutting down the stochastic component, then the effective index depends only upon domestic policies and characteristics (i.e. $e_d = \gamma r_d - \delta X_d$) and there are no cross-state externalities. More generally, when transportation costs are low, this index will depend upon both domestic and foreign policies, and an increase in the stringency of gun laws in a given source state will have external effects in the sense of reducing criminal possession rates in other states.

In terms of empirical implementation, the key thing to note here is that the deterministic component of this effective stringency index e_d can be computed with information on the key parameters from our baseline supply side analysis, as reported in Table 2. That is, shutting down the stochastic component, using the specification for transportation costs, and using the parameter estimates in Table 2, we compute $\widehat{e}_d = -\ln\sum_k \exp(-\gamma r_k - \phi 1(t_{ds} > 0) - \theta t_{ds} + \delta X_k)$ and use this in a cross-state regression of possession rates on effective stringency indices.

Table 13 presents the results from this analysis, using the measure of criminal possession of guns, as described above, based upon robbery data. As shown in column 1, which reports the results from a 49-state OLS analysis, possession rates are declining in the stringency

[16] To generate this specification, first note that equating aggregate supply and aggregate demand leads to a closed-form solution for the equilibrium price [$P_d = \frac{\nu_d - \beta + e_d}{\alpha+\rho}$]. Plugging this back into the demand equation and re-arranging yields the equilibrium quantities.

index. This result is consistent with the hypothesis of an elastic demand curve and suggests that state gun laws have externalities in the sense that an increase in the stringency of gun laws in a given source state reduces criminal possession rates in other states, and especially so in nearby states.

A key concern in interpreting this coefficient in column 1 involves policy endogeneity. In particular, if unobserved criminal demand for guns among criminals (ν_d) is correlated with gun regulations (r_d), then the estimates in column (1) will be biased. In terms of the direction of any bias, however, one plausible scenario is that states in which criminal possession is otherwise high will tend to enact strict gun laws to counteract this problem. In this case, policy endogeneity would tend to move the coefficient on the stringency index in a positive direction, and, if anything, this endogeneity will tend to understate the hypothesized negative effect of state gun laws on criminal possession rates.

To address this issue empirically, we next control for the domestic stringency index. That is, we calculate the stringency index under the assumption of no-trafficking.[17] Controlling for this domestic stringency index, we then use the variation induced by laws in neighboring states. Intuitively, we compare criminal possession rates in two states with similar laws but with different laws in neighboring states. According to our hypothesis, possession rates should be higher in the state surrounded by other states with weak gun laws. As shown in the second column of Table 12, this is indeed the case. That is, after controlling for domestic laws, the effective stringency index has an even stronger effect on criminal possession rates. This suggests that the endogeneity on gun laws in the destination state is not driving our results.

Using these parameter estimates, we next conduct counterfactual scenarios analogous to those in Table 12. We first consider a counterfactual scenario in which gun laws are fixed but in which incentives for trafficking of firearms are eliminated.[18] Table 14 reports the

[17] In particular, we calculate the domestic stringency index based solely upon domestic variables [i.e., $\widehat{e}_d = \gamma r_d - \delta X_d$].

[18] In this case, every state adopts the policies in destination state d, and the effective regulatory index becomes $e'_d = -\ln \sum_k \exp(-\gamma r_d - h(t_{dk}) + \delta X_k)$. Plugging this into the equation 16, we then compare these counterfactual possession rates to the baseline predictions of the model.

results from this counterfactual. As shown, possession rates fall in states with strict gun laws but increase in states with weak gun laws. The largest proportional declines are again in states with weak gun laws, states surrounded by states with weak gun laws, and in small population states. These include, for example, DC, New Jersey, and Rhode Island.

To summarize, the results from this equilibrium empirical analysis suggest that gun laws in other states influence criminal possession of guns. While these analyses require additional assumptions and the full equilibrium analysis is limited by its reliance on purely cross-sectional data, the consistency of the results with the predictions of the theoretical model is encouraging.

8 Time-to-Crime Analysis

While the tracing data are useful for detecting inter-state trafficking, they are necessarily an indirect measure of trafficking. Given this, we follow the existing literature by also analyzing an additional proxy for trafficking known as time-to-crime, defined as the time elapsed between the initial purchase of the gun and its recovery at a crime scene.[19] In particular, the literature has argued that guns with a short time-to-crime, typically measured as less than two years, is a strong indicator of trafficking.

