Geoffrey Michael Steeves

# Perceptions, Patterns, and Arms: An Analysis of the Panorama of Brazilian Violence

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## Perceptions, Patterns, and Arms: An Analysis of the Panorama of Brazilian Violence

Essa tese foi julgada adequada para obtenção do Título de "Doutor em Economia", e aprovada em sua forma final pelo Programa de Pós-graduação em Economia da Universidade Federal de Santa Catarina.

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## NOTA DE ESCLARAMENTO

A maior parte deste trabalho é apresentado em Inglês, o que não seria uma prática padrão para teses e dissertações submetidas na universidade onde a pesquisa foi conduzida. A razão pela qual este trabalho é apresentado principalmente em Inglês é dupla: primeiro, o Inglês é a *lingua franca* da comunidade científica e internacional e da linguagem comum de pesquisadores, cientistas e economistas de todo o mundo. Para que o presente trabalho seja aceito pela comunidade internacional de pesquisa, o mesmo deve ser acessível. O fato de estar escrito em Inglês cumpre esse objetivo. Em segundo lugar, o trabalho acadêmico do autor da pesquisa no Brasil foi financiado pelo governo dos Estados Unidos. Para que essa pesquisa seja acessível aos patrocinadores deste intercâmbio acadêmico é necessário que a mesma seja apresentada em Inglês. No entanto, dado que o estudo foi realizado em uma universidade brasileira e examina a violência no Brasil, é altamente desejável que o mesmo também seja mais facilmente acessível para os brasileiros. Assim, capítulo 6 serve como um resumo estendido que inclue a a Introdução, resumos, palavras-chave, e Considerações Finais, todos traduzidos para o português. Esse capítulo serve como um resumo da pesquisa para os leitores de português com o objetivo de melhor compreender suas principais conclusões.

## NOTE OF EXPLANATION

The majority of this work is presented in English, which is a nonstandard practice for theses and dissertations submitted at the university where this research was conducted. The reason this work is presented in primarily English is twofold: First, English is the *lingua franca* of the international research community and the common language of researchers, scientists, and economists around the world. In order for this work to be accepted by the international research community, it must be accessible. Writing in English fulfills this goal. Second, the research author's academic work in Brazil was funded by the government of the United States. For this research to be accessible to the sponsors of this academic exchange, it is necessary that it be presented in English. However, given that this research was conducted at a Brazilian university and examines violence in Brazil, it is highly desirable that it also be more easily accessible to Brazilians. To that end, Chapter 6 serves an extended summary (*resumo estendido*) which includes the introduction (*introdução*), abstracts (*resumos*), key-words (*palavras-chave*), and final considerations (*considerações finais*), all translated in Portuguese. This chapter serves as a summary of the research for Portuguese readers to better comprehend its main findings

# Perceptions, Patterns and Arms: An Analysis of the Panorama of Brazilian Violence

Geoffrey Michael Steeves

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Abstract:

The goal of this doctoral dissertation is to explore Brazil's panorama of violence by developing innovative ways to better understand the heavy burden violence imposes on the Brazilian society. Using the homicide rate as its principal variable, this research measures the effects of violence, develops models, and identifies patterns. The interplay of the homicide rate with a host of other explanatory variables, principally employment in private security, expenditures on public security, and the prevalence of domestic small arms involved in homicides, form the foundation of this research. The overall contributions of this research are two-fold: First, to arm the researcher with new and innovative tools to assess the patterns, trends, and effects of violence, and second, to apply these tools to diverse data sets to better understand the factors that explain violence. Overall, the hope is that a more informed society can act to reduce the great toll violence imposes on Brazil.

# Percepções, Padrões, e Armas: Uma Analise do Panorama da Violência Brasileira

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Resumo:

O objetivo da presente tese de doutorado é explorar o panorama da violência no Brasil através do desenvolvimento de formas inovadoras para melhor compreender a carga pesada que a violência impõe para a sociedade brasileira. Usando a taxa de homicídios como principal variável o estudo mede os efeitos da violência, desenvolve modelos e identifica os padrões. A interação entre a taxa de homicídios e uma série de outras variáveis explicativas, principalmente, o emprego na segurança privada, os gastos com a segurança pública e a prevalência de armas de pequeno porte nacionais envolvidas nos homicídios formam a base desta pesquisa. As contribuições totais do estudo são duas: primeiro, prover ao pesquisador com ferramentas novas e inovadoras para avaliar os padrões, as tendências e os efeitos da violência e, segundo: aplicar essas ferramentas em diversos conjuntos de dados para compreender melhor os fatores que explicam a violência. Portanto, se espera que uma sociedade mais informada consiga agir para reduzir a grande taxa de violência existente no Brasil.

Palavras-chave: Violência; Homicídios; Brasil

Keywords: Violence; Homicides; Brazil

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# Introduction

V IOLENCE is both a cause and a reflection of the numerous social issues and challenges Brazil faces. It is an undercurrent that influences the way individuals make decisions as well as changes their perceptions of security and safety. The effects of violence are particularly severe in places that are more urban and with greater inequality. Its toll is disproportionately high on the young and male demographic. The factors shaping these violent outcomes are as complex as the impacts they have on society. This study endeavors to unravel some of this complexity to better understand how violence behaves and affects society. Principally this research provides two main contributions to the literature of violence. The first contribution is the development of new methods to measure and assess the effects of violence. The second is to apply these new methods to further understand the forces at work that generate the patterns and perceptions associated with violence.

## 1.1 Motivation

Violence has devastating effects on society. It erodes the fabric of communities and the fear it generates can cause people to invest less in one's community. It disrupts important public and social services, lowers productivity, and decreases the values of homes and businesses (CDC, 2013). Above all, it is responsible for the loss of life.

Violence is particularly acute in Brazil, where it continues to devastate communities, placing it among the nation's top challenges. Brazil ranks among the bloodiest places in the world, and by several measures, is more violent than actual war zones. Other statistics show Brazil to have the dubious distinction of being one of the few places where homicide rates actually exceed traffic fatality rates. Furthermore, the burden of this armed violence falls disproportionately upon the shoulders of young males (Waiselfisz 2011, 2012).

The drastic effects of violence has led to widespread dissatisfaction and national discourse. Politicians consider legislation and funding proposals aimed at stemming violence while private citizens take actions to increase their own personal safety. In response to this problem, a wealth of literature

spanning multiple disciplines has been written to better understand violence and ultimately reduce its impacts on society. This dissertation aims to add to this literature by identifying, discussing, and developing new ways to assess violence and its effects through quantitative analysis. Because the majority of literature offers generally qualitative analyses of violence, this research intends to create a niche by exploring violence in a quantitative manner through the application of empirical and econometric techniques.

Besides a general notion that violence is a severe national problem, the motivation for this dissertation was largely born from anecdotes presented by the news media aimed at explaining patterns and perceptions of violence along with conversations with Brazilians about their impressions of violence and personal security. The constant media coverage of violence prompts questions about how Brazilians actually perceive their personal safety relative to actual levels of homicidal violence. Another topic highlighted in the press, and also presented by Waiselfisz (2011), is the observed pattern that violence is fleeing well-policed cities for easier targets in the once-tranquil countryside. For example, gangs have been apprehended robbing ATMs in sparsely populated and policed towns hundreds of kilometers from urban centers. This research aims to further understand these patterns and the factors behind them. A final factor which motivates this research is the highly controversial debate about arms restrictions and the role that access to weapons may play in contributing to violent outcomes. In particular, the arms control debate received considerable attention in 2003 when the *Estatuto do Desarmamento* (Disarmament Statute) was passed into law and the general population's access to weapons was greatly reduced.

These subsequent chapters are framed within a cycle of violence in which numerous inputs such as social factors, law enforcement, policy implementation, and access to weapons contribute to violent outcomes. This violence, as measured by the homicide rate, in turn gives rise to numerous responses and outcomes within society. These outputs, such as the government and individuals increasing their security expenditures; the passage of new laws and policies to reduce violence; and the heightened levels of fear and insecurity in society are all reactions to violence. The cycle is completed when these outputs return to interact with the same inputs that originally influenced the violent outcomes.

These chapters explore violence through varied lenses using several key variables. The main variable that is common throughout this research is the homicide rate, which is assumed to capture most closely the true effect of violence. The use of the homicide rate to represent violence is justified using the same rationale as Waiselfisz, 2007. The first assertion to justify the use of homicides to represent general violence is that death reveals violence in its most severe form. In this sense, relating violence to homicides is akin to public health studies that measure the effect of an epidemic by its death toll, even though lesser forms of violence, such as armed robbery, may exist. The second justification that homicides are the best measure of violence is one of practicality — simply, there are few alternatives. Comprehensive data on lesser forms of violence are serially under-reported, misreported, miscategorized, and prone to heterogeneity and inconsistencies across micro-regions, and therefore not trustworthy. Homicides, however, are easier to classify and are more likely to be

reported. Given these justifications, the homicide rate is the most appropriate proxy for violence. Other key variables are also explored in each chapter. The next chapter relates homicides to private security expenditure to measure perceptions of fear in society. The third chapter focuses on the relationship between public security expenditures and the homicide rate. The fourth chapter discusses the positive correlation between domestic weapons manufacturing and homicides within the framework of a robust national small arms industry.

A logical application of this research is to encourage discussion about the policies aimed at addressing the violence epidemic. The implicit goal of these policies is, of course, the overall reduction in violence. However, often times these policies fall short of their objectives. Instead of actually reducing violence, policies may either merely mitigate the effects of violence or it is transfer elsewhere. In other words, policies often treat the symptoms of violence or dislocate it to another place rather than treating the root causes of violence. For example, in Chapter 2, the byproduct of violence is fear, which private individuals treated by increasing their holdings in private security. Chapter 3 considers patterns where violence, rather than being reduced across-the-board, is merely shifted to less protected and populated areas. In the background of Chapter 4, on the Brazilian arms industry, policies such as the *Estatuto do Desarmamento* were enacted with popular support with an end goal of overall violence reduction. Yet despite this legislation, violence continued to persist. The chapters are reviewed in more detail in the following section.

## 1.2   Overview of Chapters

This dissertation is composed of three chapters. Each explores the panorama of Brazilian violence from different angles. While all chapters are related, each also has the ability to *stand alone* as a separate, publishable article outside this dissertation. This section outlines each chapter as well as highlights the points of intersection and commonality in regards to this dissertation's overall theme. Each article is presented in its own chapter in the following pages:

### 1.2.1   Chapter 2: Perceptions of Violence and Fear in Brazil

This chapter focuses on the perceptions of fear as related to violence in Brazil. While it is clear that violence negatively changes a society's perceptions of fear and security, it is less clear how these perceptions can be quantitatively measured. This paper aims to address this issue. The first step toward measuring perceptions of the fear of violence in society is to model the factors that determine employment in private security. Here, private security holdings serve as a proxy for fear in the sense that more fearful individuals have a propensity to contract more private security. The second step is the construction of a *Fear Index* that relates the employment in the private security industry with counter-factual levels of employment in the *hypothetical* absence of homicidal violence. This relationship highlights the amount of private security hired *exclusively* to counter the effects of homicidal violence.

Lastly, a micro-region's fear is compared with actual homicide rates to identify how Brazil's most violent, most fearful, and most populous micro-regions rate on the spectrum of fear and violence.

## 1.2.2   Chapter 3: The Interiorization of Brazilian Violence: Is Increased Violence in the Countryside Related with Increased Public Security Expenditures in Big Cities?

This chapter explains and analyzes a pattern redefining the landscape of Brazilian violence: the spread, or *interiorization*, of violence from historically more violent urban areas to the previously tranquil rural countryside. It contributes to the literature on violence in two main ways. The first is the introduction of a novel approach to analyze this diffusion of violence by using inequality measures. Gini and Hoover indices are calculated to approximate these patterns and demonstrate the equalizing effect of violence witnessed across Brazilian states. Additionally, representing this redistribution of violence in a single variable facilitates empirical analysis of these patterns by allowing for direct comparison between these patterns and other explanatory variables. The second contribution explores whether a government's expenditures on public security are correlated with these shifts in violence. In other words, this research aims to determine if increased government expenditures in more urban areas are related to crime fleeing from the cities to the less policed countryside. This paper finds evidence of a strong correlation between public security expenditures and the dispersion of violence to the countryside. However, further analysis is required to determine if the increased public security presence in urban areas are actually causing this redistribution.

## 1.2.3   Chapter 4: Armed Violence and Weapons Production: An Analysis of Brazilian Small Arms Manufacturer Taurus

The motivation behind the final chapter originates from two observed patterns that relate to small arms and homicidal violence. The first motivating factor highlights that the strong majority of violent acts perpetrated in Brazil were carried out by domestically produced firearms rather than military-style, foreign-made small arms. The second motivating factor highlights that the Brazilian small arms industry underwent a production boom in the same periods that the nation experienced dramatic increases in violence. These patterns do not imply a causal relationship between the Brazilian arms industry and the high levels of violence. Diverse factors shape violent outcomes. However, given these correlations, this research analyzes the Brazilian arms industry more carefully. Particularly, this work considers the possibility that the robustness of the Brazilian small arms industry may be, at least to some extent, related to these high levels of violence. To gain insight about the Brazilian arms industry, this paper analyzes Brazil's largest and most important small arms manufacturer, Forjas Taurus (Taurus). Various factors, such as the the company's history, foreign involvement, and government support, are considered to understand not only the forces that shaped this company,

but also the arms industry as a whole. By increasing the understanding of Brazil's arms industry, this paper hopes to unravel some of the complexity of the panorama of Brazilian violence.

## 1.2.4   Commonalities and Contributions

While each chapter can stand alone as an independently publishable article, together the chapters of this dissertation form a general analysis of Brazilian violence. One commonality is that observable patterns provided the motivation for each of the chapters. In the case of the first chapter on perceptions and fear, the curious pattern of private security employment drastically outpacing regular employment rates motivated this research. The second chapter was motivated by a noted pattern of violence increasing in rural areas and decreasing in urban areas, all despite massive increases in public security spending - particularly in the big cities. The final chapter recognizes the pattern between the increased domestic production in the manufacturing of small arms and the increases in homicides. With this pattern, this research seeks to better understand the arms industry that ultimately supplied the majority of weapons used to perpetrate this violence, through the lens of Taurus, Brazil's largest weapons manufacturer.

A second commonality that unifies these chapters is the development of new measures to aid in the analysis of homicidal violence. In the case of Chapter 1, a novel way was developed to quantitatively analyze the effects of homicidal violence by creating the *Fear Index* to capture individual's perceptions of violence. In Chapter 2, Hoover and Gini inequality measures were employed to explain the redistribution of violence within states. While the use of inequality measures are hardly a novelty to the science of economics, their application to analyze trends in the dispersion of violence most surely is. Finally, Chapter 3 aims to understand some possibly related factors to homicidal violence by exploring the history and circumstances that led Brazil to become a major producer of small arms. The development of innovative measures to analyze the effects of violence on Brazilian society is not only a unifying trait of these chapters, but also a major contribution to the overall research.

A final commonality of the three chapters is the application of these new tools to analyze trends in Brazilian violence. In the case of Chapters 1 and 2, robust models are developed to explore how expenditures in either public or private security relate to the homicide rate. In Chapter 1, investment in private security is shown to be significantly related to the homicide rate as well as a host of other control variables. In Chapter 2, significant and large correlations are found between the spread of violence to the countryside and spending on public security. And while Chapter 3 does not empirically analyze the relationship between small arms and homicides, it analyzes the industry responsible for the manufacture of the weapons used to perpetrate violent crimes.

# Perceptions of Violence and Fear in Brazil

Abstract: As one of the world's most violent places, inclusive of actual war zones, the impacts of violence on Brazilian society are severe. These effects are measured in various ways, to include loss of life as well as expenditures on both public and private security. And while it is clear that homicides negatively affect how society perceives violence and security, there exists few measures to quantitatively capture these perceptions. This study aims to fill this void in the literature. Using Zero Inflated Poisson (ZIP) estimation and panel data across all 558 Brazilian micro-regions from 2008-2011, this research models the factors that determine employment in private security. Using private security as a proxy for society's perceived level of security, this research constructs a *Fear Index* that relates employment in the private security industry with counter-factual levels of employment in the *hypothetical* absence of homicidal violence. Higher index values imply higher levels of fear and less relative security. Then, this index is employed to analyze the relationship between fear and violence. A major contribution of this research is the identification of how Brazil's most violent, most fearful, and most populous regions rate on the spectrum of fear and violence. Generally speaking fear increases with violence in a predictable manner. However, certain micro-regions are identified that *defy* this predicted relationship and exhibit excess levels of fear. The identification of these regions, both as compliers and defiers, serves as a starting point to identify and analyze factors other than homicidal violence responsible for heightening fear in society.

## 2.1   Introduction

Brazil is known as a violent place for justified reasons. A host of staggering statistics paint a grim picture that demonstrates the great toll violence imposes on society. [1] However, less is known about how Brazilians perceive their security relative to this violence. The factors shaping these violent outcomes are as complex as the impacts they have on society. This study endeavors to unravel some of the complexity and contribute to the literature on violence by creating a measure that captures society's perceptions of violence.

The first step towards capturing society's perceptions is to model the factors that determine employment in the private security industry. To model the relationship between private security sector employment and violence, a rich and robust data set was assembled using the 558 Brazilian micro-regions (the Brazilian equivalent of a county) as an individual unit. The years 2008-2011, where Brazil experienced higher than normal levels of growth in private security, were analyzed. The dependent variable is the number of individuals formally contracted in the private security industry, which serves as a proxy for an individual's perceived level of security. The data is aggregated from the municipal to the micro-region level to reduce the amount of the excess zeros observed within both the dependent and some of the independent variables. The data set includes a host of explanatory variables to include homicide rates, overall employment, urbanization, poverty and the presence of penal institutions. This model empirically validates intuitions that individuals change their holdings in private security based on a host of factors, to include homicidal violence.

Building upon this model a *Fear Index* is created that relates model-predicted levels of employment with levels in the *hypothetical absence* of homicidal violence. This counter-factual level of employment is the *natural rate*, or the baseline level, of employment demanded to mitigate factors other than homicidal violence. It can be thought of as the amount of private security that society will continue to demand to mitigate other threats. Possibilities of other factors that heighten fear are non-lethal violence (such as armed robbery), nonviolent crime (such as vandalism or larceny), drug trafficking, and the trust and competence of the police force. The index thus measures, in quantitative terms, the amount of security contracted above its natural rate due to homicidal violence. It is in this sense that the *Fear Index* reflects society's perception of violence.

This paper's final contribution relates *Fear Index* values to observed homicide rates in order to identify and analyze where each of the 558 Brazilian micro-regions are positioned on the spectrum of fear and violence. This analysis focuses on several key categories to better understand this interplay between fear and violence. The categories considered are the most violent, the most fearful, and the most populous Brazilian micro-regions, as well as the micro-regions that defy predicted behavior and exhibit excess amounts fear.

The results allow for peer evaluation, which enables a direct comparison of a micro-region's

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[1]   For a comprehensive source on Brazilian violence see the *Mapa da Violência* series: www.mapadaviolencia.org.br

levels of fear and violence. For example, the micro-region of São Paulo, with homicide rates less than half of Rio de Janeiro, and one-fifth that of Salvador, also show correspondingly lower levels of fear. Additionally, the two most violent regions in Brazil, and among the most deadly in the world, Maceió, Alagoas and Marabá, Pará, also exhibit *normal* behavior. Their high homicide rates, which range from 86.5 to 110 homicides per 100,000 inhabitants, remain proportionate to high levels of fear. Marabá is not only among the most violent, but also among the most fearful places in the nation. These examples exhibit *complier* behavior where fear remains a positive function of violence in a predictable manner.

However, the micro-regions that *defy* the predicted relationship between fear and violence are also analyzed. Of particular interest are the most fearful micro-regions in Brazil. For example, in 2011 Alagoana do Sertão do São Francisco, Alagoas was the most fearful micro-region in the sample, across all years, despite a fairly modest homicide rate of 33.6. Figures, tables and maps were used to identify these types of curious results, which beg the question about what other factors or circumstances could be creating disproportionately high levels of insecurity and fear in society. In this sense, this research provides a starting point for further analysis of factors other than violence that could generate fear in society.

Overall, this research makes the following key contributions to the literature and study of violence: First, it develops a robust model that documents the relationship between private security employment, violence, and a host of explanatory variables. Second, it adapts this model to develop a *Fear Index*, which expresses perceptions of violence in an analytic and quantitative way. Finally, it identifies where the Brazilian micro-regions fall on the spectrum of fear and violence considering patterns and possible causes of these relationships, especially in regards to defiers.

The remaining organization is as follows: The first section, "Motivation and Context," highlights the background reasons for pursuing this research. The second section, "Data," describes the primary data sources and challenges. The third section, "Methodology and Model," discusses the empirical methodology and model, including development of the baseline model, ZIP, and Fear Index. The fourth section, "Results and Interpretation," presents the main findings for both the baseline model and Fear Index. The fifth section, "Discussion," focuses on the results, while the last section, "Conclusion," concludes the paper.

## 2.2   Motivation and Context

Two main ideas served as motivators for this study to analyze the perceptions of fear in society as they relate to violence. The first originated in the frequent and vivid news reporting of the high amount of homicidal violence in Brazil. The prevalence and consistence of this reporting begged the question of how fearful society was becoming due to this violence, and if society was taking any measures to mitigate the effects of this violence. This relationship prompted the search for possible variables that

Table 1 – Employment in Private Security relative to homicides and general employment

| Year | Total Number | | | Index | | |
|------|------|------|------|------|------|------|
| | H | Y | y | H | Y | y |
| 2007 | 47.7 | 54.6 | 533.5 | 100.0 | 100.0 | 100.0 |
| 2008 | 50.1 | 59.7 | 604.3 | 105.0 | 109.3 | 113.3 |
| 2009 | 51.4 | 61.1 | 654.1 | 107.8 | 111.9 | 122.6 |
| 2010 | 52.3 | 74.3 | 847.1 | 109.6 | 135.9 | 158.8 |
| 2011 | 52.2 | 71.0 | 779.5 | 109.4 | 129.9 | 146.1 |

Source: DATASUS and MTE. Table generated by author.

H: homicides (per 1000) Y: formal employment (per million); y: employment in priv. sec (per 1000).

could serve as a proxy to capture fear in society. When considering private security expenditures as a candidate a second motivating factor appeared–the above average growth of employment in private security during the same years where homicide rates increased.

Table 1 represents general trends from 2007-2011 for growth in the private security industry relative to growth in homicide and general employment. As noted in columns 2 and 5 homicide rates increased for Brazil as a whole during this period. During the same period general employment, columns 3 and 6, also increased. However, as evidenced by columns 4 and 7 formal employment in private security greatly outpaced general employment. Relative to the base year of 2007, the employment index for private security increased to 146.1 while general employment rose at a more modest rate to 129.9. This faster than expected growth motivated the choice to analyze the extent to which homicidal violence shapes the private security sector. In this sense employment in the private security sector serves as a proxy for fear and security in society.

The main variable of interest in the model is formal employment (as defined by a signed work card) in the private security sector. Analyzing this variable has several advantages. One advantage is that private security expenditures capture the effect of individuals taking matters into their own hands in order to avoid being victimized, possibly to augment the protection provided by the regular police force, or possibly out of a lack of confidence in the same. In this sense, private security employment expresses society's perception of violence in a more direct and immediate manner than, for example, public security expenditures. If levels of violence, or perceptions of violence change, individuals can quickly adjust the amount of labor contracted. A second advantage is the availability of data in the private security industry. While finding data on monetary expenditures in private security remains a challenge employment figures are readily available. A final reason linkages between the private security sector, violence, and fear are explored is explained by the disproportionate growth of employment in the private security industry in recent years already addressed in Table 1. Do these increases reflect growing unease and fear within society? If so, to what extent does homicidal violence explain these expenditures and fear? By analyzing this sector, this study considers these questions and analyzes the role homicidal violence plays in generating fear and insecurity in society.

## 2.3   Data

The analysis for this research is based upon an extensive data set that includes various factors to explain violence and employment in private security. The result is a short panel or four years with numerous individual units.

The dependent variable, is the number of *documented* workers in private security sector, as evidenced by a signed work card. Using the national classification system CNAE (Classificação Nacional de Atividades Econômicas) from Labor Ministry's Annual Report section (Ministério de Trabalho e Emprego and Relação Anual de Informações Anuais) figures were obtained for all types of employment in this sector at the municipal level. The workers analyzed in the data set are classified into two main groups. The first are classified as security guards who provide a physical presence to deter crime at businesses and residences (classified under code 8011-1: Atividades de Vigilância e Segurança Privada). The second group are involved in monitoring and the installation of closed-circuit cameras, alarms, and other electronic monitoring devices (classified under code 8020-0: Atividades de Monitoramento e Sistemas de Segurança).

The dependent variable comes with the complication that a large percentage of municipalities have zero employment in private security. A data set with a large amount of zeros creates a situation where the mean is lower the variance, know as *overdispersion.* [2] As the Poisson distribution is only valid under the assumption of *equidispersion*, where the mean and variance are equal, distributions other than the standard Poisson must be considered.

This phenomenon of excess zeros is likely a result of many factors. One possible factor is that the municipality could be small and non violent and therefore does not contract labor. A second is that the municipality actually employs documented private security workers but these employees are actually registered elsewhere. Both these issues are somewhat resolved by aggregating the data from the municipal to the micro-region level thereby reducing the overall amount of zeros. In the first case, the percentage of zeros is reduced due to a scaling effect. In the second case it is assumed that workers registered in other municipalities still work within the same micro-region.

Another advantage to aggregating observations at the micro-region strata is to control for any possible contagion of violence between municipalities. For example, should a relatively peaceful municipality neighbor a more violent one, it is conceivable that the less violent municipality may be induced to increase its amount of private security to ameliorate any *spillover* violence

While aggregating at the micro-region level greatly reduces the amount of zeros, it does not eliminate them. These remaining excess zeros are likely explained by Brazil's large undocumented labor force. It is likely that a non-trivial amount of personnel are employed in private security but are simply undocumented, and therefore do not appear in the data set (ETCO 2013). In fact, roughly 42 percent of micro-regions still register zero documented private security workers.

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[2]   Cameron Trivedi 2005, page 668-671

Table 2 – Homicide Rate relative to general employment and private security

| Year | $h$ | $Y/Pop$ (%) | $y/Pop$ (%) | $y = 0$ (%) |
|---|---|---|---|---|
| 1st Quartile: Average Population +/- 70 thousand | | | | |
| 2008 | 14.45 | 12.95 | 0.03 | 87.14 |
| 2009 | 14.96 | 13.55 | 0.02 | 84.29 |
| 2010 | 15.86 | 14.93 | 0.04 | 82.14 |
| 2011 | 16.21 | 15.24 | 0.06 | 77.86 |
| 2nd Quartile: Average Population +/- 140 thousand | | | | |
| 2008 | 16.41 | 18.17 | 0.15 | 56.12 |
| 2009 | 17.27 | 18.43 | 0.18 | 46.76 |
| 2010 | 17.50 | 20.19 | 0.23 | 43.88 |
| 2011 | 18.43 | 20.61 | 0.24 | 38.85 |
| 3rd Quartile: Average Population +/- 230 thousand | | | | |
| 2008 | 18.86 | 22.21 | 0.22 | 35.00 |
| 2009 | 20.64 | 22.20 | 0.21 | 28.57 |
| 2010 | 19.99 | 24.97 | 0.21 | 25.71 |
| 2011 | 19.85 | 24.88 | 0.22 | 23.71 |
| 4th Quartile: Average Population +/- 940 thousand | | | | |
| 2008 | 25.90 | 32.88 | 0.67 | 4.32 |
| 2009 | 26.39 | 33.47 | 0.71 | 2.88 |
| 2010 | 26.70 | 39.96 | 0.71 | 2.16 |
| 2011 | 26.92 | 38.57 | 0.71 | 3.60 |

Source: IBGE, DATASUS e MTE. Table generated by author.