Following Mayors Against Illegal Guns (2010), we correlate an index of gun laws with the fraction of recovered guns by source state that have a time-to-crime of less than two years. As shown in Figure 2, the fraction of recovered guns with a short time-to-crime varies from under 10 percent from guns originally purchased in New Jersey to 40 percent for guns originally purchased in Missouri.[20] More importantly, there is a strong and statistically significant correlation between gun laws and time-to-crime. In terms of the magnitude of this effect, these results suggest that states with the weakest laws have approximately 25 percent of guns with a short time-to-crime, whereas states with the strictest laws having only 15 percent.

[19] See, for example, Cook and Braga (1999) and Mayors Against Illegal Guns (2010).

[20] While these fractions may seem low at first glance, guns purchased in the last two years account for only around 6 percent of all handguns in circulation (Cook and Braga, 2001).

9 Conclusion

In this paper, we have provided a theoretical and empirical analysis of cross-state externalities associated with state-level gun regulations. This analysis yields three key results. First, trafficking flows respond to gun regulations, with guns imported from states with weak gun laws into states with strict gun laws. Thus, the necessary condition for cross-state externalities is satisfied. The second key result is that proximity matters, with trafficking flows more significant between two nearby states than between two distant states. Thus, any externalities have a spatial component, with a weakening of gun laws having a more significant effect in nearby states. The third key result is that, consistent with the existence of cross-state externalities, criminal possession rates tend to be higher in states exposed to weak gun laws in other states.

These findings of cross-state externalities have a number of policy implications. First, to the extent that states do not internalize these externalities when setting gun regulations, gun policy may be too lax under decentralization. This idea is consistent with the standard result of inefficient policies under decentralization and cross-state spillovers. Second, there may be a role from a welfare perspective for increasing the stringency of federal regulations. For example, federal laws equivalent to those in New York would eliminate incentives for trafficking into this state. On the other hand, there would be a cost of further federal interventions, as a key advantage of decentralization involves the ability of states to tailor policies according to local preferences. While our analysis sheds light on this benefit of greater centralization, weighing these benefits and costs would require information on the value of policies being tailored to local preferences under decentralization.

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Figure 1: Index of Gun Law Stringency by state

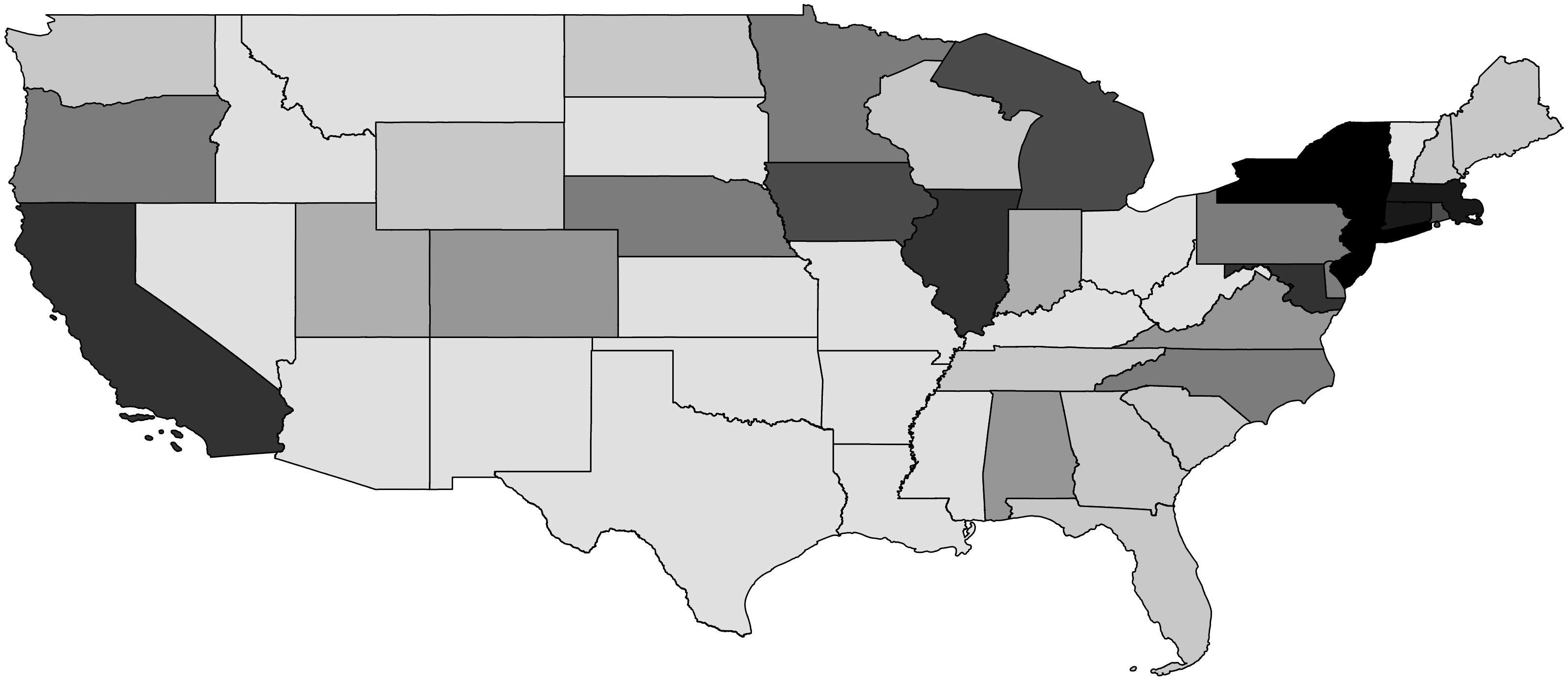

Figure 2: Time-to_Crime and Gun Laws

(by source state)