Table 2 highlights this phenomenon of excess zeros by breaking the micro-regions into quartiles based on their urban population. The four variables highlighted are the homicide rate, $h$, the percent of population with formal employment, $Y/Pop$, the percent of population with formal employment in the private security industry, $y/Pop$, and the percent of micro-regions with zero formal employment private security, $y = 0$. Breaking out the micro-regions by their urban populations highlights that both homicide and formal employment rates are higher in urban areas. Additionally, while private security represents less than 1 percent of overall employment, it is much more likely in more urban centers. Finally, as noted by the final column, the percentage of micro-regions without any formal employment is much higher in less urban areas. In the smallest urban quartile, 77-87 percent of these micro-regions do not contract formal private security. However, in the most urban quartile only 2 to 4 percent of the micro-regions fail to contract formal employment.

The continued presence of excess zeros in the data set necessitates more sophisticated estimation techniques and a distribution that to treat these issues. This complication is addressed using the Zero Inflated Poisson (ZIP) distribution, which not only treats overdispersion, but also allows for the existence of two types of zeros that could either be attributed to the informal work force or low demand for private security. The ZIP distribution is explained further in the Methodology and

Modeling section.

The key explanatory variable in the data set is the homicide rate, which serves as the proxy for violence, and is measured in homicides per 100,000 inhabitants. To calculate this variable data on the total number of homicides in a micro-region is collected from the national health system, DataSUS (Data Sistema Único de Saúde), and divide that number by the region's population collected from the Brazilian Statics and Geography Institute (IBGE, Insituto Brasileiro de Geografia e Estatística). Contemporaneous and lagged values of the homicide rate are included given that individuals are likely to adjust private security holdings based on both current and past levels of violence. As young men comprise a high percentage of total homicides the percent of homicides in this demographic are included as a control (Waiselfisz 2012).

Homicide rates are assumed to be the best measure of violence citing the same assertions of Waiselfisz, 2007. The first is that even though violent behavior can be classified in a wide array of activities that fall short of homicide, such as armed robbery, death reveals violence in its most severe form. In this sense relating violence to homicides is akin to public health studies that measure the effect of an endemic by its death toll.

The second reason homicides are the best measure of violence is one of practicality—there are simply few alternatives. Trustworthy and comprehensive data on lesser forms of violence are serially under-reported, misreported, miscategorized, and prone to heterogeneity across micro-regions. Homicides, however, are easier to classify and are more likely to be reported. Considering these arguments, the homicide rate was chosen as the most appropriate proxy for violence.

The model also controls for the effects of urbanization. Glaeser and Sacerdote (1999) find that the urban crime premium is associated with the characteristics that define urban centers. The model uses two variables to control for the relationship between violence, security, and urbanization. The first variable is population density, or a region's ratio between its total population and area. The second is a dummy variable representing the region's *urban population* relative other regions. Here all micro-regions are broken into quartiles where the regions with the smallest urban population pertain to the first quartile and the most urban regions the fourth quartile. All data is gathered from IBGE.

The model is also controlled for the percent of population employed in the formal work force. As previously noted in *Table 1* both the percentage of the population in the formal workforce as well as the the percent of population formally employed in private security grew during the sample period. Trends in the general workforce are controlled for by including each micro-region's percent of population employed in the formal work force. Employment and population data were collected from the Labor Ministry (MTE) and IBGE respectively.

Poverty is also shown to be related with crime and violence, and therefore may influence a micro-region's willingness to contract security. A host of studies cite relationships between crime, violence, and poverty. Marmot et al. (1987), Towsend and Davidson (1990), and Szwarcwald et al. (1999) documented relationships between income inequality, homicide rates, and other social ills, such as crime and health. Kelly (2000) also found that the type of crime relates differently to poverty and

income inequality. Violent crime is more correlated with income inequality while non-violent crime is associated with poverty.

To capture the effects of poverty, a proxy variable is created that measures the percent of region's population receiving Bolsa Família payments. [3] This measure is calculated using data from the Ministry of Social Development (Ministério do Desenvolvimento Social) on the number of families receiving these payments.

The model also controls for numerous effects using a host of dummy variables. Realizing that cities with large penal institutions are likely to have a disproportionate number of private security guards, a dummy variable is included for whether a micro-region has a maximum security penitentiary or presidio. Data on the presence and locations of the various types of penal institutions was gathered from the Justice Ministry (Ministério da Justiça). Of note, approximately 15 percent of micro-regions have these types of maximum security facilities.

Dummy variables for each year are included to account for the tendency within Brazil for its work force to become more formal with time. Finally, a dummy variable for each Brazilian state is included to account for any possible state fixed effects which could explain levels employment trends in this sector. Some possible fixed-effects, common to individual states, could be differences in public security spending, gang activity, or the presence and degree of organized crime.

## 2.4   Methodology/Model

### 2.4.1   Poisson

Given that the dependent variable, the number of employees in the private security industry, is a necessarily a positive integer or zero ($n = 0, 1, 2, 3...$) and a random variable the canonical Poisson regression is used to model the count data (Greene 2007).

The baseline model takes the following form:

$$\lambda_{it} = E(Y|X) = e^{\alpha_0 + \ln(E_{it}/100) + \beta_1 H_{it} + \beta_2 H_{it-1} + \beta_3 Y M_{it} + \beta_4 X_{it} + \beta_5 D_i + \beta_6 D_t}$$

where $\lambda_{it}$ is the expected value of the number of workers employed in the private security sector in micro-region $i$ and year $t$, $\ln(E_{it}/100)$ is the offset where $E_{it}$ is the formal employment in the micro region, $H_{it}$ is the homicide rate measuring violence, $H_{it-1}$ is its lag, and $Y M_{it}$ is the percent of homicides where victims were young and male. $X_{it}$ is the vector of other explanatory variables which includes the general employment rate, population density, and the percent of population considered impoverished, as measured by whether they receive *Bolsa Família* payments. Also included several dummy variables. The vector of time invariant dummies $D_i$ includes the following indicators: the presence of a maximum security penal institution, a state specific dummy that captures fixed effects

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[3]   The Bolsa Família Program is Brazil's large scale and widely popular income redistribution program that provides payments to poor families provided they meet certain criteria.

(São Paulo is omitted), as well as three urbanization dummies that segment the micro-regions into their respective urban population quartile (quartile 1 is omitted). The vector of time-dependent dummies, $D_t$, includes one indicator for each year 2009-2011 (2008 omitted) to capture the effect of any time trends. $\alpha$ and $\beta$ are the parameters to be estimated.

The standard Poisson distribution takes the following form:

$$f(k|\lambda) = Pr(Y = y|\lambda) = \frac{e^{-\lambda}\lambda^y}{y!}$$

Here the probability density $f(k|\lambda)$, for the discrete random variable $Y$, the number of employees in the security industry, is a non-linear function of the expected value of the number employees, $\lambda$, and the discrete value $y$ that the random variable assumes. In terms of the model, this density function expresses the probability that the number of employees in the security sector $Y$ will be equal to a certain number $y$.

### 2.4.2 Zero Inflated Poisson

The data set exhibits two characteristics that prevent estimations of the model with the standard Poisson distribution. The first relates to standard assumption of the baseline Poisson of *equidispersion* meaning the expected value and variance are assumed to be equal ($E[Y] = \lambda = Var[Y]$). However, as previously addressed in the data section, the excess zeros make the data set prone to *overdispersion*.[4] It is therefore not possible to assume that the expected value of security employees is also equal to its variance.

A common way to treat overdispersion is the Negative Binomial distribution. However, a second characteristic of the data set, the fact that zeros originate from different sources, also invalidates this option. As previously mentioned, given the large informal work sector in Brazil it is likely that zero employment in the private security sector is likely a result of one of two causes: 1) there is no demand for private security employment in either a formal or informal capacity or 2) there exists demand for private security employment but this demand is filled by the informal sector. Both causes register zeros in the data set. The model therefore requires a technique that also allows for the possibility that data generation process yields zeros from these two distinct distributions. To account for this possibility the Zero Inflated Poisson (ZIP) distribution of Lambert, 1992 is used.[5]

The seminal Lambert ZIP model (1992), which considers counts of manufacturing defects, explains how two types of zeros could exist. The first type of zero originates from a binary distribution which is determined by whether the manufacturing process is operating in a perfect state. *If* the process is operating perfectly, then zero manufacturing defects are assumed to occur. However, zeros are also possible when the process is operating in an *imperfect* state. In this case, this second type of zero, comes from the count distribution. These zeros result from the fact that even when the

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[4]  Cameron Trivedi 2005, page 668-671
[5]  Estimation via the Negative Binomial distribution was attempted without success.

the manufacturing is imperfect, zero defects are still possible. In this example, the majority of the manufactured products are defect free (zero defects) because the process was operating in a perfect state. However, some products also arrive without defects even though the process was acting in an imperfect state.

Analogous to Lambert, the two types of zeros in the private security sector are represented as follows: Type I zeros, which originate from the *binary distribution*, are attributed to *other factors* that lead certain micro-regions not to *formally* contract employees in private security, analogous to the manufacturing process operating in a perfect state. In other words, these zeros could be attributed to certain micro-region's general reluctance to contract private security. One possible explanation is that certain regions, particularly the less populated, may be more averse to formally contract labor, preferring to contract security in the informal market.

The Type II zeros originate in the *count distribution*. These zeros are attributed to factors in the model such as levels of violence and urbanization. These zeros may be explained, for example, by the fact that certain micro-regions choose not to contract workers because levels of violence are low. This type of zero considers that a micro-region may be reluctant to contract *either* formal or informal labor. In this example, differing perceptions of violence may induce some regions to heavily invest in security and others to contract zero employees, but both outcomes have origins in the same count distribution.

As presented in Cameron and Trivedi (2005) the probability relationships that the random variable takes a certain value is based on two distinct distributions:

$$Pr(Y = y) = g(y) = \begin{cases} f_1(0) + (1 - f_1(0))f_2(0) & \texttt{if } y = 0 \\ (1 - f_1(0))f_2(y) & \texttt{if } y \geq 1 \end{cases}$$

or in the expanded form

$$Pr(Y = y) = g(y) = \begin{cases} f_1(0) + (1 - f_1(0))e^{-\lambda} & \texttt{if } y = 0 \\ (1 - f_1(0))\frac{e^{-\lambda}\lambda^y}{y!} & \texttt{if } y \geq 1 \end{cases}$$

These equations take into consideration two distinct density functions. The first density function, $f_1(\cdot)$, represents the binary process of whether a micro-region is predisposed to contracting private security officials in the formal labor market. In this sense, the micro-region either does or does not hire. The second distribution, $f_2(\cdot)$, represents the count density, or the probability that a micro-region will contract a certain value of employees in the formal private security sector.

The first equation in each set considers the two distinct possibilities for a micro-region to contract zero workers. The first term $f_1(0)$ represents the binary density that zeros attributed to the fact that the micro-region is predisposed to not contracting this labor. However, zeros can also be a product of the count distribution. Here, the second term, $(1 - f_1(0))f_2(0)$ (or alternatively $(f_1(1))f_2(0)$) considers the probability that a micro-region fails to contract zero employment, presumably due to lack of demand, *even if* it is amenable to contracting formal security.

The second equation models outcomes where the number of security workers are not zero. For this to be the case, two criteria must be met. The first is that the binary distribution $f_1(\cdot)$ must be unity. The second is that the count process, $f_2(\cdot)$, must generate a necessarily positive integer (such as $1, 2, 3...$). The binary process is modeled using Logit, while the count process, now corrected for excess zeros, is modeled using a standard Poisson process.

Parameters are obtained using Maximum Likelihood Estimation to solve for $\alpha$, $\beta$ as well as the binary distribution, $f_1(\cdot)$, and the count distribution $f_2(\cdot)$.

### 2.4.3 Fear Index

Building upon the baseline model that predicts the expected number of employees in the private security industry, the *Fear Index* is created. This index relates the model estimated number of security employees in a given micro-region (the factual) to the number of employees that would be contracted in the *hypothetical absence* of homicidal violence (the counterfactual). The index takes the following form:

$$FEAR_{i,t} = \frac{E(Y|X, H = H^*)}{E(Y|X, H = 0)} = \frac{\lambda_{factual}}{\lambda_{counterfactual}}$$

In long form the Fear Index is viewed as:

$$FEAR_{i,t} = \frac{e^{\alpha_0 + \ln(E/100) + \beta_1 H_{it} + \beta_2 H_{it-1} + \beta_3 Y M_{it} + \beta_4 X_{it} + \beta_5 D_i + \beta_6 D_t}}{e^{\alpha_0 + \ln(E/100) + \beta_4 X_{it} + \beta_5 D_i + \beta_6 D_t}} = e^{\beta_1 H_{it} + \beta_2 H_{it-1} + \beta_3 Y M_{it}}$$

The numerator reflects the model-predicted amount of private security when $H = H^*$, such that $H^*$ is the observed amount of homicides in a given micro-region. The denominator represents the amount of security contracted when the number of homicides is artificially set to zero, or $H = 0$. Because individuals are assumed to contract more private security when perceived levels of insecurity rise, the *Fear Index* could reflect the amount of fear attributed to homicidal violence. In this sense, one can consider an individual's utility a decreasing function of the homicide rate and fear. Therefore, the higher the index, the more security a micro-region contracts, the greater the fear of homicidal violence, and the lower the ceteris parabis level of utility in that region.

It is appropriate to consider some of the implications in the construction of the Fear Index, particularly setting the number of homicides to zero. One consideration is that the model, when adjusted for zero homicides, reflects the *natural rate of private security* demanded by society. This is the amount of security society is willing to contract for reasons *other than* homicidal violence. This baseline level of private security is largely captured by the model's constant term.

Another implication of artificially setting the homicide rate to zero is the necessity to consider, and distinguish between, the the myriad forces responsible for generating violence. The model controls for various social factors, such as poverty, urbanization, and employment, all of which affect the homicide

rate to varying degrees. However, a growing wealth of literature suggests that other variables, in addition to social factors, are partly responsible in violence generation. Raine (2013), Gat (2006), and Seabright (2004) suggest that violence is also rooted in human nature and biological factors as the result of evolutionary processes. It is in this sense that these factors, in addition to social factors, play a role in generating violence. This line of research suggests that the homicide rate is necessarily non-zero, due to these biological and evolutionary factors. Therefore, a certain baseline level of homicidal violence is a *natural* outcome in society regardless of varying social factors or circumstances.

This research, based upon biological considerations, suggests that setting $H = 0$ in the Fear Index is artificial because zero violence is not a natural outcome. Both society and biology dictate otherwise. Instead the natural, baseline level of violence occurs when $H = H^{**}$, where $H^{**}$ is the non-zero *naturally* occurring number of homicides. The implications of a *natural rate of violence* within society pose numerous political and social implications. Specifically, these results imply that despite society's best efforts to create a safer and more equal society by controlling and manipulating social factors, there will always exist a baseline, or *natural* level of violence, based upon biological or evolutionary factors.

However, while these considerations are important to understanding the premises of the model, they do not alter the fundamentals, utility, or practical application of the Fear Index. Despite the fact that there exists a non-zero *natural rate of violence* in society, homicides, for any motive, tend to generate fear. In this sense, it is trivial whether the origin of a homicide is based upon biological, evolutionary, or social factors—individuals will take measures to protect themselves against all forms of violence. Individuals are predisposed to contracting more private security regardless of whether homicides occurred for strictly social motives, such as income inequality, or for biological ones, as a hedge against the ever present "natural born killers" in society. This end result implies that a *natural rate of violence* implies a baseline level of fear in society and a corresponding *natural rate of private security* to mitigate this fear.

## 2.5   Results and Interpretation

This section is divided into two parts. The first explains and interprets the results of the baseline ZIP model. The second focuses on the Fear Index and explains the relationship between Fear and Violence while identifying the behavior of the micro-regions.

### 2.5.1   Baseline model Results and Interpretation

The baseline model, which predicts the expected value of employees in the private security sector given a host of explanatory variables, shows numerous robust results. As noted in Table 3 the explanatory variables relating to violence and several of control variables are highly significant.

Table 3 – ZIP Regression Results, Coefficients, Incidence Rate Ratio and Inflate

Dependent Variable: Private Security Employment– State dummies omitted

| PS Employment | (1) Beta | (2) IRR | (3) Inflate |
|---|---|---|---|
| Homicide Rate | 0.010*** | 1.0101*** | -0.003 |
| | (0.002) | (0.002) | (0.008) |
| Homicide Rate Lag | 0.004** | 1.0041** | -0.024*** |
| | (0.002) | (0.002) | (0.008) |
| Young Male | 0.009*** | 1.0090*** | -0.012** |
| | (0.003) | (0.003) | (0.005) |
| Employment Rate | 0.005** | 1.0052** | -0.040*** |
| | (0.002) | (0.002) | (0.012) |
| Population Density | 0.116*** | 1.0001*** | -1.11 |
| | (0.013) | (0.013) | (1.097) |
| Poverty | -0.054*** | 0.9472*** | 0.049*** |
| | (0.006) | (0.006) | (0.015) |
| Penal Institution | 0.251*** | 1.2850*** | 0.006 |
| | (0.067) | (0.067) | (0.293) |
| d2009 | -0.01 | 0.9897 | -0.247 |
| | (0.037) | (0.037) | (0.189) |
| d2010 | -0.034 | 0.9664 | -0.379** |
| | (0.043) | (0.043) | (0.185) |
| d2011 | 0.011 | 1.0108 | -0.590*** |
| | (0.037) | (0.037) | (0.189) |
| 2.quartil | -0.065 | 0.9371 | -1.755*** |
| | (0.31) | (0.31) | (0.187) |
| 3.quartil | -0.24 | 0.7867 | -2.403*** |
| | (0.308) | (0.308) | (0.205) |
| 4.quartil | 0.105 | 1.1102 | -4.640*** |
| | (0.288) | (0.288) | (0.381) |
| Constant | -1.027*** | 0.3581*** | 2.849*** |
| | (0.327) | (0.327) | (0.651) |
| | | | |
| Observations | 2,232 | 2,232 | 2,232 |

Robust standard errors in parentheses

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

Column (1) highlights regression results for predicted levels of private security employment originating in the count distribution. For example, the coefficients for the homicide rate and its lag in column (1), are significant at the 1 and 5 percent level respectively, and with the expected positive sign. These results imply that increased holdings in private security are explained by increases in homicidal violence. The coefficient for the percent of homicide victims that are young males is also positive and significant at the 1 percent level. Key control variables are found to be highly significant at the 1 percent level and have the expected sign. The general employment rate is positive and significant reflecting that private security employment increases with general employment. Population density, which considers a micro-region's urban population relative to its area, is also positive and significant controlling for possible effects of urbanization. The poverty indicator, the percentage of the population receiving Bolsa Família, is negatively correlated and highly significant implying that more impoverished regions have less propensity to contract private security. Additionally the presence of a maximum security penal institution is also significant at the 1 percent level and *positively* correlated controlling, therefore controlling for the increased presence of private security guards in these micro-regions. Dummy variables for the years 2009-2011 were not significant suggesting a lack of time trend.

A challenge of non-linear models is interpreting the magnitude of the coefficients. In the case of Column (1), while sign and significance have direct interpretation, the magnitude of the coefficients do not. Unlike linear model counterparts, where beta coefficients capture the marginal effect of a change in a explanatory variable, often expressed as an elasticity or semi-elasticity, non-linear coefficients can not be interpreted as such. As the partial derivative of a non-linear model remains a function of both the regressors and parameters the direct interpretation of the marginal effect is no longer possible (Cameron and Trivedi, 2005 pg 122). Instead the coefficients have an interpretation of difference in logs of the expected amount of employment. In this sense the coefficients in Column (1) explain that for a one unit change in an explanatory variable, the difference in logs of the dependent count variable (employment) is expected to change by the respective regression coefficient, all other variables held constant (UCLA 2014).

Given that the difference in logs provides limited direct interpretation the Incidence Rate Ratio (IRR) is provided in Column (2), to obtain more clarity. The IRR, which is obtained by exponentiating the Poisson coefficient in Column (1), facilitates interpretation about how a dependent variable reacts given a marginal change in the independent variable (UCLA 2014). For example, the homicide rate's IRR presented in Column (2) implies that if the homicide rate increased by one point (an increase of 1 homicide per 100,000 inhabitants) the rate ratio for the number of expected private security employees would be expected to increase by a factor of 1.0101, while holding all other variables constant. This is equivalent to saying a one unit increase in the homicide rate is expected to raise employment in private security by roughly one percent. Furthermore, IRRs that are greater (less) than unity imply positive (negative) correlations.

Similar relationships exist for other explanatory variables. The homicide rate lag, the percent of homicides that were young and male, the employment rate, and population density all predict increases

in private security employment by factors ranging from 1.004 to 1.009. These results imply that a one unit change in these variables leads to an approximate 0.4 to 0.9 percent increase in employment. The poverty variable demonstrates the case of a negative relationship between variables given that its IRR is less than unity. In this case employment is expected to *decrease* by a factor of 0.9472 given a 1 percent increase in the percent of population receiving welfare payments. This result implies a greater than 5 percent decrease in the amount of security contracted, all else being equal. This is by far the largest magnitude effect of the significant variables considered. Additionally, the dummy for the presence of a maximum security penal institution implies that micro-regions with these institutions are predicted to have a factor of 1.285 times greater for the number of employees in private security than micro-regions without these facilities—a premium of nearly 29 percent.

Column (3) explains the Type I zeros that originate in the binary distribution, or in other words, are likely the result of a micro-region's reluctance to *formally* contract private security. Of note, the dummy variables for quartiles are all statistically significant, with negative sign, and increase in magnitude with the urban population. This result implies that the most urban micro-regions (quartile 4), are less likely to have Type I zeros (zeros due to the informal labor market), than their less urban peers. This result corroborates the results presented in Table 2 which showed that less urban areas are less likely to formally contract private security. The sign of the poverty coefficient is positive and significant suggesting that perhaps impoverished areas are less likely to formally contract private security and may prefer the informal market. The coefficients for the percent of homicides that are young and male, the homicide rate lag, the employment rate, and the 2010 and 2011 dummy variables are also significant. These admittedly curious have no immediate explanation.

The 26 dummy variables representing all Brazilian states as well as the capital region, Brasília, were excluded from Table 3. All estimates take into account robust variance (Cameron and Trivedi 2005).

Generally the predictive model demonstrates a good fit with the data. As presented in Table 4, Model Verification, the model predicted employment in private security, $y\,predicted$, closely approximates the actual data set, $y$, at over 99 percent. Further, the high $R^2$ value suggests that most variance is explained.

## 2.5.2 Fear Index Results and Interpretation

In addition to modeling the determinants of private security, one of the main contributions of this paper is the identification of where the diverse Brazilian micro-regions place on the spectrum of fear and violence. This section uses graphics, tables, and maps to visually aid in the interpretation of the patterns of fear and violence for several key categories of micro-regions. The first step is to identify standard and non-standard behavior among micro-regions. The first group identified are the compliers that behave as predicted. Next considered is the group of micro-regions that defy predicted behavior. These defiers are defined by their common characteristic that their levels of fear exceed their

Table 4 – Model Verification

| VARIABLE | y |
| --- | --- |
| y predicted | 0.994*** |
|  | (0.002) |
| Constant | 14.993 |
|  | (16.488) |
|  |  |
| Observations | 2,232 |
| R-squared | 0.992 |

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

corresponding levels of violence at the 5 percent significance level. In the second step the interplay between violence and fear is considered, highlighting the characteristics of the most violent, most fearful, and most populous micro-regions, while paying careful attention to how the defier regions integrate in these categories. Finally, various state and regional maps are presented to facilitate spatial analysis of the relationship between violence and fear, to highlight possible contagion effects between micro-regions.

The range of values in terms of both homicide rates and fear speaks to the diversity of Brazil's micro-regions on the spectrum of fear and violence. In terms of homicide rates, micro-regions vary from extremely safe with zero homicides, as in the case of the tranquil island resort Fernando de Noronha, to some of the most violent in the world such as Maceió, Alagoas and Marabá, Pará, with annual rates ranging from 100 to 110 homicides per 100,000 inhabitants. The levels of fear associated with this violence are equally diverse ranging from 1, implying no increased security presence due to homicidal violence, to over 22, where homicidal violence clearly plays a large role in a region's decision to contract private security. Additionally, micro-regions vary in their relative relationships between fear and violence. In the vast majority of micro-regions, complier behavior dominates, and fear and violence follow the predicted relationship in which fear is an increasing function of violence. However, some micro-regions behave differently than expected, sometimes dramatically, exhibiting a disproportionate amount of fear relative to its homicide rate.

Figure 1 provides a general summary of the relationship between fear and violence from 2008-2011. For each year the natural log of fear for each of the 558 micro-regions is plotted against its homicide rate. As expected, fear increases as homicide rates rise. The trend lines demonstrate this predicted positive relationship between the two variables. However, a large percentage of the micro-regions exhibit defying behavior as characterized by the observations displaced furthest from the trend line. Micro-regions below the trend line represent the Type II Defiers characterized by low levels of fear relative to violence. Type I Defiers, on the other hand, exhibit proportionally higher levels of fear, and are located above the trend line.
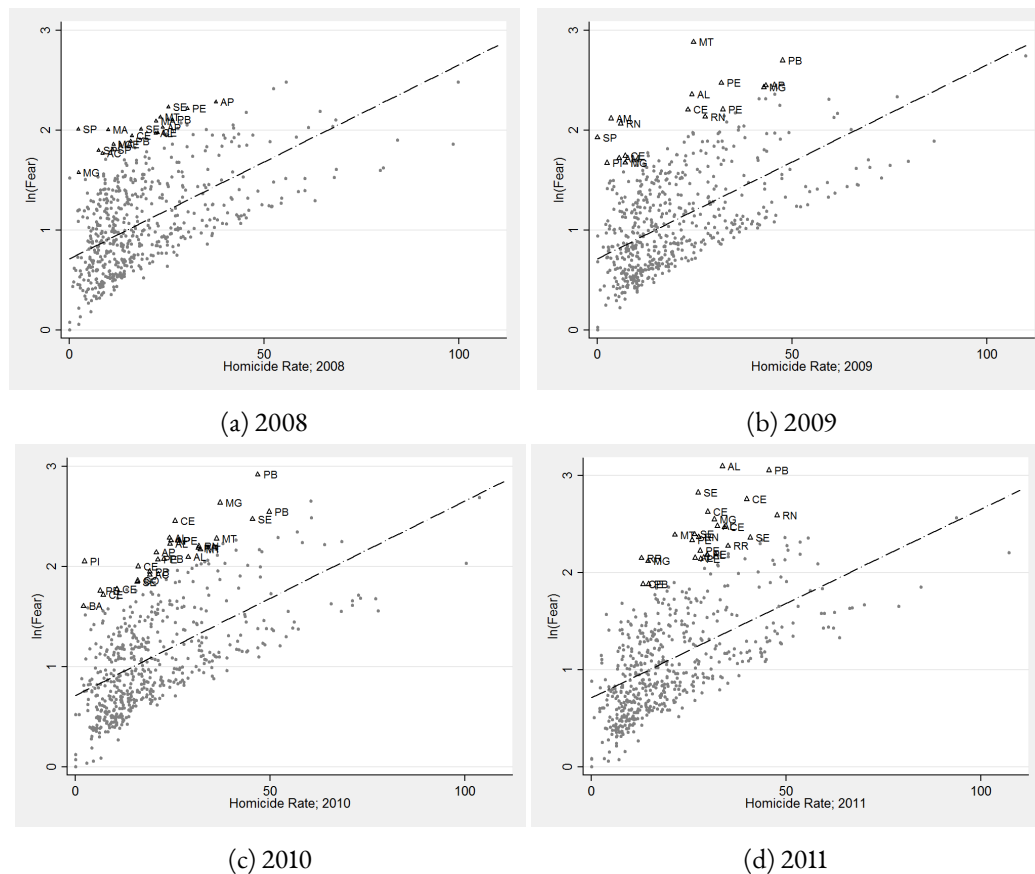
Figure 1 – Scatterplot of ln(Fear) vs Homicide Rate. Defiers annotated by state. Figure generated by author.