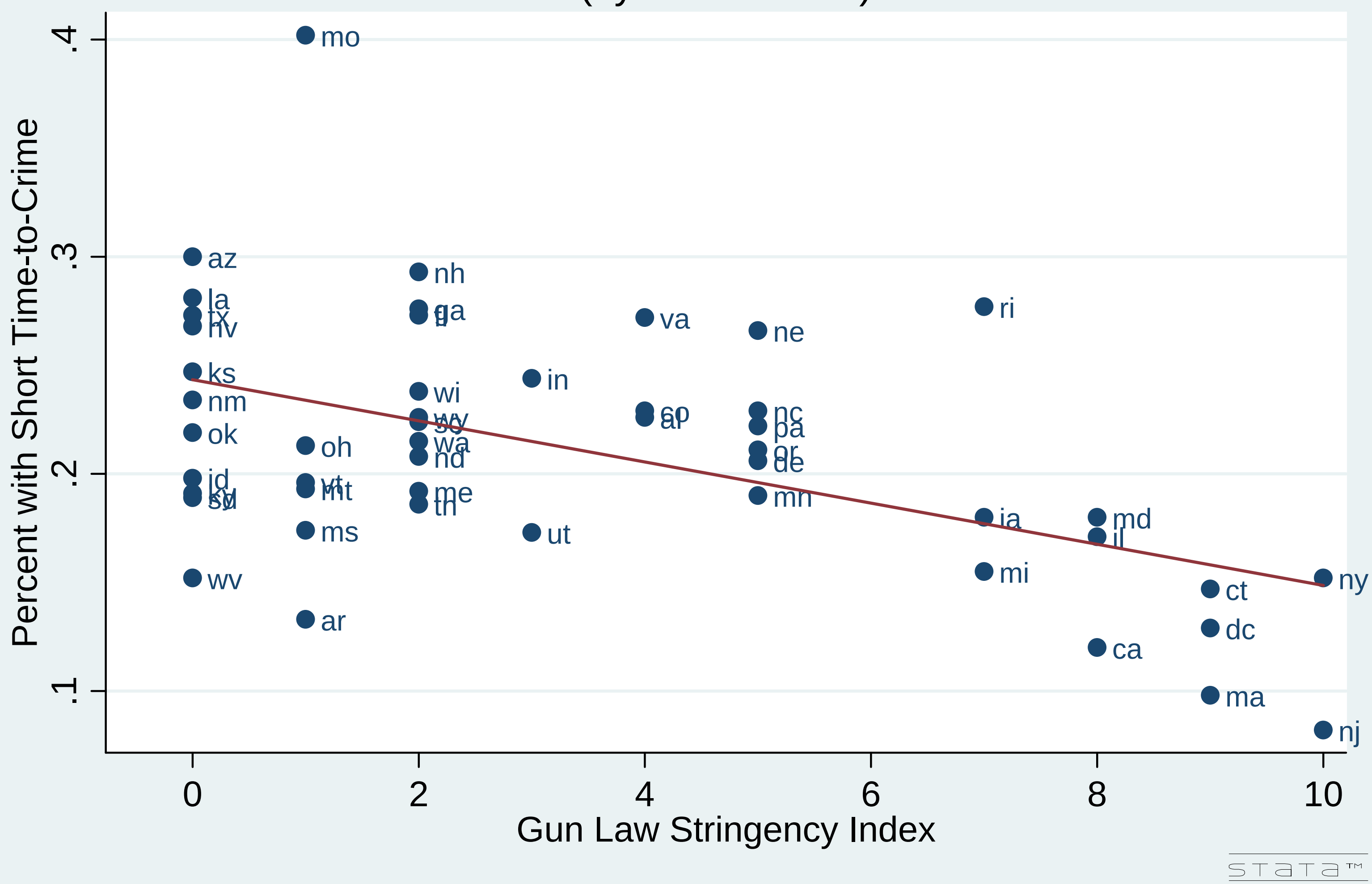

TABLE 1A: GUN LAWS (MAYORS AGAINST ILLEGAL GUNS INDEX)

Law	Additional Information
straw purchase liability	A "Straw purchase", purchasing a gun on behalf of somebody else, is a federal crime. Some regions have passed laws allowing for the local policing and and prosecution of straw purchasers.
falsifying purchaser information liability	It is a felony under federal law to provide false information when purchasing a gun. Some states allow for local prosecution of offenders.
background check failure liability	A dealer who fails to conduct a background check has committed a misdeamnor under federal law. Some states allow for prosecution and incarceration of these offenders.
gun show checks	Infrequent sellers of firearms are not required to be licensed under federal law. Several states have attempted to close this "gun show loophole" with a variety of restrictions on casual gun merchants.
required purchaser permit	Several states require that all prospective gun purchasers acquire a permit, regardless of whether the dealer has a federal firearms license. This procedure often includes a background check.
local discretion to deny carry permits	Concealed carry permits are available in every state except Illinois and Wisconcin. Some states allow local law enforcement discretion to deny carry permits, even if an individual meets the state and federal requirements.
misdemeanor restrictions	Federal law prohibits gun ownership by individuals convicted of felonies or domestic violence misdemeanors. Some states extend the restriction to those found guilty of other violent misdemeanors.
required reporting of lost or stolen guns	Some states require that lost or stolen guns are reported.
local discretion over gun regulations	Eight states currently allow municipalities, cities and countries authority to enact gun control and regulation.
dealer inspections by state	ATF has inspection authority over licenced firearms dealers, but some states supplement these inspections by allowing or requiring their own.

TABLE 1B: GUN LAWS (BRADY CENTER INDEX)

Law	Additional Information	Score
dealers require state license		2
dealer record keeping and retention		2
dealer reports records to state/state retains records		2
mandatory theft reporting (dealers)		2
at least one store security precaution required		2
inspections by police allowed		2
purchase limit of one handgun per month, no exceptions	Bulk purchases of firearms are restricted in an effort to discourage gun trafficking. Individuals can purchase only one handgun per month	10
purchase limit of one handgun per month, two or more exceptions	There are limits on bulk purchasing, but state law contains certain exceptions.	3
ballistic fingerprinting		5
required microstamping on semi-auto handguns	"Microstamping" is used to record information about the gun (i.e. make and serial number) on its firing pin. When the gun is fired, the information is transferred to the spent cartridges, allowing for a cartridge to be linked to the gun from which it was fired.	5
mandatory reporting of lost/stolen guns (firearm owners)		3

TABLE 2: BASELINE SPECIFICATION

distance between source and destination	-0.546*** (0.054)	-0.546*** (0.054)	-0.546*** (0.054)
stringency index (source less destination)	-0.130*** (0.023)		
source stringency index		-0.102*** (0.022)	
destination stringency index		0.156*** (0.032)	
log population difference (source less destination)	0.626*** (0.066)	0.628*** (0.066)	0.654*** (0.084)
log square miles difference (source less destination)	0.072 (0.094)	0.064 (0.088)	0.029 (0.092)
constant	-4.287*** (0.110)	-4.474*** (0.125)	-4.286*** (0.101)
straw purchase liability			-0.387* (0.220)
falsifying purchase liability			-0.140 (0.110)
background check failure liability			0.036 (0.118)
gun show checks			-0.101 (0.170)
requires purchaser permit			-0.013 (0.271)
local discretion to deny carry permits			-0.099 (0.110)
misdemeanor restrictions			-0.135 (0.164)
required reporting of lost or stolen guns			-0.524** (0.227)
local discretion over gun regulations			-0.327* (0.187)
dealer inspections by state			0.044 (0.110)
R-squared	0.542	0.548	0.572

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 1861 observations

TABLE 3: DESTINATION STATE FIXED EFFECTS

distance between source and destination	-0.680*** (0.049)	-0.693*** (0.043)
source stringency index	-0.120*** (0.022)	
log population (source)	0.772*** (0.061)	0.813*** (0.064)
log square miles (source)	0.065 (0.053)	0.016 (0.054)
straw purchase liability		-0.332* (0.173)
falsifying purchser information liability		-0.177 (0.114)
background check failure liability		-0.086 (0.110)
gun show check		-0.056 (0.192)
requires purchaser permit		-0.189 (0.200)
local discretion to deny carry permits		-0.045 (0.132)
misdemeanor restrictions		-0.172 (0.202)
requires reporting of lost or stolen guns		-0.538*** (0.151)
local discretion over gun regulations		-0.042 (0.156)
dealer inspections by state		0.149 (0.119)
R-squared	0.711	0.724

Standard errors (clustered at source) in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$, 1861 observations

TABLE 4: FIRST DIFFERENCE SPECIFICATION

stringency index (source less destination)	-0.278*** (0.031)		
source stringency index		-0.278*** (0.035)	
destination stringency index		0.277*** (0.046)	
log population difference (source less destination)	1.180*** (0.075)	1.180*** (0.075)	1.193*** (0.086)
log square miles difference (source less destination)	0.063 (0.098)	0.063 (0.099)	-0.008 (0.112)
constant	0.193 (0.163)	0.195 (0.184)	0.191 (0.132)
straw purchase liability			-0.615** (0.273)
falsifying purchaser information liability			-0.358** (0.182)
background check failure liability			0.147 (0.179)
gun show checks			0.003 (0.256)
required purchaser permit			-0.280 (0.255)
local discretion to deny carry permits			-0.320* (0.169)
misdemeanor restrictions			-0.304 (0.282)
required reporting of lost or stolen guns			-0.867*** (0.216)
local discretion over gun regulations			-0.748*** (0.202)
dealer inspections by state			-0.009 (0.158)
R-squared	0.685	0.685	0.743

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 806 observations

TABLE 5: CONTROLLING FOR INTERSTATE MIGRATION

distance	-0.267*** (0.054)	-0.266*** (0.052)	-0.260*** (0.053)
stringency index (source less destination)	-0.142*** (0.020)		
source stringency index		-0.120*** (0.020)	
destination stringency index		0.164*** (0.027)	
log population difference (source less destination)	0.315*** (0.061)	0.318*** (0.063)	0.340*** (0.070)
log square miles difference (source less destination)	0.117 (0.087)	0.110 (0.081)	-0.065 (0.087)
migration flows (source to destination)	0.562*** (0.050)	0.558*** (0.049)	0.576*** (0.012)
constant	-0.245 (0.352)	-0.428 (0.348)	-0.145 (0.342)
straw purchase liability			-0.361** (0.168)
falsifying purchaser information liability			-0.160 (0.104)
background check failure liability			0.026 (0.107)
gun show checks			-0.077 (0.138)
required purchaser permit			-0.051 (0.180)
local discretion to deny carry permits			-0.106 (0.103)
misdemeanor restrictions			-0.159 (0.146)
required reporting of lost or stolen guns			-0.614*** (0.166)
local discretion over gun regulations			-0.349** (0.171)
dealer inspections by state			0.033 (0.095)
R-squared	0.666	0.670	0.702

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 1,861 observations

TABLE 6: BRADY CENTER STRINGENCY MEASURES

distance between source and destination	-0.532*** (0.053)	-0.553*** (0.049)	-0.531*** (0.050)
log population difference (source less destination)	0.574*** (0.065)	0.572*** (0.066)	0.608*** (0.067)
log square miles difference (source less destination)	0.026 (0.073)	0.025 (0.064)	-0.065 (0.078)
Brady stringency index (source less destination)	-0.040*** (0.015)		
source stringency index (Brady)		-0.022 (0.017)	
destination stringency index (Brady)		0.057*** (0.016)	
constant	-4.329*** (0.131)	-4.483*** (0.136)	-4.332*** (0.0511)
dealers require state license			0.249 (0.166)
dealer record keeping and retention			-0.143 (0.171)
dealer reports records to state/ state retains records			0.125 (0.191)
mandatory theft reporting (dealers)			-0.022 (0.384)
at least one store security precaution required			-0.414** (0.186)
inspections by police allowed			-0.001 (0.153)
purchase limit of one handgun per month, no exceptions			-0.412 (0.427)
purchase limit of one handgun per month, two or more exceptions			0.365** (0.146)
ballistic fingerprinting			-0.778* (0.416)
required microstamping on semi-auto handguns			-0.086 (0.807)
mandatory reporting (firearm owners)			-0.777*** (0.206)
R-squared	0.419	0.434	0.477