### 2.5.3 The Nature of the Type I Defiers

This study considers defiers that are statistically significant at the 5 percent level, or in other words, are at least 1.96 standard deviations away from the mean. The micro-regions representing defier behavior are identified in the upper part of Figure 1 with their corresponding state abbreviation code. Only Type I defiers are significant at the 5 percent levels. Visually it is apparent that the dispersion of fear increased along the years such that overtime the Type 1 defiers even became more diffused.

The concept of defiers and compliers is also represented in Table 5. Quadrants II and IV exhibit complier behavior such that low (high) levels of violence are matched by low (high) levels of fear. The more curious results relate to the defiers represented in Quadrants I and III. Quadrant I highlights the Type II defier where high levels of violence are not matched by high levels of fear, and are illustrated as the points below the trend line in Figure 1. While the data has Type II defiers, none are more than 1.96 standard deviations from the mean.

Quadrant III explains the Type I defier. This defier, which is more prevalent in the data, explains the micro-regions with high levels of fear despite relatively low levels of violence. The micro-regions above the trend line exhibit Type I behavior at varying degrees. As previously mentioned, the threshold in the analysis to be considered a Type I *fearful* micro-region is exhibiting behavior at least 1.96 standard

Table 5 – Defiers and Compliers

| | | Violence | |
|---|---|---|---|
| | | Low | High |
| Fear | Low | Complier | Defier (Type II) |
| | High | Defier (Type I) | Complier |

deviations from the mean.

Table 6 in Appendix 1 names the Type I Defiers and summarizes each of the micro-region's fear and homicide rates in the years that they demonstrated abnormally high levels of fear, along with their population in 2010. The micro-regions identified as defiers also represent a certain degree of diversity, however some commonalities also exist. Of the 53 micro-regions considered (25 of which are defiers in multiple years), 35 are from the Northeast of Brazil. Of the remaining, 9 are from the North Region, 5 from the Southeast, and 4 from the Central West. No Type I defiers are from the South Region. These fearful micro-regions also vary considerably in terms of population, ranging from 20,000 inhabitants to over 300,000.

## 2.5.4   Top Ten Most Violent Patterns

Identification of patterns of fear among the most violent micro-regions in Brazil is also an objective of this research. Tables 7-10 list the Top Ten most violent micro-regions where homicide rates range from 62.1 to 110. Maceió, the capital of Alagoas, and Marabá, Pará have the dubious distinction of topping these lists. Maceió garnered the position of Brazil's most violent (and among the most violent in the world) with a rate of 107.3 in 2011. Marabá had the highest overall level of violence with a rate of 110 in 2009. Similar to the defiers, these most violent places were concentrated in the Northeast and North Regions. Of the 40 micro-regions listed, eight are from the state of Pará while Alagoas and Espirito Santo each have seven. The populations of these micro-region's range from among the smallest in Brazil, with Alto Paraguai, Mato Grosso and its 20,000 inhabitants, to among the nation's largest metropolitan areas including the capitals of Salvador, Recife, Vitória, João Pessoa, and Maceió.

Generally, these micro-regions behave as compliers such that their high levels of violence are matched in kind by high levels of fear. The notable exception is Alto Paraguai which showed uncommonly high levels of fear in 2009-2011. Interestingly in 2008, violence in this micro-region spiked to 67.6 earning it the 9th most violent place in the country. In the subsequent three years levels of violence lowered to a more reasonable 24.6, 36.2, and 21.4 respectively, but fear remained stubbornly high. As seen in Table 12, in 2009, the year after the micro-region placed ninth nationally in homicide rates, Alto Paraguai became Brazil's number one most fearful micro-region.

### 2.5.5   Top Ten Most Fearful Micro-Regions

Tables 11-14 exhibit that characteristics of the Top 10 most fearful micro-regions from 2008-2011. Upon analysis similar themes recur. The Northeast Region continues to be over-represented garnering 25 of the 40 places. These tables also make clear, at least among the most fearful micro-regions, that levels of fear increased year after year. For example, in 2008 the highest level of fear nationally was 12 and by 2011 it nearly doubled to a high of 22.1. The populations of these micro-regions are similar to the defiers presented in Table 6 ranging from approximately 26,000 to 300,000. In addition to previously mentioned Alto Paraguai, MT the only other micro-region included on both the most fearful and violent lists is Marabá. Here Marabá behaves as a classic complier where its extreme levels of violence were matched by some of the nations highest levels of fear. Marabá was the second most fearful micro-region in the nation from 2008-2010, and the seventh overall in 2012.

However, in contrast to the most violent places in Brazil, a majority of these micro-regions (25 of 40) are also identified as Type I defiers on Table 6. One example is Alagoana do Sertão do São Francisco, Alagoas. From 2009 to 2010 this region's homicide rate leaped from 24.2 to 60.4, a 2.5 fold increase. The subsequent year, 2011, this micro-region registered as the most fearful in the entire sample. In this case it seems fear reacts, often pointedly, to volatility in the homicide rate.

### 2.5.6   Largest Micro-Region Patterns

The next category of micro-regions considered on spectrum of fear and violence are the most populous micro-regions in Brazil, highlighted in Tables 15-18. These large and important micro-regions generally exhibit complier behavior such that increases in violence are matched by increases in fear. For example, São Paulo state, which is home to eight of Brazil's largest 20 micro-regions, generally exhibits low levels violence, but also low fear, when compared to other populous micro-regions. For example, the capital of São Paulo, with a homicide rate of 12.2 in 2011 had a Fear Index of 1.8. For comparison, Rio de Janeiro and Salvador had a homicide rates of 29.7 and 66.9 and Fear Indices of 2.5 and 5.1 respectively. Additionally the more violent metropolises of Salvador, Recife and Vitória registered homicide rates ranging from 60 to 80, but also realized much higher levels of fear. Of note, these large and populous micro-regions has a tendency toward violence and fear as in any given year 11 out of the 20 micro-regions exceeded a homicide rate of 30. These same areas exhibited correspondingly high levels of fear.

### 2.5.7   Spatial Analysis

Incorporating regionalized maps that juxtapose violence and fear allow for a spatial analysis of fear and violence in Brazil. Principally maps aid in finding possible contagion effects between micro-regions in the sense that one micro-region may choose to contract more security in response to high levels of violence in a neighbor.

As seen in Figures 2-25 in Appendix 1, these maps visually display violence along side fear. The darker shades reflect a more violent micro-region. Additionally, a black dot is added to the micro-regions that reflect Type I defier behavior, and thus express excess fear.

For example Figure 5 shows the 2011 map for the Brazilian state of Alagoas. The most darkly shaded area on the coast is Maceió, one of the most violent areas in the world with a homicide rate of 107. However, the absence of a black dot on this micro-region indicates that levels of fear in this area are in line with levels of violence. To the northeast of Maceió is the micro-region Litoral Norte Alagoano, which has a comparatively modest homicide rate in the range of 25-50 (its actual rate in 2011 was 30). The presence of a black dot on this region indicates this region has excess fear. Considering the proximity of these two micro-regions it is logical to wonder whether violence in Maceió is causing additional fear in Litoral Norte Alagoano.

While this contagion is certainly possible, it is more difficult to accept this outcome with certainty. Considering the fact that several other highly fearful micro-regions exist in the state do not border Maceió, perhaps other forces are at work in addition to contagion. It is by no means certain to conclude contagion is responsible for elevated levels of fear in certain areas. However, spatial analysis provides the starting point for further investigation.

The superficial analysis of simply noting the relative position between violent and excessively fearful micro-regions could be fruitful, but given the diverse causes of fear, it is also limited. However, these visual aids coupled with context and local knowledge could become important tools in discovering other forces at work that cause excess fear. For example, an untrained eye may only be able to characterize the more obvious patterns that relate the proximity of defiers to more or less violent areas. However, an individual armed with additional knowledge and context of certain micro-regions may be able to identify other possibilities excess fear.

For example, when analyzing Figure 21, which plots the Northeast region in 2011, one may note that that dark gray artery that extends deep into the region is fraught with violence. One may further notice a cluster of defier regions in the several of the non-coastal micro-regions within this band of gray forming a diamond pattern. At this point further analysis is not possible without more information. However, a person with more local knowledge may readily realize that this cluster of highly fearful regions rests in the heart of Brazil's Marijuana Polygon (Polígono da Maconha)[6]. This kind of knowledge may beg the question of whether drug trafficking is responsible for these micro-region's excess fear?

These maps visually express the relationship of violence of fear. Figures 2-25 tell the story of the North and Northeast regions along with some of their most violent and fearful states—Alagoas, Pará, and Pernambuco. Espirito Santo, which has a heavy concentration of defiers is also included. Alagoas has high levels of violence but also significant excess fear. In contrast, Pará and Espirito Santo, both violent states, do not have any defiers. In thess case violence seems to explain fear in these states. In

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[6]    The Polígono da Maconha is a region in Pernambuco state (Figures 14-17) of heavy marijuana cultivation (Souza, 2014)

Pernambuco the amount of defiers increases overtime while the micro-regions continue with moderate to high levels of violence. Looking at regional trends, the Northeast has consistently high levels of violence compared to the rest of the country. Additionally the defiers seem to increase and concentrate over time in the states of Pernambuco and Alagoas. The North region shows great geographical areas with little violence, however certain states, such as Pará, with extreme levels. Discernible patterns for defiers are less obvious in the North.

## 2.5.8 General Trends Among Categories

Admittedly, it is a difficult task to identify patterns of violence and fear given the diversity of Brazil's micro-regions coupled with the limitation of only four years of observations. Despite this challenge, this research conjectures at some possibilities of how, and perhaps why, certain micro-regions defy expectations and exhibit excess levels of fear. The first focus is on the relationships between the most violent and fearful micro-regions in Tables 7-14 that also exhibited Type I Defier behavior as shown on Table 6.

Two micro-regions on the Table 6 list of defiers were previously considered. Alto Paraguai, Mato Grosso seemed to react to a spike in violence in 2008 with elevated fear that slowly decayed in the following years. Alagoana do Sertão do São Francisco, Alagoas, which registered the highest overall level of fear in the sample, seemed to have followed a similar pattern where in the year following a large increase in violence, the level of fear spikes. Interestingly, in both these cases the increase of fear was not contemporaneous and required one year to manifest. This reactionary pattern of increases in fear following spikes in homicides seems prevalent among several of the micro-regions.

The differences in these reactions seem to depend more on the reaction time and persistence of the reaction. Several micro-regions seemed to react immediately to spikes in violence, while others waited to incorporate the information. Further the persistence of fear is not uniform. Some micro-regions remain with elevated levels of fear, while others tend to recover more quickly when homicide rates return to *normal*. The analysis of some micro-regions do not allow for a discernible pattern. For example, Caririaçu, Ceará is the only micro-region that is a defier in all 4 years considered, realizing high levels of fear despite relatively low levels of violence.

But that is one of the fundamental points of this research, to identify which micro-regions defy predicted behavior to allow for a starting point for further investigation. In the case of Caririaçu, as with all other micro-regions that exhibit excess levels of fear, more information is required to explain these regions behavior. Perhaps with more context about the nature of *other factors* that lead individuals to contract private security, the behavior of these defiers could be understood.

Spatial analysis adds a new dimension to the identification of trends and patterns among the micro-regions, particularly in regards to identifying contagion between regions. Using the spatial dimension allows for analysis to observe how violence may or may not cluster, whether it has potential spill over effects, or even if patterns of fear and violence are related to a larger geographic phenomenon

such as drug trafficking.

## 2.6 Discussion

Identification of the trends and patterns of violence and fear in Brazil is among the chief goals of this research. These results highlight one more way that violence takes a toll on Brazilian society...by propagating fear. In this sense this paper shows that micro-regions really do adjust their private security holdings in relation to their perceptions of violence.

In the case of compliers a connection between fear and violence is demonstrated. In these cases it is more clear that people behave in a predictable manner to promote their own personal safety and mitigate fear. More simply, individuals tend to increase their expenditures on private security as violence increases. In these cases individual's perceptions of fear seem to be validated. Micro-regions exhibiting complier behavior seem to more accurately perceive information about homicidal violence. Nonetheless, the costs on society associated with elevated levels of fear, even in complier regions, are substantial.

In the case of defiers, especially the Type I fearful defiers, it is shown that violence is not enough to explain these excesses. In this sense, this work provides the foundation from which to depart to analyze the factors other than violence that are causing certain micro-regions to contract an abnormal amount of private security to assuage their fear.

Does this mean that the defier micro-regions fail to perceive violence correctly? The simple answer is no, not necessarily. In some instances it seems that defiers react to increases in homicidal violence as in the cases of defiers where fear elevated in the years subsequent to a homicide spike. Yet in other instances, defiers exhibited high and constant levels of fear despite relatively low levels of homicidal violence. It is certainly possible, and more likely plausible, that individuals are accurately perceiving their security, and that *other factors* are causing these excesses of fear. It is in the spirit of the Solow Residual (Solow 1956) that the challenge remains to explain these *other factors* that reside in the residual and dictate the behavior of these defiers.

Some *other factors* possibly influencing fear are a micro-region's expenditures on public security, non-violent crime rates, non-homicidal violent crime rates (such as armed robberies), crime solution rates, trust in or performance of the police force, contagion, or even drug trafficking. Still another possibility is access to information. This possibility considers whether an individual's decisions could be biased toward recent news in the form of a *Availability Heuristic* (Tversky and Kahneman 1973). One conceivable example of the availability heuristic increasing fear and perceptions of violence could be related to an individual's access to news. If an individual monitors a news channel that frequently reports on violent crime in other micro-regions, such as Globo News, it is possible that this increased exposure could bias an individual to overestimate the likelihood of violence, thus distorting one's perceptions away from reality.

In the sense that the model fails to incorporate all possible determinants of fear this research provides a second best solution that strikes a balance between an ideal model and a practical one. That being said, several factors remain in the Solow Residual to be explained. This research, however, provides a point of departure to explore these other factors that generate fear in society.

## 2.7 Conclusion

In this paper, robust statistical relationship is documented between the number of employees contracted in the private security industry and a host of explanatory variables, to include homicidal violence. While using employment in the private security industry as a proxy for fear, this baseline model is built upon to construct a *Fear Index* that relates predicted and counterfactual employment in private security to assess the role that homicidal violence plays in perpetuating fear in society. In this sense this paper fills a void in the literature on violence by providing a quantitative measure to capture perceptions of fear and violence in society. A major contribution of this research is the identification of how Brazil's most violent, most fearful, and most populous regions rate on the spectrum of fear and violence. In the case of compliers, or micro-regions that behave in a predictable manner, this research highlights another toll violence takes on Brazilian society. Meanwhile, the identification of defiers provides a starting point for further analysis of the various other factors that contribute to and heighten fear in society.

## 2.8   Appendix 1

Table 6 – Type I Defiers*: High Fear and Relatively Lower Homicide Rate

| State | Micro-Region | Fear | | | | Hom. Rate | | | | Pop |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2008 | 2009 | 2010 | 2011 | 2008 | 2009 | 2010 | 2011 | 2010 |
| SE | Agreste de Lagarto | 7.5 | | | 10.6 | 18.4 | | | 40.8 | 115.1 |
| AL | Alagoana do Sertão do S. Fco.*** | | 10.6 | | 22.1 | | 24.2 | | 33.6 | 80.4 |
| PE | Alto Capibaribe | | | | 8.5 | | | | 28.0 | 268.7 |
| MT | Alto Guaporé | | | 8.8 | | | | 32.0 | | 68.7 |
| MA | Alto Mearim e Grajaú | 8.1 | | | | 22.2 | | | | 292.6 |
| MT | Alto Paraguai** | | 17.9 | 9.8 | 10.9 | | 24.6 | 36.2 | 21.4 | 28.4 |
| PI | Alto Parnaíba Piauiense | | 5.3 | 7.8 | | | 2.4 | 2.3 | | 43.0 |
| AP | Amapá | 7.6 | | | | 23.9 | | | | 20.9 |
| RN | Angicos | | 7.9 | | | | 6.0 | | | 50.1 |
| PE | Araripina | | | 7.9 | | | | 21.2 | | 307.0 |
| SP | Auriflama | 7.5 | 6.9 | | | 2.2 | 0.0 | | | 44.7 |
| SP | Bananal | 6.0 | | | | 7.4 | | | | 26.9 |
| CE | Barro | | | | 6.6 | | | | 13.2 | 90.7 |
| AL | Batalha*** | 7.2 | | 8.1 | 11.9 | 22.1 | | 28.9 | 32.4 | 92.7 |
| PB | Brejo Paraibano | | | | 6.6 | | | | 14.6 | 116.2 |
| CE | Brejo Santo | | | 7.4 | | | | 16.0 | | 99.9 |
| SP | Campos do Jordão | 6.1 | | | | 11.1 | | | | 72.0 |
| RR | Caracaraí | | | 8.9 | 9.7 | | | 31.5 | 35.1 | 42.8 |
| CE | Caririaçu*** | 7.0 | 9.1 | 11.6 | 13.8 | 16.0 | 23.2 | 25.6 | 29.9 | 56.9 |
| RN | Chapada do Apodi | | 8.4 | 9.0 | 10.7 | | 27.6 | 31.7 | 27.5 | 72.6 |
| GO | Chapada dos Veadeiros | | | 6.4 | | | | 16.0 | | 62.6 |
| MA | Coelho Neto | 7.4 | | | | 9.9 | | | | 80.6 |
| CE | Coreaú | | 5.7 | 5.9 | | | 7.1 | 10.7 | | 56.2 |
| AC | Cruzeiro do Sul | | | 6.8 | | | | 19.1 | | 128.6 |
| PB | Esperança | 6.6 | | 8.0 | | 15.7 | | 22.7 | | 52.9 |
| MA | Gerais de Balsas | 6.4 | | | | 11.3 | | | | 124.0 |
| PE | Itaparica*** | | 11.9 | | 10.3 | | 31.8 | | 25.8 | 129.0 |
| AM | Japurá | | 8.3 | | | | 3.4 | | | 29.3 |
| AL | Litoral Norte Alagoano | | | 9.8 | 8.9 | | | 24.1 | 29.7 | 66.5 |
| PB | Litoral Sul | 8.2 | | 18.5 | 21.2 | 26.4 | | 46.8 | 45.6 | 83.3 |
| BA | Livramento do Brumado | | | 5.0 | | | | 2.0 | | 97.7 |
| MG | Mantena*** | | 11.3 | 14.0 | 12.8 | | 42.7 | 37.1 | 31.6 | 62.1 |
| AP | Mazagão | | | 9.6 | | | | 24.5 | | 69.4 |
| CE | Médio Jaguaribe*** | | | | 15.8 | | | | 39.8 | 62.7 |
| SE | Nossa Senhora das Dores | | | 6.3 | | | | 15.8 | | 63.3 |
| AP | Oiapoque*** | 9.8 | 11.6 | 8.5 | | 37.6 | 43.2 | 20.7 | | 27.8 |
| CE | Pacajus | 7.2 | | | | 22.7 | | | | 105.8 |
| MT | Paranatinga*** | 8.4 | | | | 23.3 | | | | 30.0 |
| AM | Parintins | | 5.6 | | | | 5.6 | | | 249.8 |
| PB | Patos*** | | 14.9 | 12.7 | | | 47.6 | 49.7 | | 126.1 |
| MG | Pedra Azul | 4.8 | 5.3 | | 8.3 | 2.3 | 7.1 | | 14.5 | 83.0 |
| SE | Propriá*** | | | 11.9 | 16.8 | | | 45.4 | 27.4 | 91.4 |
| PB | Sapé | | | 7.0 | | | | 19.0 | | 133.2 |
| AC | Sena Madureira | 5.9 | | | | 8.4 | | | | 47.4 |
| PB | Seridó Oriental Paraibano | | | 5.8 | | | | 6.3 | | 63.4 |
| CE | Serra do Pereiro | | | 5.6 | | | | 7.2 | | 41.9 |
| PE | Sertão do Moxotó | | 9.1 | | 9.2 | | 32.2 | | 28.0 | 214.7 |
| RR | Sudeste de Roraima | | | | 8.6 | | | | 12.8 | 46.9 |
| SE | Tobias Barreto*** | 9.3 | | | 11.0 | 25.4 | | | 26.5 | 109.4 |
| AL | Traipu | | | 9.3 | 8.6 | | | 24.2 | 26.6 | 37.2 |
| RN | Umarizal*** | | | | 13.3 | | | | 47.7 | 65.1 |
| CE | Uruburetama*** | 6.4 | | | 11.8 | 13.1 | | | 34.2 | 102.5 |
| PE | Vale do Ipanema*** | 9.2 | | 9.5 | 8.9 | 30.3 | | 26.4 | 29.8 | 178.1 |

Source: DataSUS, IBGE, 2010 Population (in thousands), Table generated by author.

Homicides per 100,000. *Defiers defined as $\geq$ 1.96 Std Dev (95 percentile); 87 observations are Type I Defiers

**Micro-region is on a Top Ten list for Violence & Fear; ***Micro-region is on a Top Ten list for Fear

Note: Missing observations indicate years as compliers

Table 7 – 2008 Top 10 Most Violent Micro-Regions (per Homicide Rate)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Marabá | PA | 99.8 | 12.0 | 203.1 |
| Maceió | AL | 98.6 | 6.4 | 1125.6 |
| Suape | PE | 84.2 | 6.7 | 215.6 |
| Tucuruí | PA | 80.6 | 5.1 | 221.1 |
| Vitória | ES | 79.9 | 4.9 | 1550.8 |
| Recife | PE | 68.5 | 5.0 | 3246.2 |
| Paragominas | PA | 68.4 | 8.2 | 198.5 |
| Salvador | BA | 68.0 | 4.6 | 3427.7 |
| Alto Paraguai* | MT | 67.6 | 7.6 | 20.2 |
| Barra de São Francisco | ES | 64.4 | 8.9 | 55.1 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.
*indicates micro-region is also a Type I Defier; see Table 6

Table 8 – 2009 Top 10 Most Violent Micro-Regions (per Homicide Rate)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Marabá | PA | 110.0 | 15.5 | 277.3 |
| Maceió | AL | 86.5 | 6.6 | 1150.7 |
| Vitória | ES | 79.8 | 5.4 | 1575.7 |
| Ariquemes | RO | 77.0 | 10.3 | 174.0 |
| São Mateus | ES | 75.2 | 5.2 | 183.4 |
| Arapiraca | AL | 73.0 | 4.6 | 409.7 |
| Salvador | BA | 70.0 | 5.1 | 3477.4 |
| Suape | PE | 69.5 | 5.5 | 257.5 |
| João Pessoa | PB | 67.0 | 4.3 | 1023.5 |
| Linhares | ES | 66.7 | 4.3 | 296.7 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 9 – 2010 Top 10 Most Violent Micro-Regions (per Homicide Rate)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Marabá | PA | 103.7 | 14.7 | 283.5 |
| Maceió | AL | 100.3 | 7.6 | 1151.9 |
| Belém | PA | 77.8 | 4.7 | 2174.0 |
| João Pessoa | PB | 77.1 | 5.4 | 1035.2 |
| Salvador | BA | 73.2 | 5.4 | 3484.2 |
| São Mateus | ES | 72.7 | 5.6 | 185.7 |
| Vitória | ES | 71.2 | 5.2 | 1579.2 |
| Porto Seguro | BA | 71.1 | 5.0 | 737.1 |
| Paragominas | PA | 68.4 | 9.5 | 291.1 |
| Arapiraca | AL | 68.3 | 4.7 | 411.7 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 10 – 2011 Top 10 Most Violent Micro-Regions (per Homicide Rate)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Maceió | AL | 107.3 | 9.0 | 1153.2 |
| Marabá | PA | 93.8 | 13.0 | 290.1 |
| João Pessoa | PB | 84.7 | 6.3 | 1047.2 |
| Arapiraca | AL | 79.0 | 5.2 | 414.0 |
| Suape | PE | 70.2 | 5.3 | 269.4 |
| Salvador | BA | 66.9 | 5.1 | 3492.1 |
| Vitória | ES | 66.3 | 5.1 | 1582.9 |
| Mossoró | RN | 63.8 | 3.8 | 337.1 |
| Porto Seguro | BA | 62.4 | 4.9 | 735.2 |
| Entorno de Brasília | GO | 62.1 | 4.2 | 1070.6 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 11 – 2008 Top 10 Most Fearful Micro-Regions

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Itamaracá | PE | 55.6 | 12.0 | 158.3 |
| Marabá | PA | 99.8 | 12.0 | 271.5 |
| Itaparica* | PE | 52.4 | 11.2 | 126.0 |
| Oiapoque* | AP | 37.6 | 9.8 | 26.6 |
| Tobias Barreto* | SE | 25.4 | 9.3 | 110.3 |
| Vale do Ipanema* | PE | 30.3 | 9.2 | 171.7 |
| Barra de São Francisco | ES | 64.4 | 8.9 | 87.0 |
| Patos* | PB | 45.4 | 8.8 | 125.6 |
| Paranatinga* | MT | 23.3 | 8.4 | 30.0 |
| Litoral Sul | PB | 26.4 | 8.2 | 83.4 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

*indicates micro-region is also a Type I Defier; see Table 6

Table 12 – 2009 Top 10 Most Fearful Micro-Regions

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Alto Paraguai* | MT | 24.6 | 17.9 | 28.4 |
| Marabá | PA | 110.0 | 15.5 | 277.3 |
| Patos* | PB | 47.6 | 14.9 | 126.1 |
| Itaparica* | PE | 31.8 | 11.9 | 129.0 |
| Oiapoque* | AP | 43.2 | 11.6 | 27.8 |
| Mantena* | MG | 42.7 | 11.3 | 60.8 |
| Barra de São Francisco | ES | 45.6 | 10.6 | 87.8 |
| Alagoana do Sertão do S. Fco.* | AL | 24.2 | 10.6 | 78.5 |
| Ariquemes | RO | 77.0 | 10.3 | 174.0 |
| Vitória de Santo Antão | PE | 41.5 | 10.1 | 214.5 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