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 1815 observations

TABLE 7: NESTED LOGIT SPECIFICATION

distance between source and destination	-0.581*** (0.053)	-0.578*** (0.050)	-0.584*** (0.052)
stringency index (source less destination)	-0.118*** (0.022)		
source stringency index		-0.087*** (0.024)	
destination stringency index		0.148*** (0.031)	
log population difference (source less destination)	0.442*** (0.070)	0.441*** (0.072)	0.439*** (0.081)
log square miles difference (source less destination)	0.090 (0.110)	0.081 (0.102)	0.068 (0.107)
within group log market share	0.496*** (0.075)	0.502*** (0.070)	0.538*** (0.072)
constant	-3.316*** (0.170)	-3.517*** (0.198)	-3.231*** (0.159)
straw purchase liability			-0.296* (0.180)
falsifying purchase liability			-0.019 (0.115)
background check failure liability			0.069 (0.112)
gun show checks			-0.213 (0.215)
requires purchaser permit			0.130 (0.271)
local discretion to deny carry permits			-0.144 (0.120)
misdemeanor restrictions			-0.172 (0.170)
required reporting of lost or stolen guns			-0.509** (0.211)
local discretion over gun regulations			-0.444** (0.189)
dealer inspections by state			0.104 (0.111)
R-squared	0.623	0.548	0.664

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 1861 observations

TABLE 8: INCLUDING ZERO TRADE FLOWS

distance between source and destination	-0.449*** (0.041)	-0.445*** (0.040)	-0.449*** (0.042)
stringency index (source less destination)	-0.123*** (0.020)		
destination stringency index		0.146*** (0.029)	
source stringency index		-0.101*** (0.021)	
log population difference (source less destination)	0.642*** (0.055)	0.642*** (0.055)	0.662*** (0.065)
log square miles difference (source less destination)	0.028 (0.071)	0.028 (0.066)	-0.001 (0.065)
constant	-4.311*** (0.116)	-4.469*** (0.116)	-4.311*** (0.107)
straw purchase liability			-0.386** (0.188)
falsifying purchaser information liability			-0.155 (0.099)
background check failure liability			0.053 (0.110)
gun show checks			-0.073 (0.156)
required purchaser permit			0.026 (0.226)
local discretion to deny carry permits			-0.115 (0.089)
misdemeanor restrictions			-0.131 (0.136)
required reporting of lost or stolen guns			-0.474*** (0.184)
local discretion to over gun regulations			-0.330** (0.154)
dealer inspections by state			0.027 (0.098)
R-squared	0.562	0.566	0.590

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 2352 observations

TABLE 9: DROPPING SMALL STATES

distance between source and destination	-0.492*** (0.065)	-0.498*** (0.064)	-0.493*** (0.063)
stringency index (source less destination)	-0.140*** (0.025)		
source stringency index		-0.119*** (0.028)	
destination stringency index		0.161*** (0.033)	
log population difference (source less destination)	0.520*** (0.101)	0.521*** (0.103)	0.562*** (0.126)
log square miles difference (source less destination)	-0.043 (0.098)	-0.046 (0.096)	-0.162*** (0.102)
constant	-4.359*** (0.122)	-4.497*** (0.147)	-4.359*** (0.115)
straw purchase liability			-0.486** (0.215)
falsifying purchaser information liability			-0.136 (0.132)
background check failure liability			-0.007 (0.109)
gun show checks			0.025 (0.180)
required purchaser permits			-0.011 (0.262)
local discretion to deny carry permits			-0.211*** (0.148)
misdemeanor restrictions			-0.075 (0.210)
required reporting of lost or stolen guns			-0.476** (0.234)
local discretion over gun regulations			-0.514*** (0.199)
dealer inspections by state			0.012 (0.126)
R-squared	0.396	0.402	0.444

Standard errors (clustered at source and destination) in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 1320 observations

TABLE 10: WEAKENING OF GUN LAWS

	index	no trafficking incentives index	change		index	no trafficking incentives index	change
al	4	3.711	-0.289	nc	5	4.653	-0.347
ar	1	1.580	0.580	nd	2	2.545	0.545
az	0	0.401	0.401	ne	5	4.155	-0.845
ca	8	7.631	-0.396	nh	2	2.794	0.794
co	4	3.719	-0.281	nj	10	8.216	-1.784
ct	9	7.000	-2.000	nm	0	0.763	0.763
dc	9	5.006	-3.994	nv	0	0.677	0.677
de	5	4.290	-0.705	ny	10	8.896	-1.104
fl	2	2.110	0.112	oh	1	1.405	0.405
ga	2	2.199	0.199	ok	0	0.676	0.676
ia	7	5.494	-1.506	or	5	4.596	-0.404
id	0	0.860	0.860	pa	5	4.773	-0.227
il	8	6.909	-1.091	ri	7	5.300	-1.700
in	3	3.069	0.069	sc	2	2.333	0.333
ks	0	0.810	0.810	sd	0	1.334	1.334
ky	0	0.846	0.846	tn	2	2.268	0.268
la	0	0.636	0.636	tx	0	0.197	0.197
ma	9	7.544	-1.456	ut	3	2.973	-0.027
md	8	6.596	-1.404	va	4	3.890	-0.110
me	2	2.694	0.694	vt	1	2.517	1.517
mi	7	6.219	-0.781	wa	2	2.142	0.142
mn	5	4.560	-0.440	wi	2	2.302	0.302
mo	1	1.450	0.450	wv	0	1.330	1.330
ms	1	1.568	0.568	wy	2	2.474	0.474
mt	1	1.732	0.732				

TABLE 11: FIXED PRICE ANALYSIS

distance	-0.675*** (0.050)	-0.688*** (0.044)
out-of-state	-4.113*** (0.082)	-4.094*** (0.078)
stringency index (source)	-0.121*** (0.021)	
log population (source)	0.765*** (0.059)	0.805*** (0.0613)
log area (source)	0.063 (0.052)	0.014 (0.053)
constant	-12.994*** (0.904)	
straw purchase liability		-0.337** -0.167
falsifying purchase liability		-0.175 (0.111)
background check failure liability		-0.080 -0.107
gun show checks		-0.059 (0.186)
requires purchaser permit		-0.177 (0.192)
local discretion to deny carry permits		-0.048 (0.127)
misdemeanor restrictions		-0.169 (.197)
required reporting of lost or stolen guns		-0.538*** -0.145
local discretion over gun regulations		-0.538 (0.145)
dealer inspections by state		0.144 (0.116)
R-squared	0.713	0.726

Standard errors (clustered at source) in parentheses, all specifications include destination fixed effects,
*** p<0.01, ** p<0.05, * p<0.1, 1910 observations

TABLE 12: TRAFFICKING AND CRIMINAL POSSESSION OF GUNS, FIXED PRICE ANALYSIS

	baseline rate	no trafficking incentives rate	change	percent change		baseline rate	no trafficking incentives rate	change	percent change
al	0.339	0.332	-0.008	-0.023	nc	0.476	0.466	-0.009	-0.020
ar	0.465	0.485	0.020	0.043	nd	0.268	0.285	0.017	0.064
az	0.548	0.561	0.013	0.023	ne	0.342	0.318	-0.024	-0.070
ca	0.592	0.584	-0.008	-0.013	nh	0.195	0.217	0.021	0.108
co	0.419	0.411	-0.008	-0.019	nj	0.307	0.266	-0.040	-0.132
ct	0.300	0.253	-0.047	-0.156	nm	0.368	0.393	0.025	0.068
dc	0.243	0.165	-0.079	-0.324	nv	0.487	0.512	0.025	0.052
de	0.303	0.288	-0.015	-0.049	ny	0.394	0.368	-0.026	-0.067
fl	0.640	0.643	0.003	0.005	oh	0.398	0.411	0.013	0.032
ga	0.577	0.583	0.006	0.011	ok	0.420	0.442	0.022	0.052
ia	0.212	0.182	-0.030	-0.141	or	0.187	0.181	-0.006	-0.034
id	0.502	0.533	0.031	0.062	pa	0.364	0.359	-0.005	-0.013
il	0.430	0.400	-0.030	-0.069	ri	0.267	0.230	-0.037	-0.139
in	0.294	0.297	0.003	0.010	sc	0.443	0.455	0.012	0.027
ks	0.461	0.488	0.028	0.060	sd	0.289	0.331	0.042	0.145
ky	0.346	0.373	0.027	0.078	tn	0.560	0.569	0.009	0.016
la	0.396	0.416	0.020	0.050	tx	0.750	0.754	0.004	0.005
ma	0.296	0.264	-0.032	-0.109	ut	0.355	0.356	0.001	0.002
md	0.301	0.268	-0.033	-0.111	va	0.459	0.457	-0.002	-0.004
me	0.180	0.197	0.017	0.096	vt	0.382	0.440	0.058	0.152
mi	0.441	0.420	-0.021	-0.048	wa	0.422	0.427	0.005	0.012
mn	0.285	0.275	-0.010	-0.034	wi	0.470	0.480	0.011	0.023
mo	0.527	0.542	0.015	0.028	wv	0.197	0.230	0.033	0.168
ms	0.404	0.423	0.019	0.047	wy	0.466	0.485	0.019	0.041
mt	0.266	0.288	0.022	0.083					