*indicates micro-region is also a Type I Defier; see Table 6

Table 13 – 2010 Top 10 Most Fearful Micro-Regions

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Litoral Sul | PB | 46.8 | 18.5 | 83.3 |
| Marabá | PA | 103.7 | 14.7 | 283.5 |
| Alagoana do Sertão do S. Fco.* | AL | 60.4 | 14.2 | 79.4 |
| Mantena* | MG | 37.1 | 14.0 | 62.1 |
| Patos* | PB | 49.7 | 12.7 | 126.7 |
| Itamaracá | PE | 60.7 | 12.0 | 164.9 |
| Propriá* | SE | 45.4 | 11.9 | 92.5 |
| Caririaçu* | CE | 25.6 | 11.6 | 58.6 |
| Ariquemes | RO | 57.0 | 10.4 | 173.8 |
| Serrana dos Quilombos | AL | 52.0 | 9.8 | 146.0 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

*indicates micro-region is also a Type I Defier; see Table 6

Table 14 – 2011 Top 10 Most Fearful Micro-Regions

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| Alagoana do Sertão do S. Fco.* | AL | 33.6 | 22.1 | 80.4 |
| Litoral Sul | PB | 45.6 | 21.2 | 83.3 |
| Propriá* | SE | 27.4 | 16.8 | 91.4 |
| Médio Jaguaribe* | CE | 39.8 | 15.8 | 62.7 |
| Caririaçu* | CE | 29.9 | 13.8 | 56.9 |
| Umarizal* | RN | 47.7 | 13.3 | 65.1 |
| Marabá | PA | 93.8 | 13.0 | 290.1 |
| Mantena* | MG | 31.6 | 12.8 | 63.3 |
| Batalha* | AL | 32.4 | 11.9 | 92.7 |
| Uruburetama* | CE | 34.2 | 11.8 | 102.5 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

*indicates micro-region is also a Type I Defier; see Table 6

Table 15 – 2008 Fear and Violence in 20 Largest Micro-Regions (population)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| São Paulo | SP | 15.9 | 1.9 | 13759.6 |
| Rio de Janeiro | RJ | 35.1 | 2.8 | 11587.0 |
| Belo Horizonte | MG | 40.6 | 3.2 | 4920.9 |
| Porto Alegre | RS | 38.0 | 3.0 | 3776.5 |
| Salvador | BA | 68.0 | 4.6 | 3471.6 |
| Fortaleza | CE | 36.0 | 3.0 | 3334.3 |
| Recife | PE | 68.5 | 5.0 | 3288.5 |
| Curitiba | PR | 51.3 | 3.5 | 3188.7 |
| Campinas | SP | 13.2 | 1.7 | 2598.1 |
| Brasília | DF | 35.3 | 2.8 | 2476.9 |
| Belém | PA | 54.5 | 3.7 | 2196.5 |
| Goiânia | GO | 37.2 | 2.8 | 2076.7 |
| Manaus | AM | 34.7 | 4.3 | 1977.9 |
| Osasco | SP | 21.0 | 2.1 | 1877.2 |
| Vitória | ES | 79.9 | 4.9 | 1572.2 |
| Santos | SP | 15.9 | 1.9 | 1484.2 |
| Guarulhos | SP | 26.5 | 2.3 | 1420.6 |
| São José dos Campos | SP | 13.5 | 1.7 | 1414.4 |
| Mogi das Cruzes | SP | 20.6 | 1.9 | 1380.7 |
| Sorocaba | SP | 15.9 | 1.9 | 1340.8 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 16 – 2009 Fear and Violence in 20 Largest Micro-Regions (population)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| São Paulo | SP | 15.9 | 1.9 | 13800.0 |
| Rio de Janeiro | RJ | 32.2 | 2.5 | 11613.8 |
| Belo Horizonte | MG | 36.8 | 3.0 | 4883.5 |
| Porto Alegre | RS | 34.4 | 2.7 | 3731.4 |
| Salvador | BA | 70.0 | 5.1 | 3477.4 |
| Fortaleza | CE | 35.2 | 3.0 | 3352.3 |
| Recife | PE | 59.1 | 4.4 | 3285.5 |
| Curitiba | PR | 59.3 | 3.8 | 3155.3 |
| Campinas | SP | 15.7 | 1.8 | 2618.8 |
| Brasília | DF | 39.9 | 3.0 | 2520.5 |
| Belém | PA | 54.5 | 4.0 | 2184.9 |
| Goiânia | GO | 36.6 | 2.8 | 2100.2 |
| Manaus | AM | 38.7 | 4.4 | 2008.8 |
| Osasco | SP | 21.6 | 2.0 | 1846.9 |
| Vitória | ES | 79.8 | 5.4 | 1575.7 |
| Santos | SP | 19.5 | 2.1 | 1483.6 |
| São José dos Campos | SP | 15.1 | 1.9 | 1419.3 |
| Guarulhos | SP | 19.3 | 2.2 | 1400.2 |
| Mogi das Cruzes | SP | 22.7 | 2.1 | 1363.5 |
| Sorocaba | SP | 15.8 | 1.9 | 1340.0 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 17 – 2010 Fear and Violence in 20 Largest Micro-Regions (population)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| São Paulo | SP | 13.9 | 1.9 | 13841.1 |
| Rio de Janeiro | RJ | 35.2 | 2.5 | 11642.2 |
| Belo Horizonte | MG | 35.1 | 2.9 | 4847.2 |
| Porto Alegre | RS | 30.9 | 2.7 | 3687.1 |
| Salvador | BA | 73.2 | 5.4 | 3484.2 |
| Fortaleza | CE | 48.6 | 3.4 | 3370.7 |
| Recife | PE | 49.0 | 4.0 | 3282.6 |
| Curitiba | PR | 57.2 | 4.0 | 3122.7 |
| Campinas | SP | 14.2 | 1.8 | 2640.5 |
| Brasília | DF | 34.4 | 2.9 | 2564.8 |
| Belém | PA | 77.8 | 4.7 | 2174.0 |
| Goiânia | GO | 35.1 | 2.7 | 2124.4 |
| Manaus | AM | 43.8 | 4.2 | 2040.7 |
| Osasco | SP | 16.9 | 2.0 | 1817.4 |
| Vitória | ES | 71.2 | 5.2 | 1579.2 |
| Santos | SP | 18.3 | 2.0 | 1483.1 |
| São José dos Campos | SP | 14.8 | 1.8 | 1424.2 |
| Guarulhos | SP | 19.3 | 2.1 | 1380.2 |
| Mogi das Cruzes | SP | 19.2 | 1.9 | 1346.8 |
| Sorocaba | SP | 14.3 | 1.8 | 1339.5 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Table 18 – 2011 Fear and Violence in 20 Largest Micro-Regions (population)

| Micro-Region | State | Hom Rate | Fear | Population |
|---|---|---|---|---|
| São Paulo | SP | 12.2 | 1.8 | 13882.8 |
| Rio de Janeiro | RJ | 29.7 | 2.5 | 11671.9 |
| Belo Horizonte | MG | 40.9 | 3.1 | 4811.9 |
| Porto Alegre | RS | 32.8 | 2.9 | 3643.6 |
| Salvador | BA | 66.9 | 5.1 | 3492.1 |
| Fortaleza | CE | 48.8 | 3.6 | 3389.4 |
| Recife | PE | 47.8 | 3.9 | 3279.9 |
| Curitiba | PR | 51.8 | 3.8 | 3090.9 |
| Campinas | SP | 14.2 | 1.7 | 2663.2 |
| Brasília | DF | 37.4 | 2.9 | 2610.0 |
| Belém | PA | 60.9 | 4.2 | 2164.0 |
| Goiânia | GO | 44.6 | 3.0 | 2149.2 |
| Manaus | AM | 51.7 | 4.4 | 2073.8 |
| Osasco | SP | 19.5 | 2.0 | 1788.4 |
| Vitória | ES | 66.3 | 5.1 | 1582.9 |
| Santos | SP | 16.7 | 1.9 | 1482.7 |
| São José dos Campos | SP | 16.9 | 1.8 | 1429.1 |
| Guarulhos | SP | 22.7 | 2.1 | 1360.5 |
| Sorocaba | SP | 15.0 | 1.8 | 1339.1 |
| Mogi das Cruzes | SP | 18.2 | 1.8 | 1330.6 |

Source: DataSUS, IBGE, 2010 Population (in thousands). Table generated by author.

Figure 2 – Alagoas 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
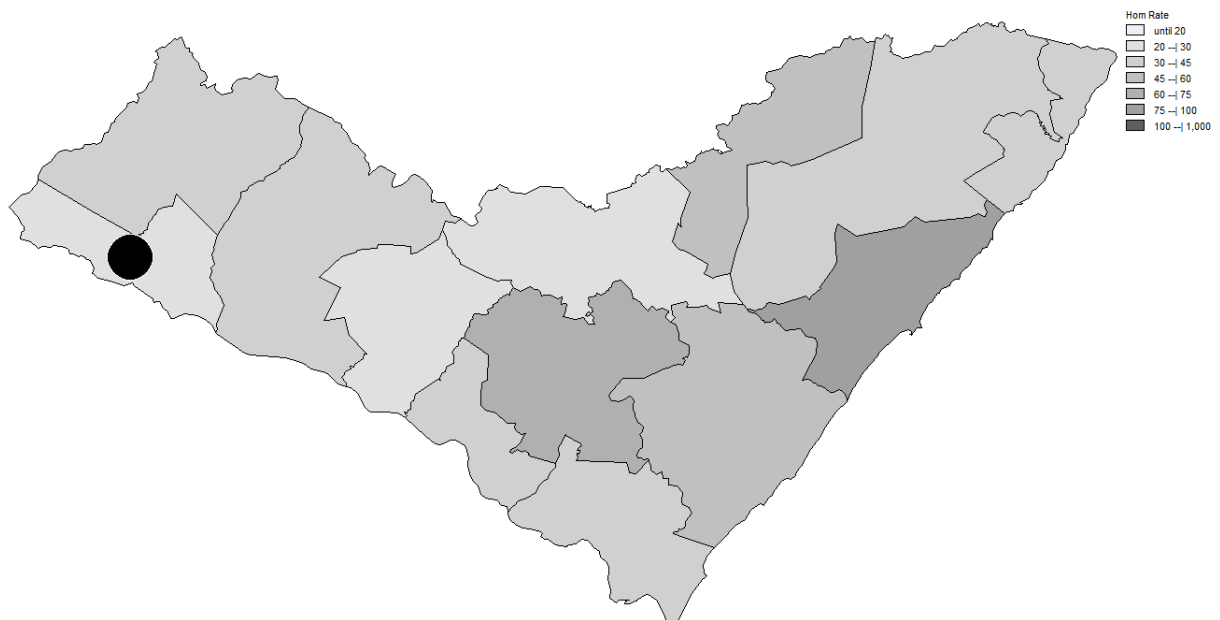


Figure 3 – Alagoas 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
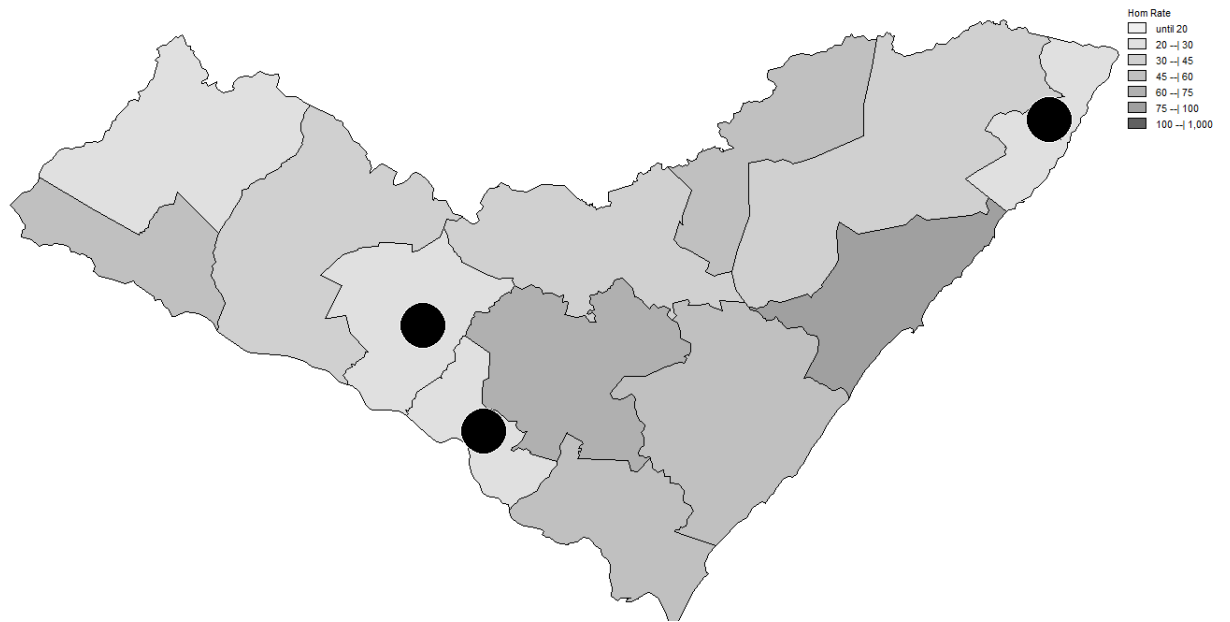
Figure 4 – Alagoas 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
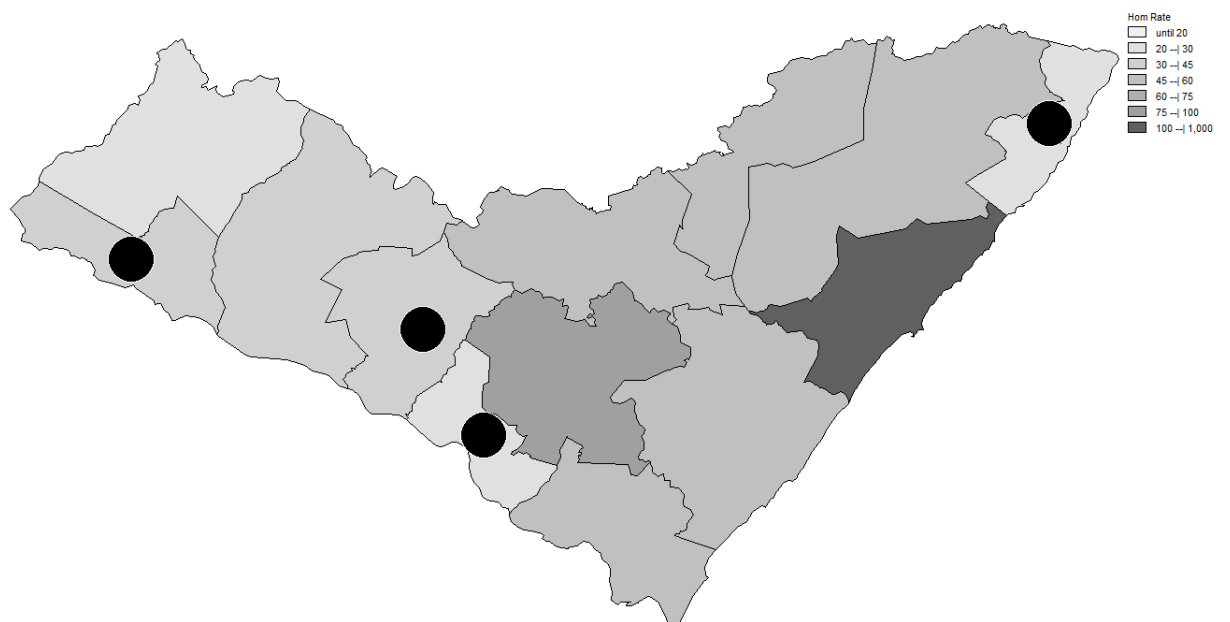


Figure 5 – Alagoas 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
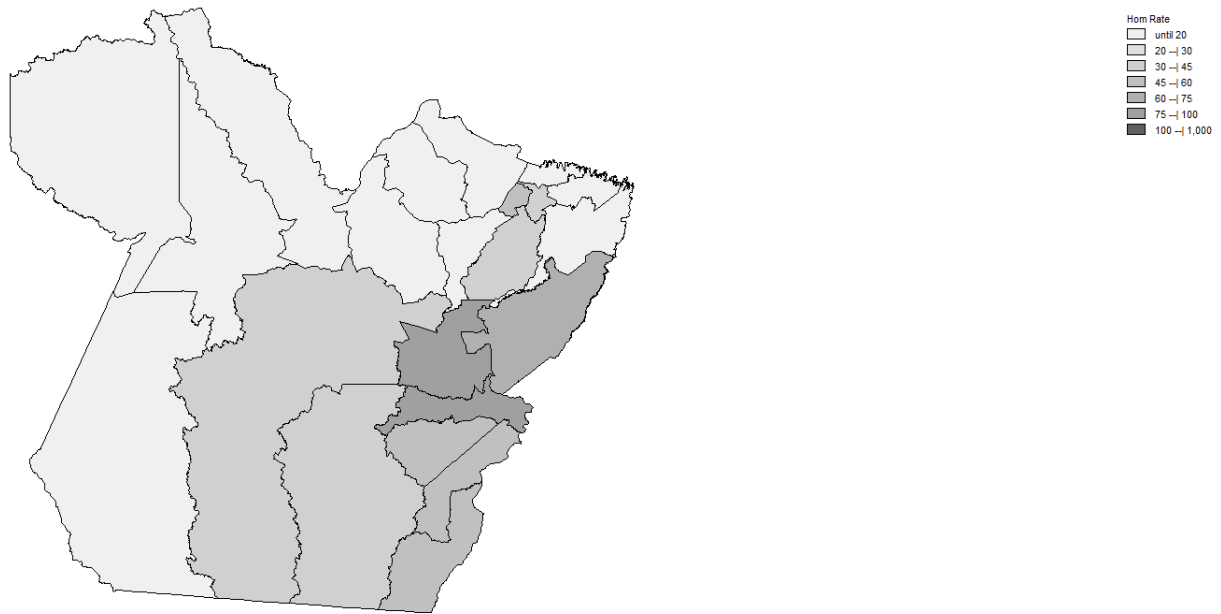
Figure 6 – Pará 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
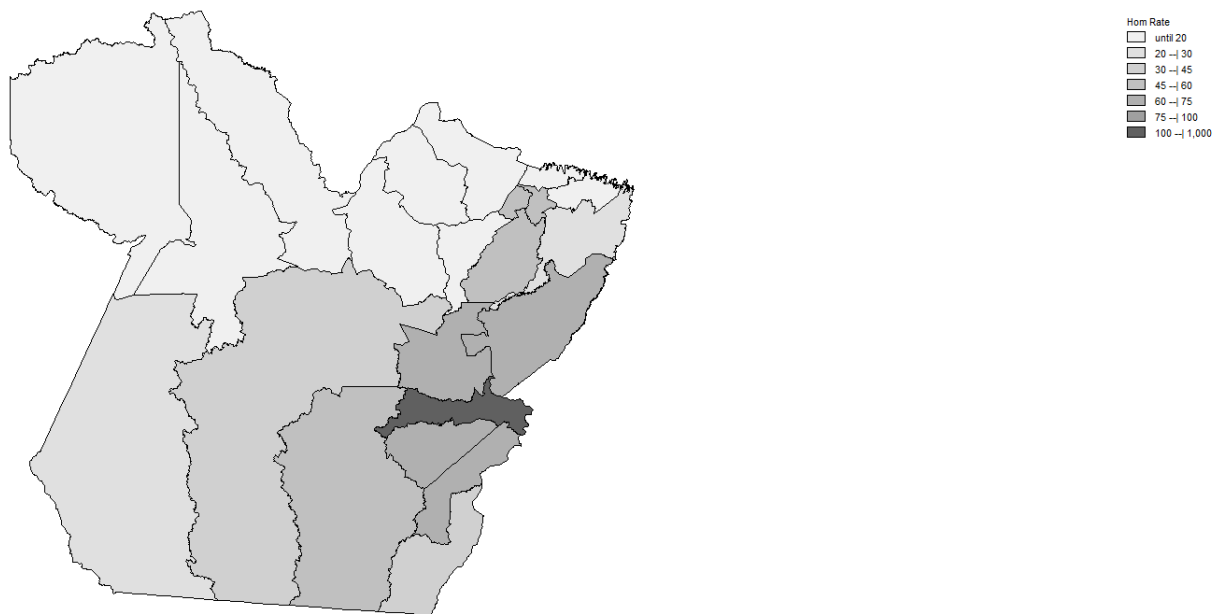


Figure 7 – Pará 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
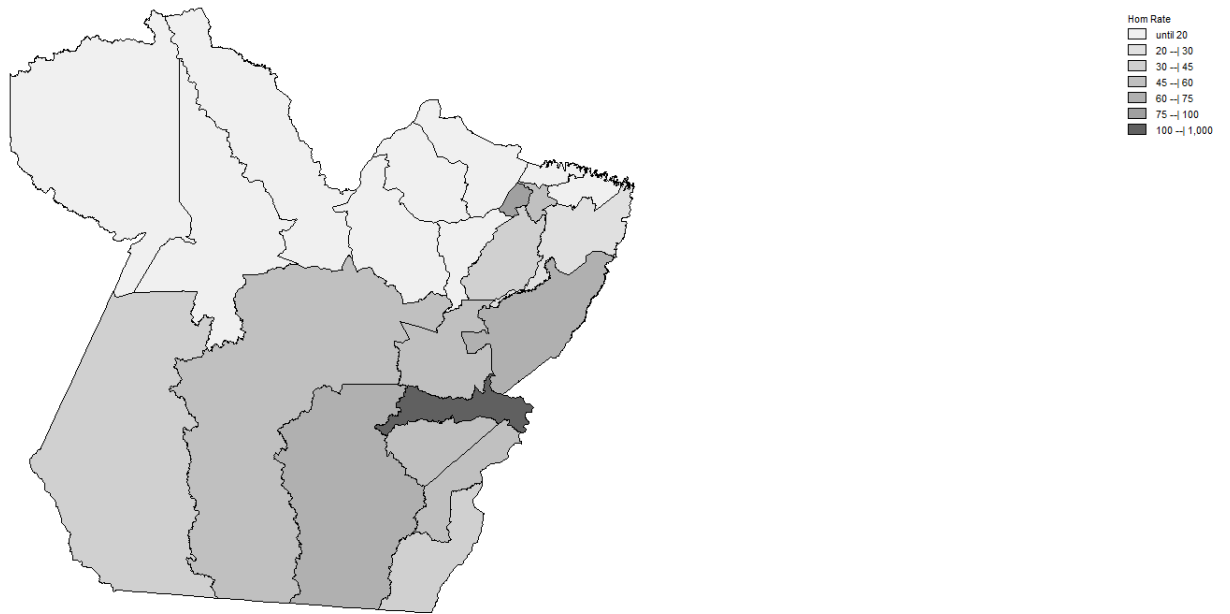
Figure 8 – Pará 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.



Figure 9 – Pará 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
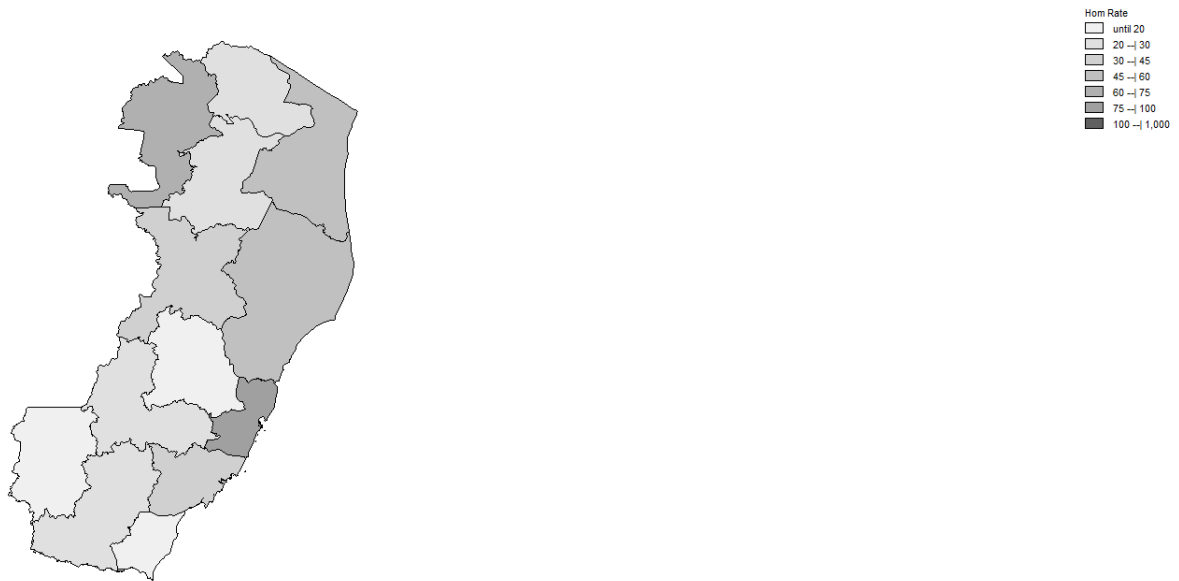
Figure 10 – Espirito Santo 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
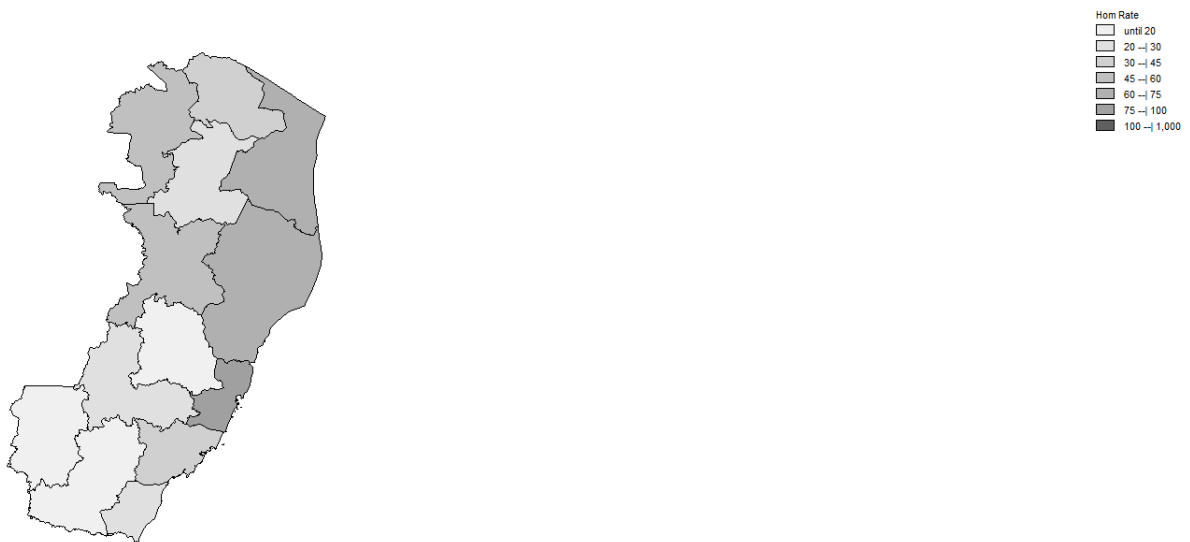


Figure 11 – Espirito Santo 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
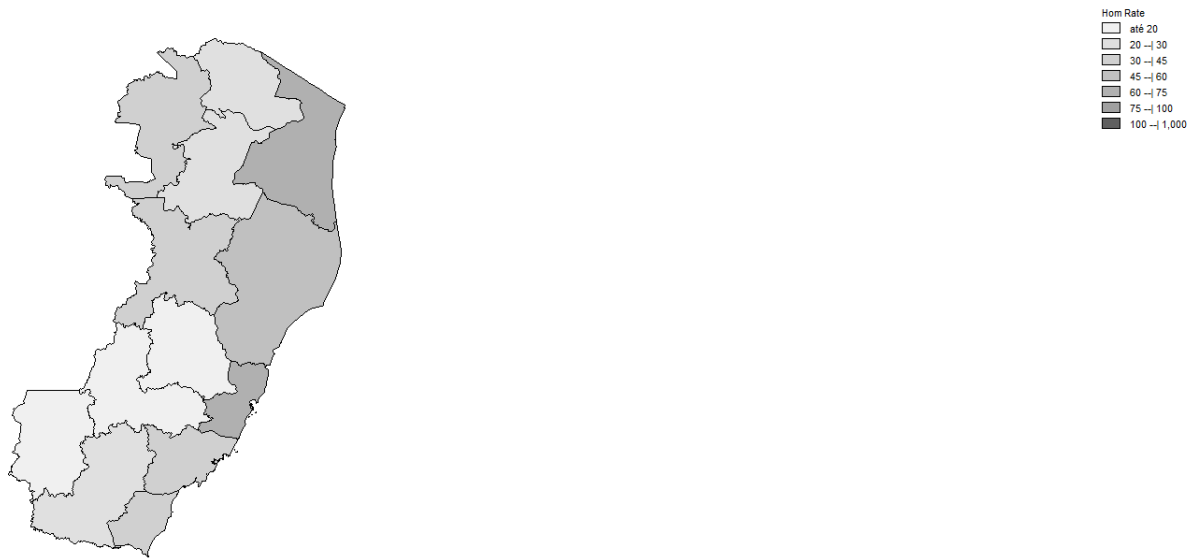
Figure 12 – Espirito Santo 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.



Figure 13 – Espirito Santo 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
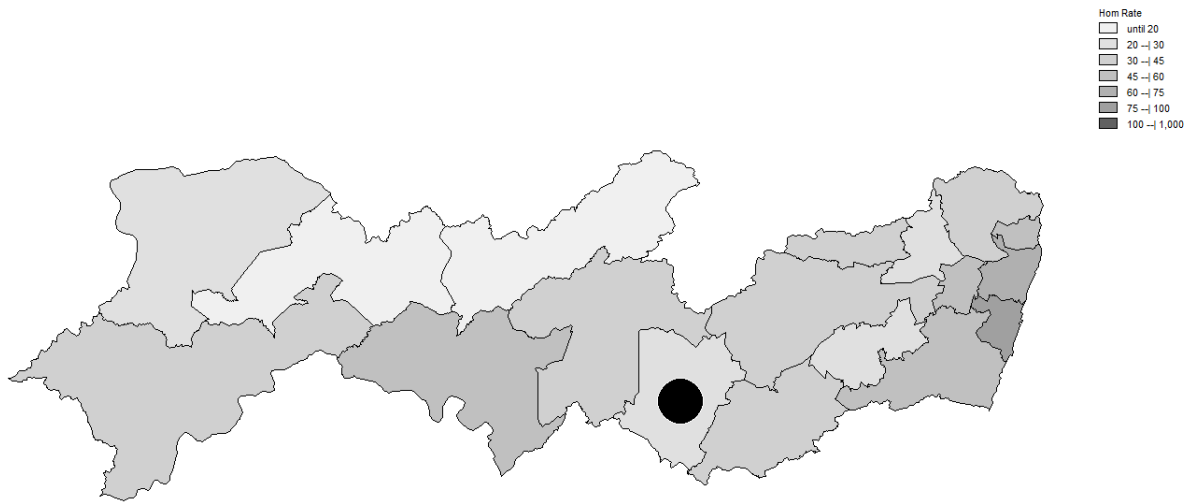
Figure 14 – Pernambuco 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
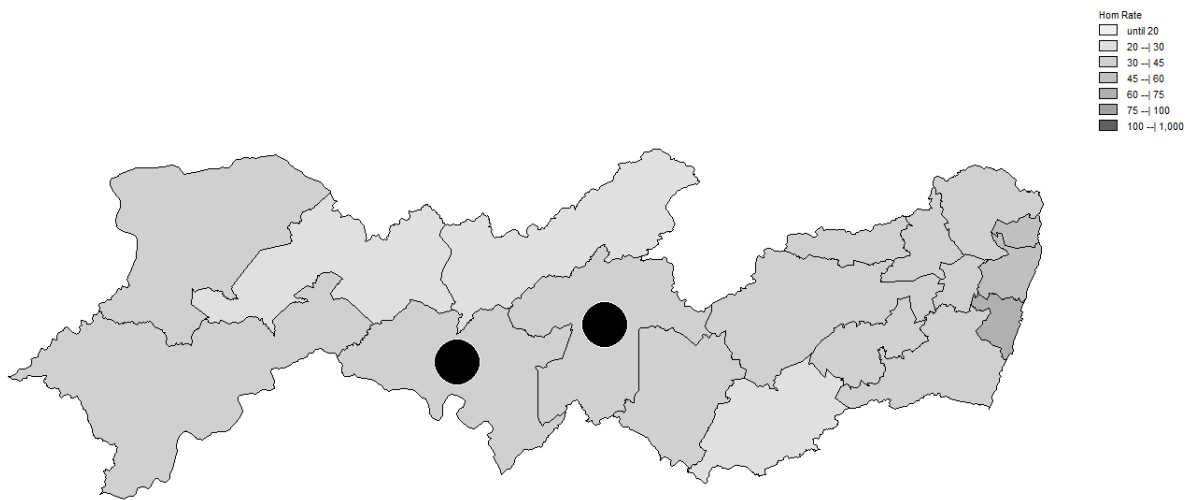


Figure 15 – Pernambuco 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
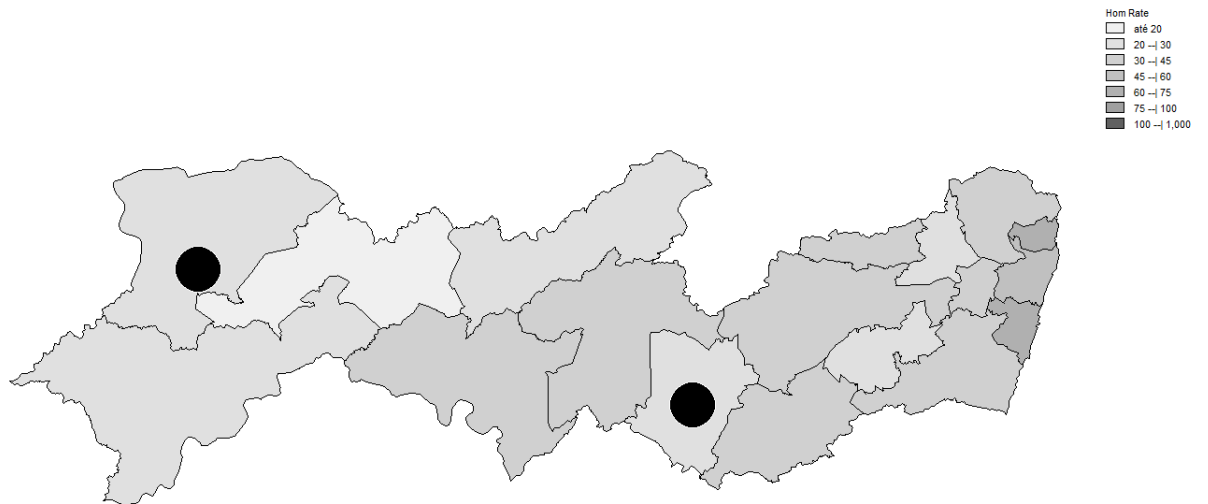
Figure 16 – Pernambuco 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
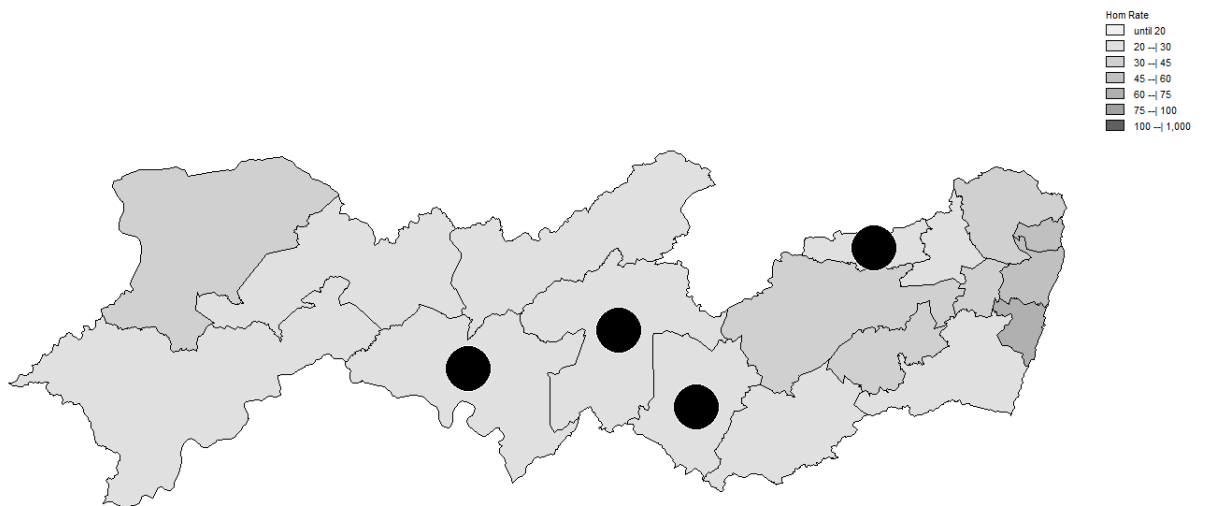


Figure 17 – Pernambuco 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.

Figure 18 – Northeast Region 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.



Figure 19 – Northeast Region 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
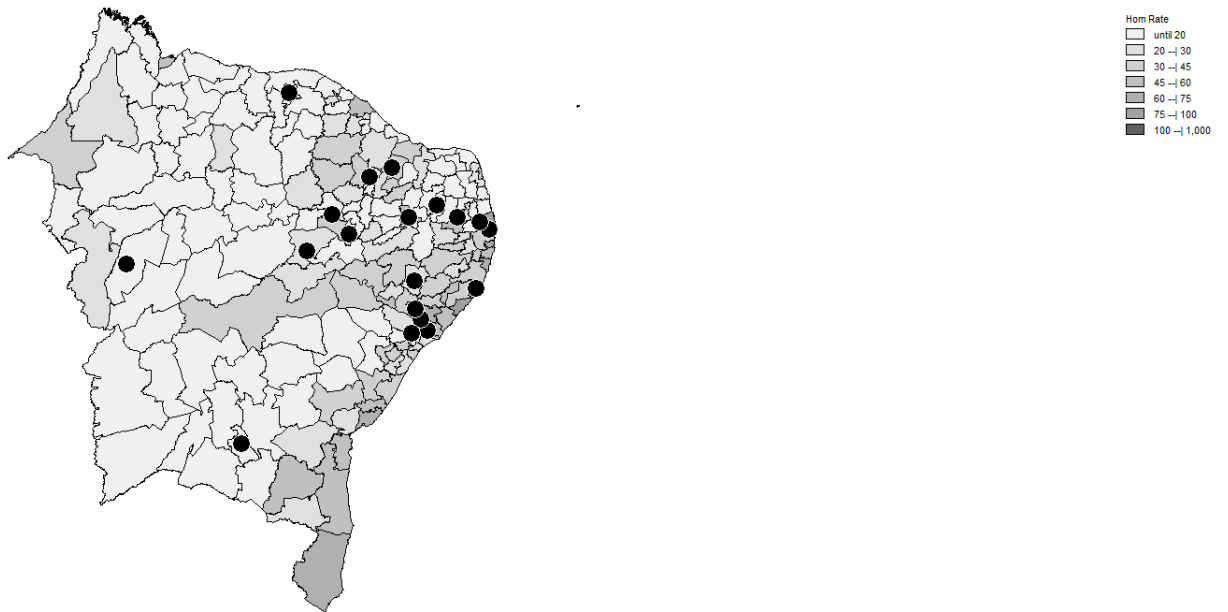
Figure 20 – Northeast Region 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
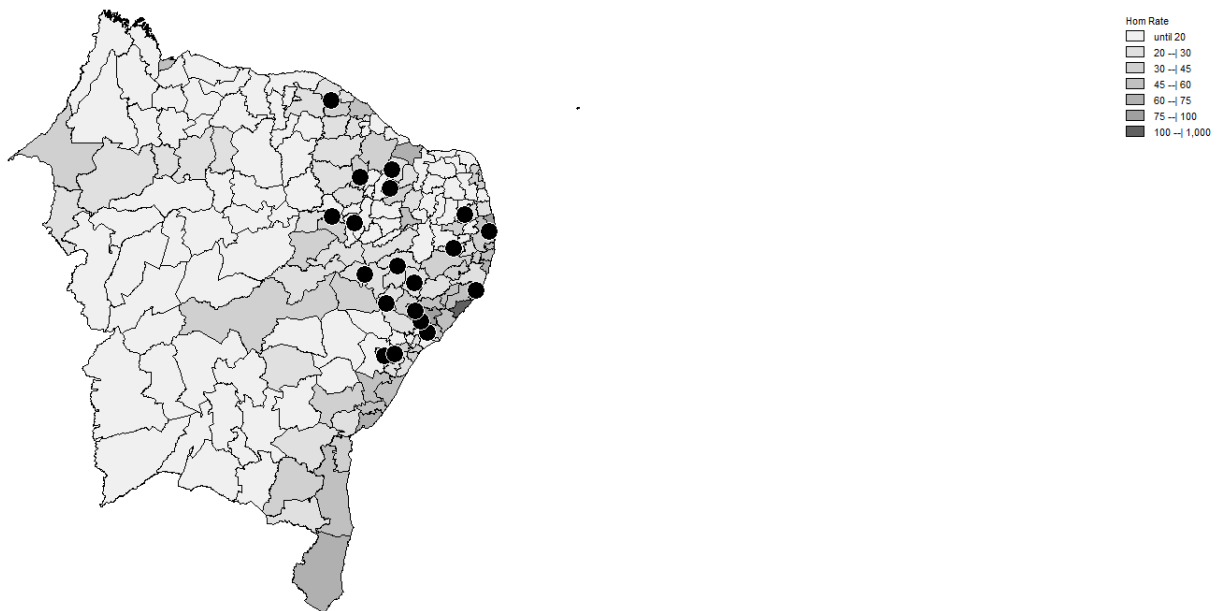
Figure 21 – Northeast Region 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
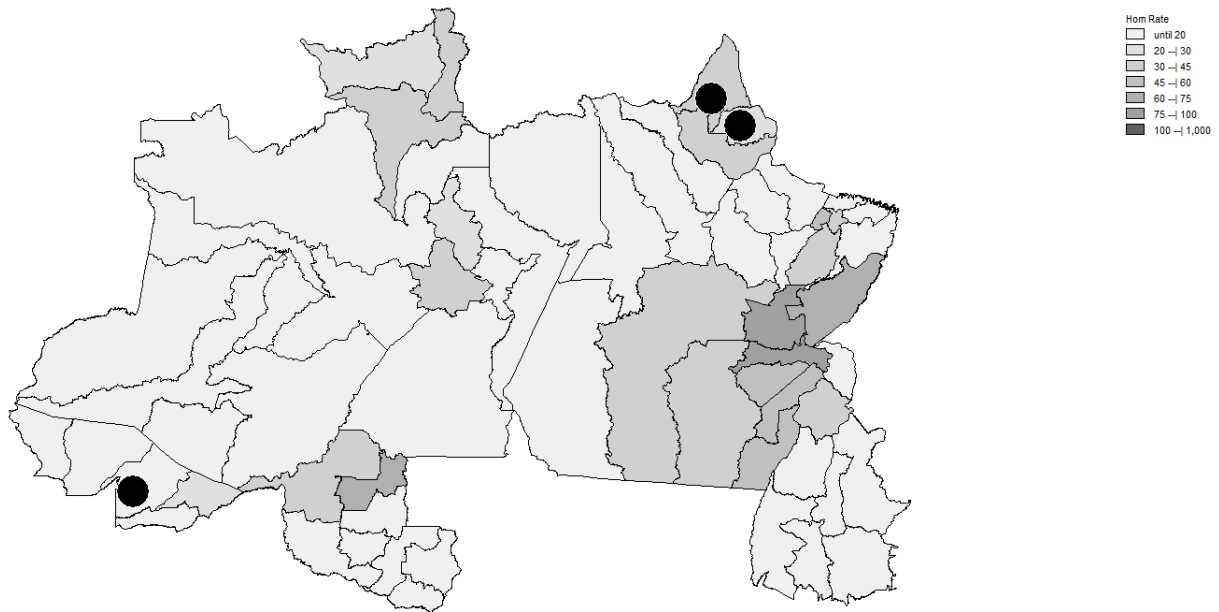
Figure 22 – North Region 2008 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
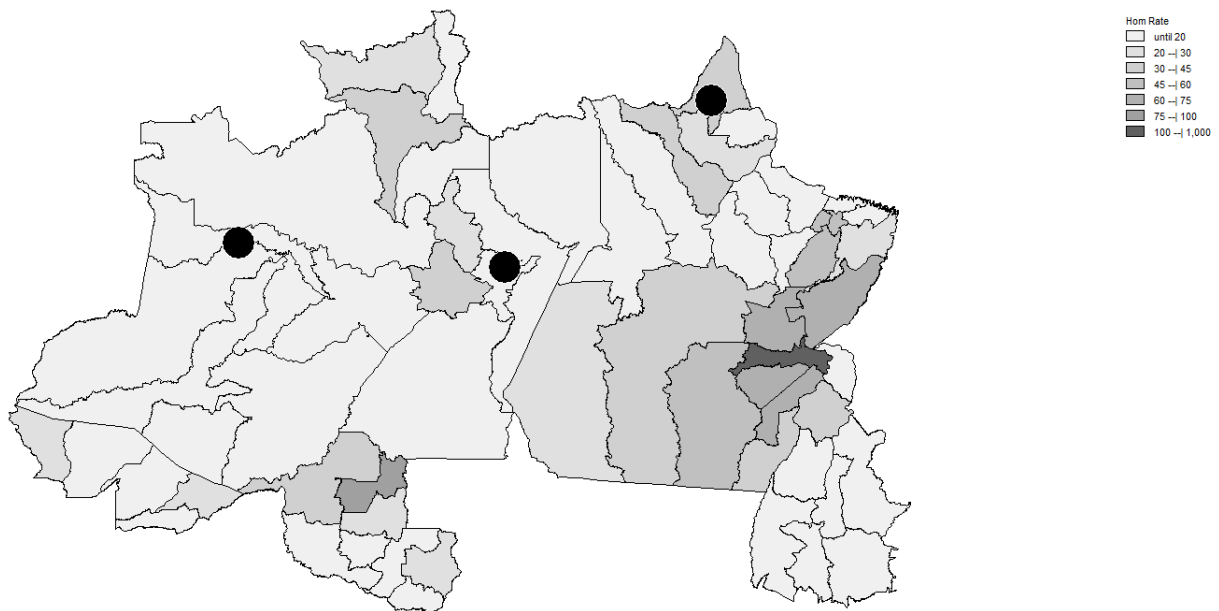


Figure 23 – North Region 2009 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
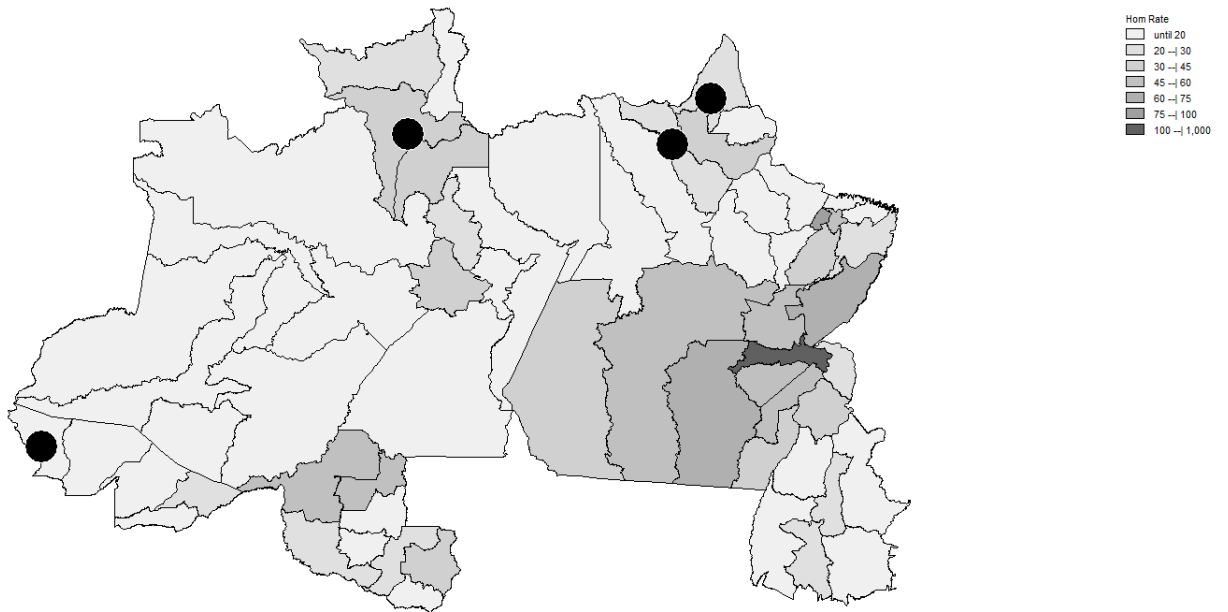
Figure 24 – North Region 2010 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.
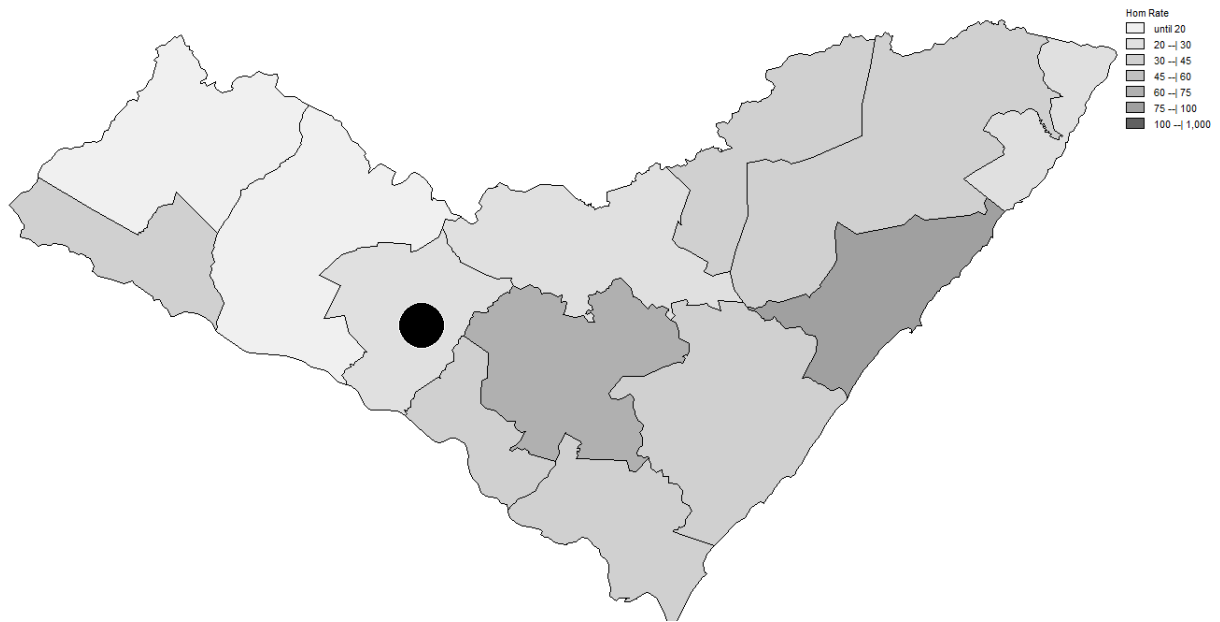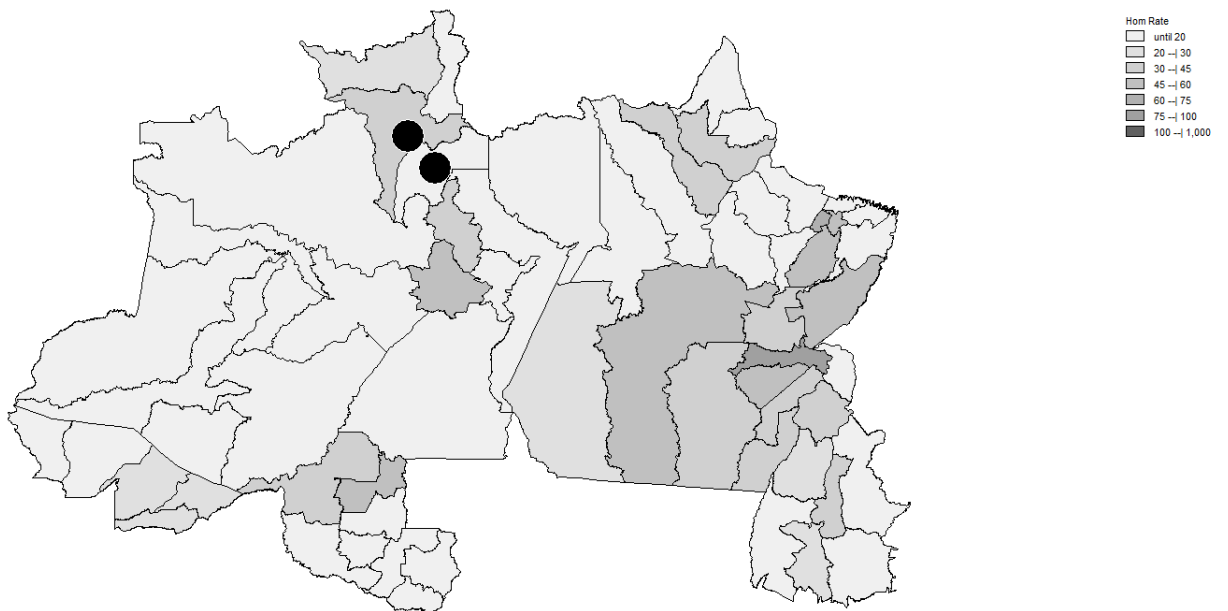


Figure 25 – North Region 2011 Spatial representation of Violence and Fear. Darker shades reflect higher homicide rates. Black dots represent Type I defiers with excess fear. Figure generated by author via TabWin.

# The Interiorization of Brazilian Violence: Is Increased Violence in the Countryside Related with Increased Public Security Expenditures in Big Cities?

Abstract: Brazilian homicide rates are among the highest in the world, inclusive of actual war zones. However, the character of Brazil's violence is changing. Emerging patterns show homicide rates in larger cities – traditionally the most violent places – have stagnated and declined while smaller cities and rural areas experienced a marked increase. The first contribution of this paper is to introduce a novel way to analyze this new pattern of the diffusion of violence to the countryside by using inequality measures. To this end Gini and Hoover indices are calculated along with Lorenz curves which serve to approximate these trends using a single variable. The second contribution explores whether a government's expenditures on public security are correlated with these shifts in violence. In Brazil's case, using panel data across all 26 states from 1995-2011, evidence of a strong correlation between public security expenditures and the dispersion of violence to the countryside is found.