TABLE 13: FULL EQUILIBRIUM SPECIFICATION

effective stringeny index	-0.919***	-1.933**
	(0.214)	(0.773)
domestic stringency index		0.853
		(0.625)
log population	-0.120	-0.870
	(0.082)	-0.085
log square miles	-0.134**	-0.041
	(0.058)	(0.089)
constant	-6.542***	-9.995***
	(1.330)	(2.852)
R-squared	0.339	0.366

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1, 49 observations

TABLE 14: TRAFFICKING AND CRIMINAL POSSESSION OF GUNS, FULL EQUILIBRIUM SPECIFICATION

	baseline rate	no trafficking incentives rate	change	percent change		baseline rate	no trafficking incentives rate	change	percent change
al	0.404	0.395	-0.008	-0.020	nc	0.419	0.409	-0.010	-0.024
ar	0.421	0.438	0.017	0.040	nd	0.294	0.307	0.014	0.046
az	0.481	0.493	0.012	0.025	ne	0.308	0.287	-0.021	-0.068
ca	0.372	0.417	-0.011	-0.025	nh	0.366	0.388	0.022	0.060
co	0.372	0.365	-0.008	-0.021	nj	0.343	0.297	-0.046	-0.134
ct	0.320	0.270	-0.049	-0.154	nm	0.388	0.410	0.022	0.056
dc	0.424	0.314	-0.110	-0.260	nv	0.396	0.416	0.020	0.049
de	0.359	0.340	-0.019	-0.053	ny	0.374	0.344	-0.030	-0.081
fl	0.542	0.545	0.003	0.006	oh	0.542	0.554	0.012	0.022
ga	0.496	0.502	0.006	0.012	ok	0.451	0.471	0.020	0.044
ia	0.314	0.277	-0.037	-0.119	or	0.313	0.303	-0.010	-0.0327
id	0.360	0.384	0.024	0.066	pa	0.443	0.436	-0.007	-0.015
il	0.451	0.476	-0.032	-0.064	ri	0.331	0.287	-0.043	-0.131
in	0.449	0.451	0.002	0.005	sc	0.439	0.448	0.010	0.022
ks	0.440	0.464	0.024	0.054	sd	0.342	0.379	0.037	0.107
ky	0.480	0.505	0.025	0.052	tn	0.462	0.470	0.008	0.017
la	0.476	0.495	0.019	0.040	tx	0.601	0.606	0.006	0.009
ma	0.335	0.297	-0.037	-0.112	ut	0.348	0.347	-0.001	-0.002
md	0.355	0.318	-0.037	-0.105	va	0.431	0.428	-0.003	-0.007
me	0.326	0.344	0.184	0.056	vt	0.344	0.386	0.042	0.121
mi	0.366	0.345	-0.021	-0.058	wa	0.432	0.437	0.004	0.010
mn	0.359	0.347	-0.012	-0.033	wi	0.438	0.447	0.009	0.020
mo	0.472	0.485	0.134	0.028	wv	0.430	0.469	0.039	0.091
ms	0.433	0.450	0.017	0.038	wy	0.280	0.292	0.012	0.041
mt	0.303	0.322	0.019	0.062					

APPENDIX TABLE 1: CRIME TYPES IN ATF TRACING DATA

Category	Number of guns	Percentage
Dangerous Drugs	25,673	10.72%
Weapons Offenses *	90,149	37.65%
Firearm Under Investigation	14,925	6.23%
Homicide	7,069	2.95%
Family Offense	4,588	1.92%
Found Firearm	20,975	8.76%
Health-Safety	11,113	4.64%
Property Crimes (Robbery/Burglary)	6,231	2.60%
Assault	9,155	3.82%
Suicide	1,972	0.82%
Other	37,350	15.60%
None Provided	10,211	4.27%

* 63,326 of weapons offenses are possession crimes