## 3.1    Introduction

Brazil is a violent place. In fact, the country ranks among the most violent nations in the world, with an intentional homicide annual rate ranging around 27 homicides per 100,000 inhabitants. This rate is roughly two to three times that of the United States and upwards of 40 times that of Japan[1]. To put Brazilian violence in perspective, consider some of these staggering facts[2]:

- Between 1980-2010 more people died in Brazilian homicides caused by fire arms than the combined total of the 12 bloodiest armed conflicts in the world during the same period.

- Brazil is one of the few countries in the world where homicide rates surpass traffic accident mortality rates. (In 2011 the homicide rate was 27.1, while the traffic fatality rate was 23.2 deaths per 100,000 individuals.)

- The youth population is hit particularly hard by armed violence. Young persons die of homicides at nearly twice the rate of the general population, and nearly two in five of all registered deaths for persons aged 15-24 are the result of homicides.

These levels of violence exist and persevere despite Brazil being a nation without territorial disputes, civil war, or pronounced racial or ethnic tensions. It is clear that this violence comes at a high cost, therefore earning a spot among Brazil's top challenges.

While the scope of Brazilian violence is astonishing, this paper does not intend to be a comprehensive source on Brazilian violence[3]. The aim of this article is more limited: to better understand some of the factors that shape violence within a nation through the lens of inequality measures.

In order to meet this objective, this study chiefly analyzes recent shifts in the distribution of violence. These changes are principally characterized by levels of homicides dropping in urban areas and rising in the countryside. This dispersion of violence is categorized into two main groups, *dissemination* and *interiorization*, which are explained more thoroughly in subsequent sections. To explore these shifts in violence, Gini and Hoover inequality measures are developed to approximate the phenomenon of interiorization.

A single variable serves as a proxy for violence redistribution, enabling us to directly correlate new patterns of violence with other variables, such as spending on public security. The intuition to explore the correlation between public security expenditures and violence redistribution was based on a documented rise in security expenditures and media coverage in the popular press, which suggested criminals were targeting less well-policed areas. The results of this research corroborate

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[1]    For more details, see UNODC (2011).
[2]    For more details, see Waiselfisz (2011, 2012).
[3]    For a comprehensive source on Brazilian violence see the *Mapa da Violência* series: `www.mapadaviolencia.org.br`.

this intuition, showing a correlation between increases in security spending and the dispersion of violence to the interior. One possible policy implication is increased spending in urban areas may have the unintended side-effect of encouraging violence to relocate to less-policed areas. This paper also suggests that major government programs aimed at reducing homicides through arms control and targeted security spending influence this correlation.

The main contribution and novelty of this paper is the application of standard inequality measures (the Lorenz Curve and Gini/Hoover indices) to examine patterns in violence. Additionally, using Brazil as the test case, this research explores the relationship between a government's expenditures on security and the spread and dislocation of violence within a nation.

The balance of this paper is organized as follows: Section 2 provides background information explaining the character of the new patterns of violence as well as highlighting the role inequality measures play in analyzing these trends. Section 3 explains the motivation for relating public security expenditures with these changes in violence. Section 4 presents the economic model and summarizes the results. The final section summarizes the salient points of this paper and considers future research possibilities.

## 3.2 The trend of dispersion of violence in Brazil

While armed violence remains an intractable problem, the characteristics of this violence are changing. Cities and states, such as Rio de Janeiro and São Paulo–once undisputed leaders in the the Brazilian violence panorama–have seen a dramatic reduction in homicide rates at the expense of less populated regions and once peaceful states.

Waiselfisz (2011) provides a thorough review of the dynamics involved of the new patterns of violence. He breaks the migration of violence into two components: "dissemination" and "interiorization."

Dissemination accounts for the part of the migration that occurs when violent crime leaves one state for another. This phenomenon can be thought of as migration *between* states. Basically dissemination of violence occurs when once safe states become more violent while previously violent states reverse course and lower their homicide rates. Table 19 highlights how the seven most violent states in 2000 became much less so by 2010. During the same period however, the 17 least violent states in 2000 became much *more* so. The outcomes are striking.

During this 10-year span, the most violent states, with the exception of Espirito Santo, became much *less* violent. In fact the seven most-violent Brazilian states saw homicide rates fall from 47.1 to 22.6, while the 17 safest states in 2000 saw rates more than double from 11.7 to 28.4.

The most dramatic changes occurred in São Paulo and Rio de Janeiro whose rankings moved from 4th to 25th and 2nd to 17th place, respectively. The counter example for rising homicide rates is

Table 19 – Homicide Rate (100 thousand) Rankings for Brazilian States, 2000 and 2010.

| State | 2000 | | 2010 | |
|---|---|---|---|---|
| | Rate | Position | Rate | Position |
| Alagoas | 25.6 | 11º | 66.8 | 1º |
| Espírito Santo | 46.8 | 3º | 50.1 | 2º |
| Pará | 13.0 | 21º | 45.9 | 3º |
| Pernambuco | 54.0 | 1º | 38.8 | 4º |
| Amapá | 32.5 | 9º | 38.7 | 5º |
| Paraíba | 15.1 | 20º | 38.6 | 6º |
| Bahia | 9.4 | 23º | 37.7 | 7º |
| Rondônia | 33.8 | 8º | 34.6 | 8º |
| Paraná | 18.5 | 16º | 34.4 | 9º |
| Distrito Federal | 37.5 | 7º | 34.2 | 10º |
| Sergipe | 23.3 | 12º | 33.3 | 11º |
| Mato Grosso | 39.8 | 5º | 31.7 | 12º |
| Amazonas | 19.8 | 14º | 30.6 | 13º |
| Ceará | 16.5 | 17º | 29.7 | 14º |
| Goiás | 20.2 | 13º | 29.4 | 15º |
| Roraima | 39.5 | 6º | 27.3 | 16º |
| Rio de Janeiro | 51.0 | 2º | 26.2 | 17º |
| Mato Grosso do Sul | 31.0 | 10º | 25.8 | 18º |
| Rio Grande do Norte | 9.0 | 24º | 22.9 | 19º |
| Tocantins | 15.5 | 19º | 22.5 | 20º |
| Maranhão | 6.1 | 27º | 22.5 | 21º |
| Acre | 19.4 | 15º | 19.6 | 22º |
| Rio Grande do Sul | 16.3 | 18º | 19.3 | 23º |
| Minas Gerais | 11.5 | 22º | 18.1 | 24º |
| São Paulo | 42.2 | 4º | 13.9 | 25º |
| Piauí | 8.2 | 25º | 13.7 | 26º |
| Santa Catarina | 7.9 | 26º | 12.9 | 27º |

Data Source: Waiselfisz (2011). Table generated by author.

equally striking. Once relatively safe states, such as Alagoas and Pará, moved from positions of relative tranquility to high rates of violence. Pará moved from 21st to fourth place and Alagoas moved from 11th place to become the most violent state in Brazil.

The second component of the migration underfoot is referred to as "interiorization" and is a new pattern of violence this paper hopes to explain. This phenomenon is characterized by violence leaving the capital cities and larger metropolitan areas for the countryside.

The first three columns of Table 20 clearly explain part of this interiorization process[4]. The first shows rising homicide rates in the interior, the second falling rates in urban areas, and the third a

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[4] The homicide and population data used to calculate the statistics represented in Table 20 were gathered from the Brazilian Health Ministry's information department, *Sistema de Informações sobre Mortalidade* and *Secretaria de Vigilância em Saúde* (SIM/SVS/MS). Santos and Kassouf (2008) present details about SIM/SVS/MS databases.

more modest increase for Brazil as a whole. The final two columns use Gini and Hoover inequality statistics to demonstrate the dispersion of violence, or how evenly homicides are distributed across Brazil. One advantage of these inequality statistics is that they neatly summarize the interiorization trend by using only one number to explain this phenomenon as a whole.

As the use of inequality statistics are crucial to explaining these new patterns of violence, below is provided the general background on these measures. The three common inequality measures used in this study are the Lorenz Curve, the Gini Index and the Hoover Index. First the Lorenz Curve is discussed as it provides the basis for both the Gini and Hoover indices.

Table 20 – Homicide rates in the Interior, Capital and Metropolitan Regions, and in Brazil; Gini and Hoover Index for Homicides, 1995-2011.

| Year | Interior | Capitals/Metros | Brazil | Gini | Hoover |
|------|----------|-----------------|--------|------|--------|
| 1995 | 11.7 | 42.6 | 23.8 | 0.467 | 0.405 |
| 1996 | 12.7 | 45.6 | 24.8 | 0.467 | 0.396 |
| 1997 | 12.6 | 45.7 | 25.4 | 0.466 | 0.391 |
| 1998 | 13.0 | 45.3 | 25.9 | 0.467 | 0.404 |
| 1999 | 13.0 | 44.6 | 26.2 | 0.466 | 0.406 |
| 2000 | 13.8 | 45.8 | 26.7 | 0.465 | 0.386 |
| 2001 | 14.9 | 46.5 | 27.8 | 0.463 | 0.360 |
| 2002 | 16.1 | 45.5 | 28.5 | 0.459 | 0.344 |
| 2003 | 16.6 | 46.1 | 28.9 | 0.458 | 0.335 |
| 2004 | 16.3 | 42.4 | 27.0 | 0.454 | 0.321 |
| 2005 | 16.9 | 38.5 | 25.8 | 0.451 | 0.313 |
| 2006 | 17.6 | 38.7 | 26.3 | 0.450 | 0.315 |
| 2007 | 17.6 | 36.6 | 25.2 | 0.448 | 0.329 |
| 2008 | 18.9 | 37.3 | 26.4 | 0.446 | 0.321 |
| 2009 | 20.4 | 37.3 | 27.0 | 0.443 | 0.313 |
| 2010 | 20.3 | 37.4 | 27.4 | 0.442 | 0.318 |
| 2011 | 20.5 | 36.4 | 27.1 | 0.440 | 0.318 |

Data Source: SIM/SVS/MS. Table generated by author.

As shown in Figure 26, the Lorenz Curve plots the cumulative percentage of homicides against the cumulative percentage of population (calculated using municipalities). The curve is plotted with a 45-degree line that represents a perfectly equal distribution of homicides across the population. Graphically, the closer the Lorenz Curve approximates the equality line, the more equal the distribution of homicides between municipalities (within a state or country). Likewise, the further the curve diverges from the equality line, the less equal the distribution.

Perhaps the most popular inequality index is the Gini. As can be seen graphically from Figure 26, the Gini index represents the ratio of area between the Lorenz Curve and the perfect equality line over the entire area beneath the equality line, or $A/(A + B)$. The larger area $A$, the larger the Gini coefficient, and the more unequal the distribution of homicides. The Gini has ordinal interpretation that allows inequalities to be compared across time or between groups.
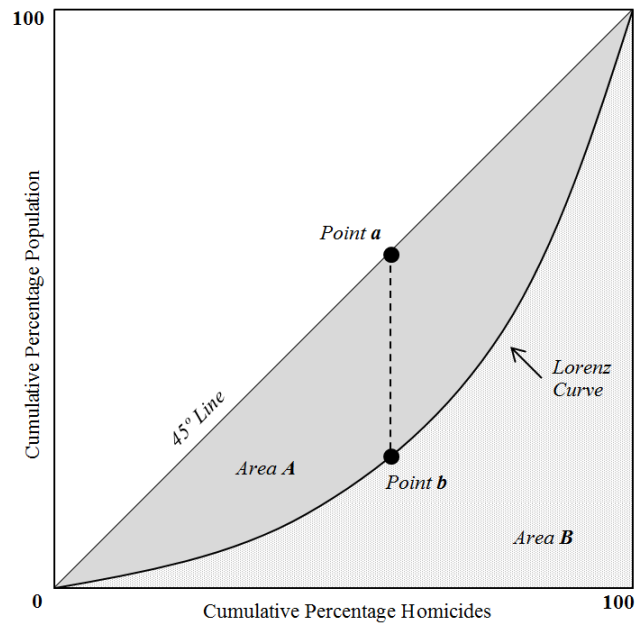
Figure 26 – Lorenz Curve and Gini/Hoover indices. Figure generated by author.

A less well-known measure of inequality is the Hoover index[5]. As seen in Figure 26, Hoover is graphically represented as the maximum distance between the prefect equality line and the Lorenz Curve, or the distance between points $a$ and $b$.

Table 20 presents the evolution of Brazil's violence distribution at a national level. Both the Gini and Hoover indices exhibit a declining trend showing that with time the distribution of violence became more equal.

While the Gini and Hoover indices are informative in explaining shifts in the patterns of violence, they are also prone to misinterpretation. Therefore, it is worthwhile to address some of the common pitfalls when employing these measures.

First, it is important to note that these indices are relative and not absolute measures. The index makes no statement as to the absolute levels of violence within or between states. Thus, a lower value of Hoover (close to zero) only implies a state has a more even distribution of violence relative to its peers, but does not make a statement about absolute levels of homicides.

Therefore, an inequality measure only provides interpretation of the distribution of violence *relative* to peers. For example, it would be incorrect, based solely upon a lower Hoover statistic to conclude that Rio de Janeiro, with a index of 0.151 in 2010, is safer than Minas Gerais, with an index of 0.340[6]. In fact, despite this lower Hoover value in 2010 Rio de Janeiro's homicide rate of 26.2 was higher than the rate in Minas Gerias of 18.1.

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[5]    Straightforward interpretation is an advantage of Hoover index. Numerically it is interpreted as the percentage of the total homicides that would need to be redistributed across the municipalities to achieve an equal homicide distribution (Rogerson and Plane, 2013).

[6]    Appendix A provides Gini and Hoover values for all states from 1995-2011.

Second, to use inequality measures to evaluate trends, one must know the initial distribution of violence at the start of the trend. Thus for this study, it is critical to know if bigger cities or smaller cities were *initially* more violent at the start of the sample period. For example, Hoover values could be falling, due to violence equalizing from big cities to small cities *or* from small cities to big cities. Consistent with the evidence already presented, it is noted that the violence distribution was initially skewed toward larger cities relative to the countryside. Knowing this initial condition validates that the migration of violence must be originating in urban areas and moving to the countryside, enabling us to analyze shifts in violence in a meaningful way.

In sum, the Gini and Hoover indices serve as proxies for measuring the interiorization and dissemination of violence at the national level because they were calculated using all Brazilian municipalities. Appendix A shows the evolution of Gini and Hoover for all the Brazilian states. In this context, these state values can be interpreted as *interiorization*, but do not capture the dissemination trend.

Waiselfisz (2011) is quick to point out that while dissemination and interiorization represent two different types of violence migration, they share a common root: "Both these processes originated as migration of violence *from* a limited number of capital cities and large metropolitan areas that increased their levels of security *to* less protected regions such as the countryside within states and to other states." The evidence presented leaves little doubt that patterns of violence have shifted in Brazil from more populated to less populated areas.

A single numerical measure to evaluate the distribution of violence facilitates direct comparison with other variables. To this end, in the following section Gini and Hoover statistics are compared to one factor that could explain these shifts in violence: expenditures on public security. Specifically, it is investigated to what extent these expenditures are correlated with the redistribution of violence.

## 3.3  Dispersion of Violence and Public Security Expenditures

The intuition and motivation for studying how police spending relates to violence diffusion (dissemination and interiorization) comes primarily from two sources. The first source is anecdotes from the popular press. News sources have provided a steady flow of stories suggesting violent criminals have a penchant for targeting less-policed areas in the interior. The second factor concerns the negative correlation between inequality indices and police expenditures during the sample period. Both of these factors are covered in turn.

First, the press has taken notice of this trend of interiorization. News stories abound, highlighting movements in crime, and especially violent crime, from big cities to rural areas. Media carry these stories on a weekly, if not daily, basis[7].

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[7] One compelling anecdote suggesting the interiorization of violence highlights a criminal gang in Goiás that specializes in armed robbery of ATM cash machines. In a taped conversation, gang leaders consider potential targets based on their relative lack of security resources. In this example, the gang preferred to rob ATMs in a smaller city with "only two police officers and one patrol car." See 1:05 the video: http://g1.globo.com/bom-dia-brasil/

Anecdotes and news stories aside, spending data reveals that the government responded to alarmingly high levels of violence in the 1990s by increasing expenditures on law enforcement and public security. As observed in Table 21, per capita expenditures for Brazil more than doubled from 1995 to 2011 from 109 to 252 reais per person[8]. Thus the following question is asked: To what extent do these expenditures play in reshaping the landscape of Brazilian violence?

Table 21 –   Annual per capita national expenditures on public security, 1995-2011.

| 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 109 | 113 | 123 | 135 | 134 | 152 | 185 | 192 | 187 | 177 | 193 | 208 | 214 | 232 | 240 | 223 | 252 |

Data Source: STN. Table generated by author. Values denominated in 2011 prices using IPCA.

To my knowledge, this paper is the first to directly relate security expenditures to the spread of violence using an inequality index. Recalling that Gini and Hoover capture the effects of the interiorization of violence in one value, it becomes possible to directly compare these statistics with security spending.

Several works explore other relationships that affect violence. The most commonly studied topic in this area of research relates income inequality and violence. As expected, these works generally show that unequal income distributions are related with higher homicide rates – Marmot et al. (1987) and Towsend and Davidson (1990). Still others examine the relationship between income inequality and other social ills, such as crime and health. Only one work was encountered relating government spending figures with an inequality measure.

These negative correlations are also found using both the Gini and Hoover income inequality measures. Kennedy et al. (1996), for example, shows that within the United States higher (more unequal) Gini and Hoover indices for income inequality are correlated with higher mortality and homicides rates. These relationships also hold for Brazil. As demonstrated by Szwarcwald et al. (1999), homicide rates, as well as several indicators of health, are highly correlated with income inequality within the state of Rio de Janeiro .

Another work relates income inequality, crime and police spending with interesting results. Kelly (2000) finds that the *type* of crime is effected differently by levels of income inequality. Specifically he finds little evidence that *property* crime is correlated with income inequality. Rather, property crime is more closely correlated with poverty and spending on policing. Meanwhile, *violent* crime, such as

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homicide, is highly correlated with income inequality. These results suggest that the economic theory on crime may be less suited to explain violent crime rather than social disorganization theory. Thus, the *type* of crime matters when considering correlation with income inequality.

In regards to spending initiatives, only one study was encountered that explores how government spending may influence income inequality within a society. Lin and Hamid (2009) examine whether a causal relationship exists between military spending and income inequality. They find little support that increased defense spending causes, in the Granger sense, income to be distributed less equally. Additionally, their work highlights how to treat some common panel data challenges such as unit roots and non-stationary processes. While Lin and Hamid do not touch upon the theme of violence, their work is nonetheless useful in developing a framework to relate spending and inequality.

While all these works are important to understanding violence they are only peripherally relevant to this study because none of them address how expenditures effect the distribution of violence. In other words, income inequalities are not equivalent to inequalities in the distribution of violence. In this sense, a novel approach is proposed relating security expenditures with the spread of violence to understand the new patterns of violence afoot in Brazil.

## 3.4   Econometric Model and Estimated Results

This study seeks to understand how patterns of violence have evolved in time with respect to security expenditures. Thus the null hypothesis that public security expenditures and violence dispersion are not correlated is tested. As previously addressed, the data comes from the ministry of health and the national treasury and includes 26 Brazilian states[9] during 17 years from 1995-2011.

Given that each state has unique time invariant characteristics that may affect its propensity to spend on public security, this model must control for this unobserved individual heterogeneity. For example, governors have the prerogative to prioritize and administer security spending. Thus, levels of police training, preparation and salaries can vary widely between states. Further, some states have stronger traditions of organized crime. To account for this heterogeneity, each state's time invariant characteristics are separated from the explanatory variable, thus controlling for any effects they may play in determining public security expenditures.

Moreover, this panel is also checked for stationarity using three specifications of the Levin et al. (2002) test for panel unit roots. The results of these LLC tests are presented in Table 22. It is found that all three of the variables of interest, Gini, Hoover, and security expenditures, are likely stationary processes at least at the 90 percent confidence level.

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[9]   *Distrito Federal* is excluded from the sample, as it only has one municipality and it is not possible for violence to redistribute to others.

Table 22 – Panel Unit Root Tests for Key Variables.

| Key Variable | (1) | (2) | (3) |
|---|---|---|---|
| Gini | -3.557 | -2.862 | -3.894 |
|  | (0.000) | (0.002) | (0.000) |
| Hoover | -2.652 | -1.328 | -3.850 |
|  | (0.004) | (0.091) | (0.000) |
| ln(Expenditures) | -4.461 | -3.755 | -5.362 |
|  | (0.000) | (0.000) | (0.000) |

According to LLC test for key variable $z_{it}$:

(1) $\Delta z_{it} = \delta z_{it-1} + \zeta_{it}$

(2) $\Delta z_{it} = \alpha_{0i} + \delta z_{it-1} + \zeta_{it}$

(3) $\Delta z_{it} = \alpha_{0i} + \alpha_{1i}t + \delta z_{it-1} + \zeta_{it}$

p-value in parentheses.

The baseline model is represented by: $y_{it} = \alpha + \beta \ln x_{it} + c_i + u_{it}$. Where $y_{it}$ is the inequality measure in state $i$ and year $t$, $x_{it}$ are public security expenditures, $c_i$ and $u_{it}$ are the state-specific idiosyncratic terms and error terms, respectively, and $\alpha$ and $\beta$ are the parameters to be estimated. In particular, $\beta$, which measures the relationship between spending and dispersion, is the primary parameter of interest.

Gini and Hoover inequality measures are used as the dependent variables because they have an interpretation most similar to interiorization. Given that these statistics are measured in percentages, and the independent variable is measured in natural logs, the slope coefficients $\beta$ have the interpretation of elasticity. Thus, $\beta$ is interpreted as the percent change in the distribution of violence given a 1 percent change in public security expenditures.

The baseline model is augmented to control for crucial events that possibly explain homicide rates and violence dispersion. To this end, two dummy variables and two interaction variables are included. Starting in 2000 the *Fundo Nacional de Segurança Pública* (National Public Security Plan) that increased security expenditures in Brazil's more violent places is accounted for. Starting in 2004 the *Estatuto do Desarmamento* (Disarmament Statue) which greatly restricted access of the civilian population to weapons is controlled for. The two interaction variables are the product of each event's dummy with public spending and therefore analyze the effects of crime dispersion after the onset of one of these national programs. Thus, the following model is estimated:

$$y_{it} = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \beta_0 \ln x_{it} + \beta_1 D_{1t} \ln x_{it} + \beta_2 D_{2t} \ln x_{it} + c_i + u_{it} \qquad (3.1)$$

Where equation (3.1) is the baseline regressions of the Gini and Hoover inequality measures $y_{it}$, $\ln x_{it}$ is the natural log of per capita expenditures on public security, $D_{1t}$ is the dummy variable for the *Fundo Nacional de Segurança Pública* taking the value of 1 from 2000-2011 and 0 otherwise, and $D_{2t}$ is the dummy variable for the *Estatuto de Desarmamento*, which takes the value of 1 from 2004-2011 and 0 otherwise.

The null hypothesis is that there is no correlation between the explanatory variables and the interiorization of violence, or $\beta_j = 0$ for $j = 0, 1, 2$. This hypothesis suggests that public security expenditures, the *Fundo Nacional de Segurança Pública*, and the *Estatuto de Desarmamento*, are not correlated with the dispersion of violence. The results of this model are presented in Table 23.

Table 23 – Regression results.

| | Gini | | | | Hoover | | | |
|---|---|---|---|---|---|---|---|---|
| | RE (1) | FE (2) | RE (3) | FE (4) | RE (5) | FE (6) | RE (7) | FE (8) |
| $\alpha_0$ | 0.400*** | 0.398*** | 0.331*** | 0.341*** | 0.630*** | 0.626*** | 0.695*** | 0.687*** |
| | (0.038) | (0.041) | (0.049) | (0.057) | (0.063) | (0.055) | (0.099) | (0.095) |
| $\alpha_1$ | | | 0.001 | -0.010 | | | -0.145* | -0.149* |
| | | | (0.061) | (0.061) | | | (0.077) | (0.077) |
| $\alpha_2$ | | | 0.207** | 0.198** | | | -0.026 | -0.031 |
| | | | (0.095) | (0.094) | | | (0.132) | (0.134) |
| $\beta_0$ | -0.006 | -0.005 | 0.009 | 0.007 | -0.064*** | -0.063*** | -0.078*** | -0.076*** |
| | (0.008) | (0.008) | (0.011) | (0.013) | (0.011) | (0.011) | (0.021) | (0.021) |
| $\beta_1$ | | | 0.001 | 0.003 | | | 0.031* | 0.032* |
| | | | (0.012) | (0.012) | | | (0.016) | (0.016) |
| $\beta_2$ | | | -0.041** | -0.040** | | | 0.002 | 0.003 |
| | | | (0.018) | (0.018) | | | (0.026) | (0.026) |

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

The first column of the table indicates the estimated parameter while the subsequent columns represent the eight different model specifications outlined in the previous section. Columns (1), (2), (5) and (6) are the baseline models for Gini and Hoover random (RE) and fixed effects (FE) respectively. Columns (3), (4), (7) and (8) show the results of the model augmented with the dummy variables[10].

The most striking result is that dispersion of violence is highly correlated with expenditures on public security when Hoover is the dependent variable. On the other hand, the Gini coefficient shows no significant correlation across the sample period in all regressions. However, the spread of violence

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[10]    The coefficients of both the random and fixed effects models were remarkably similar in both magnitude and significance. As the estimated parameters between the two models were close to identical, conducting a Hausman test to choose between the random or fixed effects model is largely a formality. Nonetheless, it was not possible to reject the null hypothesis of the Hausman Test that the unique, time invariant error terms are *not* correlated with the regressors. Thus, the random effects model is marginally more suitable than the fixed effects model in estimating this panel and conclude that the unique characteristics of each Brazilian state are not correlated with expenditures on public security. Furthermore, normality tests indicate that the residuals are normally distributed. Finally, all models were corrected for heteroskedasticity.

based on the Gini coefficient shows a strong correlation with security expenditures from 2004-2011 after implementation of the *Estatuto do Desarmamento*. The results suggest the following:

1. The null hypothesis is rejected that a correlation does not exist between Gini and expenditures <u>after</u> the *Estatuto do Desarmamento* and estimate an elasticity of -4%.

2. The null hypothesis is rejected that a correlation does not exist between Hoover and expenditures for the entire estimation period and estimate an elasticity of -7% <u>before</u> the *Fundo Nacional de Segurança Pública* and -3% <u>after</u>.

These results lead to two key findings. First, rejecting the null hypothesis provides evidence of correlation between Gini/Hoover and expenditures. This correlation between Gini/Hoover and expenditures implies a correlation between movements in the Lorenz Curve and expenditures. Second, to corroborate the estimated results the possibility is highlighted where movements in the Lorenz Curve can alter the Hoover statistic while leaving Gini unchanged. This possibility is illustrated in Figure 27(a) where the new Lorenz Curve is represented by the dotted line. The two areas between the Lorenz Curves are the same size, and thus cancel out leaving Gini unchanged. However, the Hoover statistic still moves.



(a) Hoover moves but not Gini                      (b) Hoover and Gini move
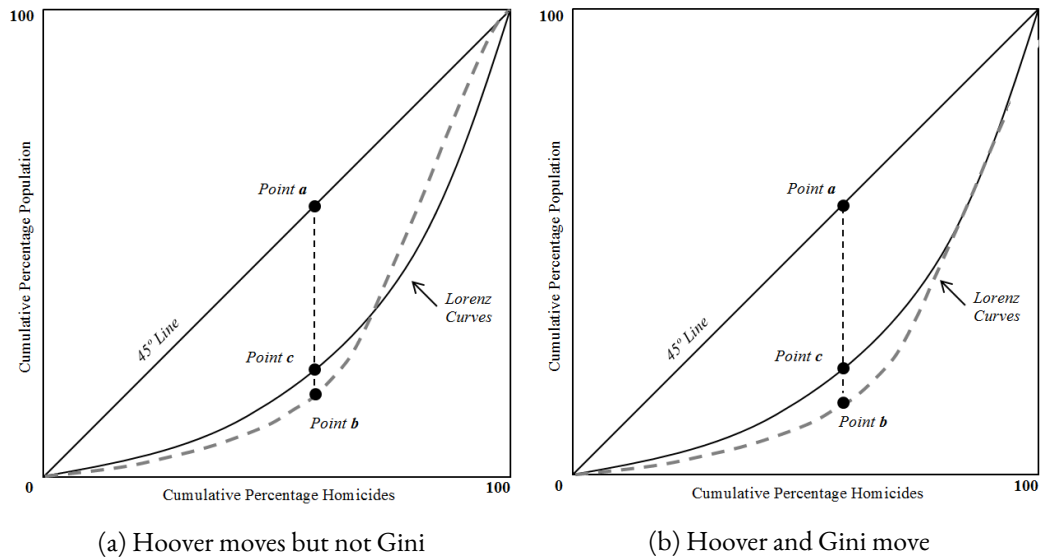
Figure 27 – Movements of the Lorenz Curve. Figure generated by author.

The movement of the Lorenz Curve outlined in Figure 27(a) is consistent with the Gini statistic prior to the *Estatuto do Desarmamento*. In this case, the Gini statistic remained static in the face of increased security expenditures, but the Hoover moved.

Figure 27(b) represents the case after the *Estatuto do Desarmamento* where both Gini and Hoover are explained by expenditures. Overall the null hypothesis is rejected finding evidence of correlation between the inequality indices for the distribution of homicides and public security spending. However, in the case of the Gini statistic, changes in the patterns of violence are only affected by expenditures after the *Estatuto do Desarmamento*.

But, how can one interpret these types of changes in the Lorenz Curve where there exists the possibility that the Hoover statistic moves without a corresponding change in Gini? Perhaps one explanation is the possibility that violence disperses in two distinct phases. As states are comprised of relatively few major urban centers compared to medium and small cities, it is possible that the first phase of violence represents a migration to a handful of smaller municipalities located geographically proximate to the more violent urban areas. This type of migration involves redistribution to a relatively small number of smaller cities is best indicated in Figure 27(a). Here the Hoover statistic changes, but Gini remains fixed. The second phase of dispersion happens when violence eventually migrates to all municipalities. The phase is indicated in Figure 27(b) where *both* the Gini and Hoover statistics move.

But, to better understand the relationship between spending, violence dispersion and Lorenz Curve movements, one must also consider the distribution of spending within a state. However, given the lack of available data showing how security spending is distributed within a state, one can only conjecture this distribution: Spending, at a per capita level, is more heavily concentrated in metropolitan areas than in the countryside.

To understand why this conjecture is plausible, consider the following counterexample: If spending were evenly distributed within a state, it becomes difficult to argue that increased spending diffuses violence to rural areas. Rural municipalities would have the same security resources as larger areas and therefore should not attract more crime and violence. A more extreme example considers proportionately higher expenditures in rural areas. Again, in this example, it would not make logical sense that crime would actually flee *less* policed areas in pursuit of more secure targets in the countryside.

A second reason why spending may be more concentrated in urban areas relates to the nature of government programs aimed at addressing increases in violence. Both the aforementioned *Fundo Nacional de Segurança* as well as the *Plano Nacional de Segurança* (National Security Plan) stipulated additional funding for areas that "were leading" in violence during that time period (see Waiselfisz, 2011).

Even though it was not possible to empirically validate that spending was more concentrated in cities, assuming that states complied with the national security programs, it follows that more violent areas (the big cities) received a proportionally higher level of funding than less violent areas.

Of final note, when considering these results, it is important to realize that this research only addresses the trend of interiorization and not dissemination of violence. As the model measures correlations at the state level, this study does not capture any effect of "dissemination" where expenditures in state $X$ spreads violence to state $Y$. Addressing the scope of dissemination of violence is left to

future study.

## 3.5   Conclusions

The contribution of this article is two fold. First a novel way was developed to measure the *interiorization* effects of violence migrating from cities to the countryside by employing inequality indices. Using a single variable to capture the dispersion of violence facilitates comparison of these trends with a host of variables. Secondly, this study finds correlation between the redistribution of violence and increased public security spending. The two key findings are:

1. The elasticity of Gini/Expenditures per capita is -4% after 2004 *Estatuto do Desarmamento.*

2. The elasticity for Hoover/Expenditures is -7% before the 2000 *Fundo Nacional de Segurança Pública* and -3% after.

It is concluded that spending on public security is correlated with the redistribution of violence from larger cities to the countryside. While these results are not evidence that public security expenditures *cause* these shifts in violence, they provide a starting point to investigate further whether increased investment in larger metropolitan regions have a causal effect in these new patterns of violence. Furthermore, the strong correlation found in Brazil may suggest that the policies taken by other governments, such as spending more on public security to combat high rates of violence, may similarly be correlated with a redistribution of violence. These themes are left for further investigation.

APPENDIX A: Gini (G) and Hoover (H) Index for Homicides, and Annual per capita national expenditures (E) on public security (values denominated in 2011 prices using IPCA) – Brazilian States, 1995-2011.

| State and Indicator | | Year | | | | | | | | | | | | | | | | | Linear Correlation between G/H and E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | |
| AC | H | 0.325 | 0.375 | 0.415 | 0.417 | 0.417 | 0.421 | 0.401 | 0.342 | 0.348 | 0.289 | 0.232 | 0.226 | 0.250 | 0.254 | 0.285 | 0.183 | 0.119 | -0.66 |
| | G | 0.330 | 0.410 | 0.432 | 0.406 | 0.336 | 0.473 | 0.356 | 0.219 | 0.438 | 0.337 | 0.276 | 0.286 | 0.328 | 0.217 | 0.380 | 0.250 | 0.211 | -0.50 |
| | E | 138 | 126 | 163 | 148 | 212 | 291 | 296 | 341 | 324 | 305 | 294 | 305 | 348 | 399 | 460 | 429 | 398 | |
| AL | H | 0.260 | 0.263 | 0.267 | 0.230 | 0.277 | 0.250 | 0.323 | 0.286 | 0.353 | 0.308 | 0.305 | 0.304 | 0.325 | 0.284 | 0.244 | 0.244 | 0.240 | -0.15 |
| | G | 0.350 | 0.324 | 0.338 | 0.277 | 0.332 | 0.271 | 0.378 | 0.345 | 0.407 | 0.421 | 0.463 | 0.396 | 0.443 | 0.347 | 0.307 | 0.308 | 0.344 | 0.01 |
| | E | 57 | 94 | 80 | 95 | 111 | 122 | 109 | 129 | 129 | 136 | 154 | 174 | 197 | 237 | 276 | 268 | 240 | |
| AM | H | 0.427 | 0.431 | 0.429 | 0.439 | 0.352 | 0.337 | 0.288 | 0.305 | 0.226 | 0.241 | 0.234 | 0.224 | 0.230 | 0.294 | 0.323 | 0.270 | 0.283 | -0.67 |
| | G | 0.401 | 0.416 | 0.429 | 0.423 | 0.363 | 0.358 | 0.329 | 0.324 | 0.439 | 0.399 | 0.368 | 0.349 | 0.403 | 0.377 | 0.395 | 0.365 | 0.316 | -0.45 |
| | E | 80 | 99 | 104 | 108 | 101 | 99 | 159 | 175 | 150 | 157 | 171 | 179 | 181 | 204 | 220 | 225 | 242 | |
| AP | H | 0.249 | 0.258 | 0.240 | 0.218 | 0.273 | 0.251 | 0.143 | 0.162 | 0.164 | 0.146 | 0.145 | 0.177 | 0.132 | 0.133 | 0.080 | 0.162 | 0.114 | -0.85 |
| | G | 0.216 | 0.380 | 0.204 | 0.360 | 0.389 | 0.333 | 0.211 | 0.510 | 0.402 | 0.392 | 0.365 | 0.343 | 0.264 | 0.236 | 0.294 | 0.269 | 0.374 | 0.08 |
| | E | 42 | 51 | 45 | 47 | 38 | 67 | 64 | 259 | 270 | 280 | 278 | 337 | 341 | 437 | 454 | 410 | 471 | |
| BA | H | 0.416 | 0.418 | 0.428 | 0.388 | 0.377 | 0.388 | 0.413 | 0.379 | 0.324 | 0.312 | 0.320 | 0.337 | 0.351 | 0.379 | 0.350 | 0.353 | 0.335 | -0.61 |
| | G | 0.359 | 0.382 | 0.374 | 0.386 | 0.347 | 0.378 | 0.397 | 0.410 | 0.417 | 0.418 | 0.404 | 0.417 | 0.431 | 0.440 | 0.420 | 0.431 | 0.411 | 0.76 |
| | E | 56 | 73 | 96 | 89 | 85 | 88 | 90 | 101 | 103 | 113 | 128 | 141 | 150 | 157 | 166 | 157 | 193 | |
| CE | H | 0.409 | 0.330 | 0.326 | 0.276 | 0.272 | 0.282 | 0.267 | 0.268 | 0.284 | 0.256 | 0.289 | 0.276 | 0.296 | 0.254 | 0.215 | 0.255 | 0.244 | -0.70 |
| | G | 0.353 | 0.334 | 0.343 | 0.320 | 0.369 | 0.334 | 0.349 | 0.301 | 0.426 | 0.379 | 0.406 | 0.418 | 0.393 | 0.359 | 0.312 | 0.343 | 0.345 | -0.16 |
| | E | 43 | 47 | 52 | 61 | 57 | 59 | 73 | 68 | 63 | 64 | 68 | 76 | 82 | 93 | 126 | 127 | 120 | |
| ES | H | 0.311 | 0.294 | 0.342 | 0.316 | 0.308 | 0.281 | 0.280 | 0.289 | 0.324 | 0.300 | 0.317 | 0.289 | 0.277 | 0.231 | 0.232 | 0.213 | 0.219 | -0.67 |
| | G | 0.407 | 0.366 | 0.428 | 0.451 | 0.416 | 0.382 | 0.389 | 0.444 | 0.367 | 0.406 | 0.409 | 0.393 | 0.430 | 0.367 | 0.377 | 0.353 | 0.408 | -0.20 |
| | E | 154 | 176 | 170 | 201 | 188 | 169 | 154 | 172 | 210 | 177 | 180 | 188 | 259 | 232 | 237 | 245 | 240 | |
| GO | H | 0.312 | 0.292 | 0.290 | 0.315 | 0.296 | 0.255 | 0.236 | 0.261 | 0.321 | 0.305 | 0.302 | 0.336 | 0.305 | 0.245 | 0.231 | 0.249 | 0.259 | -0.42 |
| | G | 0.378 | 0.341 | 0.341 | 0.361 | 0.395 | 0.387 | 0.336 | 0.364 | 0.363 | 0.375 | 0.394 | 0.414 | 0.351 | 0.391 | 0.352 | 0.340 | 0.353 | -0.08 |
| | E | 75 | 73 | 79 | 91 | 93 | 115 | 156 | 155 | 139 | 171 | 161 | 172 | 215 | 191 | 219 | 220 | 228 | |
| MA | H | 0.537 | 0.547 | 0.515 | 0.524 | 0.545 | 0.522 | 0.522 | 0.449 | 0.361 | 0.339 | 0.318 | 0.334 | 0.371 | 0.372 | 0.392 | 0.369 | 0.365 | -0.77 |
| | G | 0.396 | 0.353 | 0.370 | 0.352 | 0.348 | 0.359 | 0.414 | 0.384 | 0.430 | 0.420 | 0.417 | 0.411 | 0.431 | 0.355 | 0.401 | 0.414 | 0.370 | 0.44 |

*Chapter 3. The Interiorization of Brazilian Violence: Is Increased Violence in the Countryside Related with Increased Public Security Expenditures in Big Cities?*

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| | E | 30 | 36 | 38 | 42 | 38 | 16 | 62 | 71 | 79 | 74 | 73 | 81 | 89 | 102 | 126 | 135 | 114 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MG | H | 0.466 | 0.452 | 0.473 | 0.476 | 0.465 | 0.467 | 0.440 | 0.438 | 0.402 | 0.402 | 0.383 | 0.384 | 0.368 | 0.361 | 0.353 | 0.340 | 0.336 | -0.91 |
| | G | 0.421 | 0.398 | 0.421 | 0.424 | 0.409 | 0.416 | 0.392 | 0.437 | 0.400 | 0.403 | 0.403 | 0.408 | 0.397 | 0.384 | 0.386 | 0.371 | 0.365 | -0.70 |
| | E | 91 | 93 | 105 | 121 | 110 | 200 | 244 | 235 | 215 | 214 | 244 | 277 | 286 | 313 | 340 | 338 | 355 | |
| MS | H | 0.170 | 0.171 | 0.150 | 0.189 | 0.164 | 0.210 | 0.182 | 0.159 | 0.329 | 0.260 | 0.297 | 0.258 | 0.320 | 0.204 | 0.171 | 0.229 | 0.183 | 0.40 |
| | G | 0.310 | 0.291 | 0.267 | 0.345 | 0.318 | 0.364 | 0.338 | 0.340 | 0.404 | 0.386 | 0.355 | 0.397 | 0.393 | 0.392 | 0.321 | 0.349 | 0.301 | 0.43 |
| | E | 112 | 119 | 131 | 182 | 159 | 174 | 196 | 185 | 261 | 237 | 230 | 249 | 306 | 332 | 321 | 295 | 375 | |
| MT | H | 0.300 | 0.262 | 0.273 | 0.316 | 0.260 | 0.254 | 0.281 | 0.221 | 0.431 | 0.386 | 0.397 | 0.353 | 0.359 | 0.214 | 0.196 | 0.198 | 0.209 | -0.33 |
| | G | 0.373 | 0.351 | 0.361 | 0.393 | 0.321 | 0.365 | 0.369 | 0.351 | 0.501 | 0.419 | 0.456 | 0.414 | 0.421 | 0.358 | 0.337 | 0.311 | 0.312 | -0.21 |
| | E | 112 | 113 | 147 | 135 | 125 | 155 | 155 | 168 | 200 | 215 | 231 | 245 | 203 | 309 | 343 | 341 | 367 | |
| PA | H | 0.399 | 0.392 | 0.376 | 0.389 | 0.386 | 0.505 | 0.449 | 0.432 | 0.359 | 0.372 | 0.378 | 0.347 | 0.343 | 0.318 | 0.313 | 0.324 | 0.300 | -0.78 |
| | G | 0.413 | 0.426 | 0.476 | 0.426 | 0.460 | 0.502 | 0.489 | 0.637 | 0.417 | 0.433 | 0.439 | 0.401 | 0.418 | 0.448 | 0.476 | 0.461 | 0.409 | -0.22 |
| | E | 61 | 65 | 96 | 105 | 97 | 81 | 79 | 78 | 82 | 93 | 96 | 123 | 126 | 146 | 151 | 154 | 159 | |
| PB | H | 0.390 | 0.380 | 0.401 | 0.528 | 0.491 | 0.465 | 0.491 | 0.448 | 0.432 | 0.436 | 0.405 | 0.390 | 0.448 | 0.338 | 0.352 | 0.357 | 0.331 | -0.55 |
| | G | 0.369 | 0.331 | 0.353 | 0.358 | 0.376 | 0.366 | 0.405 | 0.415 | 0.403 | 0.405 | 0.380 | 0.352 | 0.401 | 0.328 | 0.356 | 0.410 | 0.356 | 0.07 |
| | E | 39 | 34 | 61 | 71 | 72 | 72 | 80 | 84 | 118 | 110 | 111 | 138 | 147 | 163 | 181 | 173 | 178 | |
| PE | H | 0.256 | 0.260 | 0.267 | 0.251 | 0.243 | 0.229 | 0.222 | 0.213 | 0.317 | 0.311 | 0.323 | 0.316 | 0.336 | 0.207 | 0.191 | 0.175 | 0.170 | -0.56 |
| | G | 0.325 | 0.343 | 0.371 | 0.397 | 0.352 | 0.328 | 0.347 | 0.379 | 0.424 | 0.367 | 0.422 | 0.402 | 0.447 | 0.309 | 0.293 | 0.302 | 0.259 | -0.54 |
| | E | 88 | 77 | 80 | 101 | 109 | 120 | 127 | 128 | 110 | 126 | 137 | 126 | 141 | 166 | 187 | 204 | 236 | |
| PI | H | 0.556 | 0.601 | 0.590 | 0.642 | 0.578 | 0.526 | 0.466 | 0.496 | 0.471 | 0.436 | 0.442 | 0.383 | 0.407 | 0.406 | 0.387 | 0.424 | 0.415 | -0.52 |
| | G | 0.482 | 0.351 | 0.346 | 0.405 | 0.464 | 0.397 | 0.385 | 0.470 | 0.397 | 0.395 | 0.370 | 0.316 | 0.416 | 0.321 | 0.323 | 0.327 | 0.360 | 0.10 |
| | E | 71 | 67 | 70 | 80 | 81 | 80 | 100 | 117 | 117 | 117 | 93 | 93 | 102 | 72 | 102 | 106 | 81 | |
| PR | H | 0.269 | 0.307 | 0.268 | 0.267 | 0.294 | 0.284 | 0.277 | 0.287 | 0.326 | 0.316 | 0.314 | 0.315 | 0.342 | 0.274 | 0.272 | 0.284 | 0.269 | -0.35 |
| | G | 0.331 | 0.360 | 0.338 | 0.362 | 0.409 | 0.355 | 0.349 | 0.318 | 0.394 | 0.400 | 0.366 | 0.392 | 0.401 | 0.367 | 0.336 | 0.366 | 0.350 | -0.24 |
| | E | 97 | 113 | 135 | 132 | 120 | 110 | 119 | 118 | 111 | 45 | 118 | 134 | 130 | 137 | 137 | 150 | 162 | |
| RJ | H | 0.141 | 0.139 | 0.140 | 0.157 | 0.132 | 0.136 | 0.134 | 0.128 | 0.218 | 0.223 | 0.231 | 0.245 | 0.251 | 0.140 | 0.144 | 0.151 | 0.169 | 0.51 |
| | G | 0.354 | 0.366 | 0.384 | 0.367 | 0.377 | 0.351 | 0.372 | 0.471 | 0.441 | 0.417 | 0.405 | 0.442 | 0.450 | 0.359 | 0.393 | 0.338 | 0.334 | 0.53 |
| | E | 144 | 134 | 143 | 168 | 241 | 258 | 327 | 362 | 348 | 331 | 337 | 372 | 368 | 387 | 278 | 276 | 300 | |
| RN | H | 0.384 | 0.376 | 0.405 | 0.375 | 0.336 | 0.304 | 0.322 | 0.319 | 0.349 | 0.338 | 0.330 | 0.353 | 0.361 | 0.300 | 0.304 | 0.303 | 0.294 | -0.74 |
| | G | 0.376 | 0.345 | 0.388 | 0.421 | 0.346 | 0.356 | 0.330 | 0.332 | 0.397 | 0.372 | 0.388 | 0.376 | 0.376 | 0.379 | 0.351 | 0.359 | 0.376 | -0.06 |
| | E | 41 | 42 | 47 | 68 | 82 | 94 | 101 | 107 | 111 | 114 | 120 | 134 | 169 | 197 | 215 | 185 | 193 | |
| RO | H | 0.314 | 0.307 | 0.266 | 0.284 | 0.238 | 0.303 | 0.268 | 0.216 | 0.308 | 0.342 | 0.300 | 0.344 | 0.321 | 0.300 | 0.285 | 0.273 | 0.314 | 0.12 |
| | G | 0.391 | 0.360 | 0.353 | 0.392 | 0.356 | 0.432 | 0.393 | 0.377 | 0.380 | 0.392 | 0.329 | 0.457 | 0.389 | 0.427 | 0.433 | 0.394 | 0.383 | 0.52 |

| | | 192 | 195 | 180 | 216 | 206 | 430 | 368 | 273 | 253 | 271 | 274 | 311 | 319 | 385 | 428 | 454 | 485 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR | H | 0.291 | 0.257 | 0.141 | 0.166 | 0.223 | 0.110 | 0.140 | 0.118 | 0.175 | 0.171 | 0.132 | 0.192 | 0.197 | 0.156 | 0.125 | 0.098 | 0.099 | -0.43 |
| | G | 0.347 | 0.275 | 0.334 | 0.301 | 0.451 | 0.254 | 0.314 | 0.186 | 0.343 | 0.365 | 0.227 | 0.326 | 0.288 | 0.348 | 0.311 | 0.229 | 0.246 | -0.21 |
| | E | 64 | 64 | 67 | 71 | 91 | 108 | 118 | 174 | 212 | 218 | 234 | 305 | 334 | 403 | 348 | 369 | 335 | |
| RS | H | 0.351 | 0.315 | 0.309 | 0.300 | 0.296 | 0.324 | 0.292 | 0.299 | 0.381 | 0.338 | 0.342 | 0.337 | 0.319 | 0.328 | 0.318 | 0.325 | 0.319 | -0.02 |
| | G | 0.396 | 0.391 | 0.350 | 0.353 | 0.348 | 0.376 | 0.357 | 0.319 | 0.420 | 0.385 | 0.395 | 0.403 | 0.414 | 0.401 | 0.380 | 0.408 | 0.378 | 0.25 |
| | E | 121 | 135 | 134 | 190 | 145 | 160 | 170 | 161 | 179 | 141 | 169 | 182 | 183 | 156 | 240 | 274 | 185 | |
| SC | H | 0.343 | 0.342 | 0.306 | 0.341 | 0.335 | 0.326 | 0.335 | 0.333 | 0.403 | 0.407 | 0.392 | 0.376 | 0.378 | 0.311 | 0.319 | 0.296 | 0.316 | 0.02 |
| | G | 0.354 | 0.354 | 0.360 | 0.378 | 0.408 | 0.392 | 0.351 | 0.353 | 0.415 | 0.378 | 0.407 | 0.384 | 0.445 | 0.416 | 0.355 | 0.373 | 0.375 | 0.39 |
| | E | 108 | 110 | 115 | 153 | 129 | 178 | 182 | 203 | 209 | 226 | 256 | 210 | 224 | 346 | 267 | 244 | 249 | |
| SE | H | 0.329 | 0.389 | 0.309 | 0.276 | 0.295 | 0.261 | 0.308 | 0.265 | 0.429 | 0.386 | 0.314 | 0.297 | 0.278 | 0.209 | 0.199 | 0.168 | 0.206 | -0.73 |
| | G | 0.355 | 0.381 | 0.320 | 0.323 | 0.346 | 0.338 | 0.348 | 0.224 | 0.451 | 0.393 | 0.347 | 0.395 | 0.354 | 0.278 | 0.278 | 0.293 | 0.316 | -0.36 |
| | E | 101 | 107 | 110 | 132 | 131 | 124 | 139 | 148 | 143 | 151 | 152 | 192 | 197 | 214 | 276 | 383 | 344 | |
| SP | H | 0.312 | 0.296 | 0.293 | 0.289 | 0.296 | 0.296 | 0.277 | 0.255 | 0.280 | 0.257 | 0.239 | 0.223 | 0.255 | 0.187 | 0.168 | 0.170 | 0.199 | -0.80 |
| | G | 0.415 | 0.429 | 0.408 | 0.434 | 0.434 | 0.433 | 0.413 | 0.424 | 0.433 | 0.410 | 0.394 | 0.424 | 0.410 | 0.378 | 0.349 | 0.355 | 0.356 | -0.68 |
| | E | 140 | 140 | 153 | 154 | 143 | 149 | 219 | 227 | 214 | 202 | 219 | 239 | 241 | 268 | 290 | 198 | 312 | |
| TO | H | 0.547 | 0.515 | 0.524 | 0.475 | 0.496 | 0.440 | 0.440 | 0.371 | 0.439 | 0.470 | 0.469 | 0.392 | 0.425 | 0.323 | 0.334 | 0.256 | 0.260 | -0.91 |
| | G | 0.400 | 0.407 | 0.408 | 0.427 | 0.390 | 0.346 | 0.381 | 0.291 | 0.379 | 0.442 | 0.384 | 0.329 | 0.359 | 0.308 | 0.301 | 0.248 | 0.314 | -0.72 |
| | E | 66 | 108 | 98 | 109 | 91 | 109 | 132 | 161 | 169 | 174 | 182 | 225 | 254 | 253 | 294 | 346 | 397 | |

Data Source: SIM/SVS/MS and STN. Table generated by author.

# Armed Violence and Weapons Production: An Analysis of Brazilian Small Arms Manufacturer Taurus

Abstract: Armed violence takes a heavy toll on Brazilian society. By several measures Brazil ranks among the most violent places in the world. Given that the vast majority of this violence is executed using domestically produced fire arms, this study aims to contribute to the literature on violence by analyzing more closely the Brazilian arms industry. The motivation to investigate the arms industry originates with two key facts: The first cites that domestically produced Brazilian firearms were used in an overwhelming majority of the nation's homicides. The second notes that the dramatic rise in violence coincided with a production boom in Brazilian small arms. It is beyond the scope of this paper to determine whether this correlation implies a causal link between a robust arms industry and high levels of violence in Brazil. Innumerable factors play a part in determining violent outcomes. However, given the correlation between violence and domestically produced firearms, this paper endeavors to examine the small arms industry more closely. To gain insight about the Brazilian arms industry, this paper analyzes Brazil's largest and most important small arms manufacturer, Forjas Taurus. Diverse factors are considered that shaped this company as well as the arms industry as a whole. By increasing the understanding of Brazil's arms industry this paper hopes to unravel some of the complexity of the panorama of Brazilian violence.

# 4.1   Introduction

Brazil is a violent place. In fact, the country ranks among the most violent nations in the world, with an intentional homicide annual rate ranging around 27 homicides per 100,000 inhabitants. This rate is roughly two to three times that of the United States and upwards of 40 times that Japan[1]. To put Brazilian violence in perspective, consider some of these staggering facts[2]:

- Between 1980-2010 more people died in Brazilian homicides caused by fire arms than the combined total of the 12 bloodiest armed conflicts in the world during the same period.

- Brazil is one of the few countries in the world where homicide rates surpass traffic accident mortality rates. (In 2011 the homicide rate was 27.1, while the traffic fatality rate was 23.2 deaths per 100,000 individuals.)

- The youth population is particularly affected by armed violence. Young persons die of homicides at nearly twice the rate of the general population, and nearly two in five of all registered deaths for persons aged 15-24 are the result of homicides.

These levels of violence exist and persevere despite Brazil being a nation without territorial disputes, civil war, or pronounced racial or ethnic tensions.[3] It is clear that this violence comes at a high cost, therefore earning a spot among the top challenges Brazil faces on its path toward development and prosperity.

The vast majority of this violence is carried out by small arms. Strikingly, the overwhelming majority of weapons used to perpetrate this violence were domestically produced. For example, 82 percent of 146,723 small arms seized in the states of São Paulo, Rio de Janeiro, and the Federal District between 1998 and 2006 were manufactured in Brazil (Câmera dos Deputados, 2006, p. 338-40). As noted in Dreyfus et al (2010 p. 30)

"This finding (that weapons were predominately domestically produced) runs counter to what was once conventional wisdom — in part circulated by the small arms industry itself: that criminals use military-style foreign-made small arms to commit crimes while law-abiding citizens use registered Brazilian-made small arms for legitimate self-defense. In reality, Brazil's own small arms manufacturing companies produce a large percentage of the guns that are responsible for the country's astronomical levels of armed violence."

These numbers show that domestically produced weapons, and not illegally smuggled foreign weapons, are involved in a disproportionate number of the violent outcomes in Brazil.

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[1]   For more details, see UNODC (2011).
[2]   For more details, see Waiselfisz (2011, 2012).
[3]   For a comprehensive source on Brazilian violence see the *Mapa da Violência* series: `www.mapadaviolencia.org.br`.

In its functional form violence is composed of several variables such that $V = f(L, W, X)$ where $V$ represents violence. The inputs that lead to violence are $L$, the person who commits the violent act, $W$, the availability of the weapon used to commit the act, and $X$, a vector of other factors leading to violent outcomes such as poverty, inequality, urbanization, drugs, and law enforcement. This paper does not propose that a causal link exists between a robust arms industry and high levels of violence in Brazil. In other words, it does not enter the debate of whether "people ($L$) kill people" or whether "guns ($W$) kill people." Nor does it intend to analyze any of the other numerous other possibilities ($X$) that lead to homicides. Rather, these relationships are taken as given and weapons availability is taken as one of the numerous inputs related to violence.

However, given the correlation between violence and the availability of domestically produced firearms, this paper endeavors to examine the industry that produces these weapons more closely. Given that Brazil is the second largest small arms producer and exporter in the western hemisphere, and that small arms production boomed during the same decade that violence rose dramatically, the question is raised on whether the sheer number of weapons available is related with violence. (Dreyfus, 2010 p. 27). In this sense, domestic weapons production and proliferation may explain part of the story of armed violence in Brazil, and is therefore the main thrust of this study.

To gain insight into the production side of these weapons this paper studies the Brazilian arms industry by profiling its key small arms producer, Forjas Taurus (Taurus). Taurus is considered the crown-jewel (Dreyfus et al 2010 p. 43) of the arms manufacturers in Brazil not only because of its major market share in Brazil and Latin America, but also because of its large and growing expansion into foreign markets—especially the United States. Given Taurus' prominence, this company is used as a proxy for the entire small arms industry.

The following sections highlight varying facets of Taurus and the arms industry in general. Section 2 evaluates the politics, history, and foreign interactions that shaped the industry. This section provides the context necessary to understand Taurus' role within the arms industry. Section 3 analyzes Taurus directly by discussing the company's evolution, its participation in the globalization process, as well as the ways in which it sought to innovate and develop its brand image. Section 4 discusses the importance of Taurus to the US market citing that it is now one of the nation's largest arms producers and fills a critical market niche for reliable, yet affordable, weapons. Section 5 considers the other side of this relationship by highlighting the critical importance of the US market to Taurus' business model. Section 6 offers concluding remarks and considerations.

## 4.2 Survey of Brazilian Arms Industry

This section surveys Brazil's small arms industry in order to better understand Taurus' role within the modern day industry. Primarily the study considers the factors that led to Brazil's current position as a major arms producer. Chief among the factors considered are the government's support for the

arms industry as well as technology acquisition as a result of foreign ownership. This section is not intended to be exhaustive analysis of the entire Brazilian small arms industry[4] but rather to provide a general background of the factors that have shaped and continue to shape the industry.

The steady growth in the production of Brazilian small arms, particularly handguns, has translated into big business for the industry and helped Brazil assert itself as a major world player in the manufacture of these weapons. In terms of value the industry has topped more than USD 100 million per year (Dreyfus 2010 p 28). Globally, Brazil has become the second largest small arms producer and exporter in the western hemisphere, after the United States, (Dreyfus 2010), and one of the world's top-four arms exporters, sharing this distinction with the United States, Germany, and Russia (Small Arms Survey 2001, Chap 4). Clearly, Brazil has risen to a position of prominence in world arms production.

Three Brazilian companies account for the outright majority of this arms-related growth and production: Taurus, the *Companhia Brasileira de Cartuchos* (CBC) and the *Indústria de Material Bélico do Brasil* (IMBEL). Today, Taurus and CBC account for near-monopolies in handguns and small arms ammunition, respectively, while IMBEL remains a large producer and supplier for the military. The following subsections outline the major forces that shaped the industry.

## Government Support

The Brazilian arms industry has benefited along its history both directly and indirectly from government support. In one sense, the arms industry benefited from the same Import Substitution Industrialization (ISI) policies common throughout Latin America between 1930 and 1980. However, unlike most sectors, the arms industry was given special consideration, and was viewed as critical to realizing the nation's developmental and international goals. One reason the industry was supported vigorously is that it was perceived as capable of generating spin-off effects that could spur high-tech innovation in other areas of the economy. In this sense, a strong arms and defense industry were viewed as super-chargers to promote general development of the nation. A second reason politicians promoted this sector was the belief that an autonomous arms industry, not beholden to foreign powers, was viewed as crucial for promoting national defense (Dreyfus 2010 p. 33). Chiefly, for these two reasons, politicians viewed a strong arms industry as a win-win for national development and showered this sector with extra support and attention in hopes of achieving national *grandeza* or greatness. (Schwam-Baird 1997 p. 43).

This study considers four distinct phases in the development and history of the arms industry. The first considers the founding companies that first established a presence in the Brazilian small arms market in the early years of the twentieth century. The second phase considers the strategies and actions of the pro-development, *desenvolvimentista*, governments from the 1930s-1960s, particularly the Gutúlio Vargas and Juscelino Kubitschek administrations, in supporting arms production. The

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[4]    For a more complete analysis see Dreyfus et al (2010) Special Report on Small Arms in Brazil

third phase highlights the additional support and attention afforded the industry during the military dictatorship from 1964-1985. The final phase characterizes the governments relationship with the industry in more modern times.

The beginning of the twentieth century marked the founding of a domestic small arms industry in Brazil. Although, imperial and colonial Brazil long had a military tradition that necessitated arms, the procurement and creation of weapons was largely accomplished through trade with other nations or from within the national military apparatus. Domestic manufacturers that produced weapons on a large scale did not exist. However, at the beginning of the the century, European immigrants formed Brazil's first arms companies in the south and southeast regions of the country. Beginning in the 1920s brands such as Ross, Boito and CBC began large scale production of small arms for domestic consumption forming the foundation of Brazil's modern-day arms industry.

The next phase of development of began in the 1930s as a result of the national development policies implemented by the Getúlio Vargas administrations. Throughout these years the arms industry grew, along with most other industries, on the support of generalized protectionist Import Substitution Industrialization (ISI) policies that focused on industrializing the nation via the ample internal Brazilian market. (Fonseca, 2003). The first major government program supporting the arms sector began after World War II with the National Security Doctrine (NSD) which favored more autonomous arms production. The second Vargas administration, along with the Kubitschek government, solidified the arms industry further by increasing support of the industry through increased protectionism, government investment, and subsidies. For example, during the Kubitschek administration, part of his *Programa de Metas* (Program of Goals), was devoted toward promoting Brazil's military industrial complex, alongside other investment and infrastructure priorities such as communications and transport. Even during this phase, a strong and independent arms industry was seen as essential to Brazil achieving greatness. The support throughout this period is also viewed as a precursor to the increased support the industry received during the military dictatorship, and possibly as a political hedge to satisfy more conservative elements of the government during a politically turbulent time (Benevides, 1985, pg 17).

The following phase, which treats the 1964-1985 military dictatorship, marks the high point of government support for this sector and truly laid the foundation for Brazil's modern-day robust, diversified, and export-oriented arms industry of today (Dreyfus 2010 p. 34). One of the fundamental documents that guided Brazil's development in the wake of the 1964 coup was the *Doutrina de Segurança Nacional e Desenvolvimento* (National Security and Development Doctrine) which increased the arms industry's special status (Duarte, 2011). The importance of the industry was further heightened by the 1969-1974 Medici Administration's *Brasil Grande Potência* (Brazil Great Power) Project which coincided with Brazil's economic miracle (Macarini, 2005). The military dictatorship, more so than other forms of government, viewed a powerful arms industry as necessary for Brazil's to achieve its ambitions of *grandeza* and realize its goal to become a great power.

The military dictatorship reinforced protectionist policies of the previous phase by creating private-

public partnerships that allowed these manufacturers to develop technologically and thrive. These state-sponsored partnerships enabled the flow of ideas and technology between public and private entities. The most famous Brazilian example of a successful private-public endeavor is aerospace giant Embraer. This company grew and developed in part by technology transferred from the armed force's technical institutes. Avibras, another Brazilian aerospace manufacturer, along with Engesa, which specialized in armored military vehicles, also leveraged government sponsorship to industrialize technologically advanced products, especially during years where the United States began restricting arms exports to Latin America. (Senado 2014).

The military regime further bolstered the domestic small arms producers by shielding them from international competition via import restrictions and prohibitions. The legacy of the military regime's protectionism endures today as the military still determines what type of weapons can be imported into Brazil. The close relationship of the arms industry with the government planted the seeds for the domestic small arms market to flourish and for all three of the companies considered to cement control on their respective markets. Even today these companies maintain near-monopolies on the domestic market and continue strong ties with the Brazilian defense ministry and public security sector (Dreyfus 2010, p. 31 36, 38).

The final phase characterizing the development of the arms industry considers the years in the wake of the dictatorship. While government actions in the past have generally been supportive, these years are marked by less emphasis and less support, especially when compared to the years of the military dictatorship. Generally, governmental policies have been less friendly to the arms industry, especially the small arms industry, because of high levels of domestic violence. The high homicide rates in the late 1990s and early 2000s prompted the government to consider several key pieces of legislation aimed at curbing access to weapons. The most weighty of the measures considered was the 2003 Disarmament Statute (*Estatuto do Desarmamento*) which greatly limited the general public's access to purchase and port small arms. In 2004 the Disarmament Campaign (*Campanha do Desarmamento*) focused on reducing the amount of arms in circulation by buying back weapons from the civilian population. In 2005 Brazilians voted on referendum to ban all commercial sales of fire arms and munitions. While this referendum failed, the fact that it was put on the ballot speaks to the relative decline of the domestic market. It also may explain the industry's interest in diversifying into international markets as well as into different sectors domestically.

## Foreign Technology and Trade

The three major Brazilian arms manufacturers were heavily influenced by foreign interaction either through partnerships, foreign ownership, and or extensive trade all which lead to varying degrees of foreign "know-how" and technology transfers. The Itajubá Military Arsenal in the state of Minas Gerais, a precursor for IMBEL, was heavily integrated with foreign companies since its inception. From the 1930's until after the Second World War it produced Mauser rifles under a license agree-

ment from the German arms maker Deutsche Waffen-und Minitionsfabriken (German Weapons and Munitions Works). In 1964 the Arsenal began producing assault weapons under license from Belgian weapons manufacturer FN Hertsal. Furthermore, in 1985 IMBEL began a partnership with US small arms manufacturer Springfield Armory to produce variants of the popular Colt .45 pistol and is currently in a partnership with Royal Ordnance, a subsidiary of British Aerospace Systems. (Dreyfus, 2010 p. 40-42).

IMBEL's historical ties with these foreign entities enabled technology acquisition that eventually would permit Brazil to become more independent in military products (IMBEL n.d.). These partnerships also translated into increased trade especially in the form of exports to the United States. In 2001, 40 to 50 percent of IMBEL's production was exported (Small Arms Survey 2002) while more than 90 percent of its .45 caliber pistols were exported to the United States.

Ammunition producer CBC was also heavily influenced through foreign connections. In contrast to IMBEL, CBC's history involved foreign ownership rather than partnerships. Founded in 1926 CBC was quickly sold to US arms manufacturer Remington Arms Company and Imperial Chemical Industries in 1936. It wasn't until 1980 that the company renationalized, bringing with it over 40 years of foreign "know-how," technology, and production practices. Currently CBC is owned by two foreign companies who are domiciled in the tax haven of the British Virgin Islands or operated from an undeclared location (Dreyfus, 2010 p. 440). CBC's business model depends heavily on foreign markets. In 2002, foreign sales represented 34 percent of the company's business and by 2006 represented the main source of the company's revenue (Dreyfus, 2010, p. 44). CBC began and remains intertwined and dependent upon foreign markets.

The final of the three major companies analyzed is Taurus. Taurus remained largely a domestic company until 1970 when 54 percent of the company was purchased by the conglomerate Bangor Punta, the parent company of US weapons manufacturer Smith & Wesson. During this stint, a great deal of technology passed between Taurus and Smith & Wesson until 1977 when Taurus was repurchased, and thus renationalized, by Brazilian stockholders. A second joint-foreign venture occurred between 1974-1980 with Italian arms maker Beretta. After the expiration of Beretta's contract to produce small arms for the Brazilian armed forces Taurus acquired the entire Beretta factory to include blueprints, machinery, and other manufacturing techniques. This acquisition of Beretta *know-how* proved pivotal in Taurus producing some of its most acclaimed weapons (TaurusUSA, n.d.).

The long history of government support for the arms industry, along with the acquisition of foreign technology, has lead Brazil to become one of the the largest producers and exporters in the world. In terms of production, Brazil became the second largest producer in the western hemisphere, as well as the most dominant regional manufacturer in South America. Trade and exports have also been a major source of growth. Currently Brazil is one of the world's top four arms exporters (Small Arms Survey, 2001, p. 4).

# 4.3   Survey of Taurus

Forjas Taurus is considered the crown jewel of the Brazilian small arms industry[5]. By some measures Taurus is considered one of the three largest firearms manufacturers in the world[6]. Furthermore, the company has a history of over 70 years, and employs more than 4,800 personnel to create a wide array of revolvers, pistols, rifles, machine guns, as well as numerous other products (Taurusarmas n.d.).

Taurus has long been a major player in Brazil and Latin America. This section considers some of the forces responsible that led the company to now be among the world's largest and most important small arms manufacturers. The forces considered that shaped this government support, foreign partnerships, and the degree to which the company globalized and innovated.

## Taurus' Evolution through Government Support and Foreign Influence

Similar to CBC and IMBEL, Taurus was also heavily influenced government/military support as well as foreign partnerships. This section analyzes the company's evolution in light of these crucial influences. Taurus was founded in Porto Alegre, Rio Grande do Sul, in 1937 as a tool manufacturer and forge that quickly transitioned to weapons production (Taurus and TaurusUSA n.d.). After the Second World War the company began producing revolvers and eventually achieved large scale weapons production after building an industrial park in the 1950s. To keep pace with rising demand production shifted to an even larger industrial park and factory in the 1960s.

The politically turbulent 1960s saw increased restrictions on domestic weapons sales that prompted the company to be purchased by the same conglomerate that owned US weapons manufacturer Smith & Wesson. In 1977 Taurus was repurchased by Brazilian stockholders, effectively being *renationalized*, at which point it began seeking out international partnerships. To increase the efficiency of its forge operations Taurus purchased British toolmaker IFESTEEL in 1979. In 1980 the company acquired Beretta's Brazilian subsidiary and its foreign techology.

Taurus' next major move involved making inroads into the world's most lucrative handgun market—the United States. In 1983 the company launched its first international subsidiary in Miami, Florida called Taurus International Manufacturing Inc. (TIMI). The presence of a branch in the United States helped secure a foothold in the ever important and lucrative US handgun market.

Already buoyed by the favorable policies implemented by the Brazilian armed forces to restrict weapons imports, in effect shielding Taurus from international competition, the company turned to further consolidate its position in Brazil's domestic market. In 1997 Taurus purchased the patents, designs, and production rights for short arms from the Brazilian small arms maker Rossi, further fortifying its monopoly position as the sole provider of pistols and revolvers for civilians. Additionally Taurus purchased a sizable, though non-controlling stake, of Rossi stock. (Dreyfus 2010 p. 42).

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[5]   According to Dreyfus et al Taurus is the "jewel in the crown" of the small arms industry and also to some extend the arms industry as a whole.

[6]   According to Taurus' website it is one of the three largest firearms manufacturers in the world

Even though Taurus made moves to consolidate its supremacy of the domestic market, its domestic arms sales became an increasingly less significant part of its overall sales. For example, the 2003 Disarmament Statute, which greatly limited the civilian populace's accesses to weapons, had essentially a null effect on Taurus (Dreyfus, 2010, p. 52). It seems that even though Taurus strongly objected to the legislation, because the domestic civilian market represented a diminishing share of its business, Taurus continued on without any significant downturns in its profits. The 2005 Brazilian referendum aimed at completely prohibiting firearms sales in Brazil failed by a relatively wide margin (63.94 to 36.06 percent) enabling Taurus to continue selling weapons to the civilian Brazilian populace (Taurusri n.d.).

## Aspects of globalization

The evolution of Taurus was heavily influenced by the degree to which the it integrated into the world economy and embraced globalization. In some ways Taurus embraced the international economy utilizing trade, promoting its exports, improving its processes through foreign partnerships, as well as creating foreign subsidiaries. However, in other ways Taurus remained uniquely different from some of the key patterns associated with a globalized world. In some respects it seems Taurus did not need to embrace certain attributes of a *globalized* company to stay competitive. This section discusses some of the aspects of globalization that Taurus either embraced or failed to adopt.

One of the dominating themes in the literature on globalization is the concept of of Global Commodity Chains (GCC). GCC's define and explain some of the dramatic changes in the world's industrialization processes over the past two decades citing that that the production and export of manufactured goods has become dispersed across a growing *worldwide* network (Gereffi 1994). GCCs are succinctly defined by Hopkins and Wallerstein (1986 p. 159) as "a network of labor and production processes whose end result is a finished commodity." To illustrate GCCs Gereffi (1994) uses the example of the production of a Ford Escort. The components used to assemble this vehicle are produced in fifteen countries that span three continents. In this sense Ford is not actually *building* these cars, but rather assembling them using parts manufactured the world over.

Within the scope of these production networks, Gereffi (1999) cites two major types of GCC networks–"producer-driven" and "buyer-driven." Producer-driver networks typically involve one large corporation or entity coordinating the production process across various countries and manufacturers. Companies that typically employ producer-driven processes are capital and technology intensive firms such as computer, automobiles, and aircraft manufacturers. In contrast, buyer-driver networks are characterized by a large manufacturers and retailers that coordinate decentralized production. These types of networks are usually comprised of labor-intensive consumer goods such as clothing, shoes, and toys.

Generally speaking Taurus' growth is not well explained by GCCs. In one sense Taurus fits Hopkins and Wallerstein's definition of a GCC in that Taurus does employ a network of labor and pro-

duction processes to manufacture its weapons. The key difference, however, is that this network is not part of a world wide production process as described by Gereffi. Rather, Taurus leverages a local network relying on its own subsidiaries and domestic manufacturing *within* Brazil to build its weapons. While a *buyer-driven* GCC process is clearly less suitable to a weapons producer, it is also difficult to characterize Taurus as a *producer-driven*. Despite being a capital and technology intensive industry–the type generally reserved for the producer-driven GCCs–Taurus does not "out-source" its fabrication. Most of Taurus' production happens in and around its headquarters in southern Brazil where it both creates its parts and assembles its weapons. Simply put, Taurus weapons are not fashioned in the same manner as Ford Escorts and remains decoupled from the GCC processes along with the vast majority of other Brazilian companies (IEDI 578, 2013).

Does the fact that Taurus does not seem to take part in GCCs mean that Taurus is not taking advantage of the business opportunities afforded by globalization? Storper (1997) explores this idea by asking the question:

"Do these phenomena (of increased flows of goods, services, information, capital, and people across national and regional lines) mean that the contemporary economics are becoming placeless, mere flows of resources via corporate hierarchies, which are themselves not rooted in national or regional territories and therefore not subject to territorially based state institutions?"

Storper answers his own question and concludes that despite the existence of seemingly borderless GCCs, territory still has a place in the modern economy. It is in this sense that Taurus seems to benefit from "territorialized economic development" where economic activity is dependent upon territorially specific resources (Storper, 1997 p. 170).

Taurus uses its "territory," or location, to its advantage to manufacture its weapons. Here Taurus' territory is rooted in its forge, technology, history, skilled labor, and factories, the majority of which, are all located in the state of Rio Grande do Sul. It seems the high fixed costs of building forges and factories in addition to the skilled labor required to manufacture its fire arms obviated the need for this company to import weapons parts from other parts of the world. The comparative advantages rooted in Taurus' territory allow it to manufacture and develop specialized weapons to be sold on the world marketplace.

It seems that Taurus' territory is one of the key factors that allowed it to compete on the international scale. Despite not directly integrating with GCCs to manufacture its firearms, Taurus remains part of the global system as evidenced by its high export rates, its subsidiary TIMI in the United States, and of course the high degree of market penetration and specialization of the Taurus brand in the North American marketplace.

## The Innovation of Taurus

This subsection highlights some of the factors, both positive and negative, that shaped the development of Taurus' ability to innovative and embrace technology. However, in general terms this section shows that innovation played a key role in Taurus securing a niche in the US small arms market and has lead to several performance awards and increased sales.

Several key factors enabled Taurus' ability to innovate. As previously addressed foreign ownership and partnerships played a crucial role in Taurus' ability to innovate its line of weapons. Surely its partnerships with foreign companies such as Smith & Wesson and Beretta transferred a great deal of "know-how" in weapons production. Furthermore, its buyout of a British toolmaker surely exposed the company to a wide-array of production techniques that it would not have discovered in isolation.

Another possible contributor to Taurus's innovation rests with the composition of the company. Taurus Arms is actually one of several companies which comprise the Taurus Group of companies (*Grupo Taurus*). While Forjas Taurus focuses primarily on weapons production, the affiliated companies within the group specialize in other areas allowing for opportunities of technology transfer. Figure 28 shows the structure of the overall company and how they are broken out by sector and specialty. The figure makes it clear that Taurus specializes not only in defense and security related products (ie weapons), but also a wide range of products related to its forge and plastic business. One embedded subsidiary that demonstrates Taurus' ability to manufacture both inside and outside the arms industry is Taurus Metal Injection Molding (MIM). This subsidiary uses state of the art machines to heat treat and metal plate its weapons which has applications beyond the arms industry to include medical, aerospace, chemical and the automotive industry (Taurusmim, n.d.). Taurus has also diversified into other non-firearm products such as bulletproof vests and helmets. Finally, Taurus International, the group's international arm, facilitates access to the US market.

The diverse specialties of the subsidiaries within Taurus Group likely foster innovation through technology transfers which ultimately lead to improvements in weapons manufacturing. In sum, foreign partnerships and ownership, as well as the company's diverse structure have likely positively contributed to Taurus' innovation.

However, not all the forces that shaped Taurus' development fostered innovation. One force that likely hampered innovative processes was government protectionism. Being shielded from imports and international competition allowed Taurus to maintain profits without the pressure to create new product lines. Having monopoly power obviated the need to innovate and design new weapons. One example of this is Taurus' reliance on its traditional Beretta models. Although these weapons proved reliable they do not represent cutting-edge technology. However, in the late 1990s the company chose to diversify and modernize into polymer and titanium models when faced with possible competition
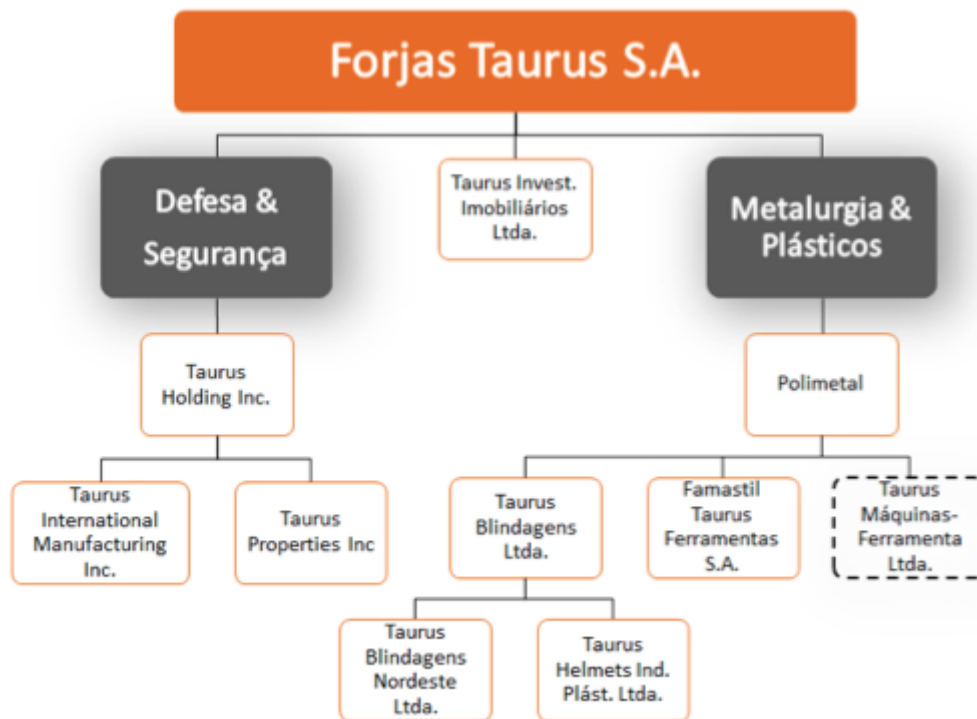
Figure 28 – Taurus Corporate structure. Figure taken from Taurus website.

or threat of Glock entering its domestic market. Creating more cutting-edge weapons in the late 1990s laid the foundation for Taurus' current position in the US market. Today Taurus has earned a reputation for 'classic but reliable' and 'trendy and good quality' handguns (Dreyfus, 2010, p. 43).

The protected domestic market may also explain part of Taurus' reputation as a inferior quality earlier on. While the modern day Taurus weapons are held in relatively high regard, its initial models of the 1960s and 1970s were often considered a cheap "knock-off" of Smith & Wesson products. Today they have fought back against this reputation as an inferior weapons producer and are now considered a "leader in modern firearms manufacturing" and no longer suffering from the "pride of ownership" problems that plagued the company in the early years. Today its weapons are reasonably priced, good quality, and use modern light weight materials [7] (Quinn 2001).

While Taurus has come a long ways in improving its brand name, Taurus' innovation seems to have been more focused on improving its reliability and production processes and less focused on creating new designs. Taurus surely made great strides to create quality weapons but the company still tends to focus on proven designs and follows other manufacturers in terms of innovation (Quinn, 2013 and 2014).

However, there are some notable exceptions where Taurus innovated their weapons rather than following industry leaders. One example is that Taurus developed its own patented Taurus Security

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[7] see www.gunblast.com/Taurus941.htm for a general review of the evolution of Taurus

System used to disable its weapons. The unique design utilizes an unobtrusive device and special key to render their handguns inoperable and speaks to its recent improvements in production. Taurus also showed innovation by moving to fill vacancies within the handgun industry for specialty type weapons. For example, Taurus is the only producer of a "rimfire double-action trail gun" thus filling a small but key niche within the industry (Quinn 2001). Still other models cater to the concealed carry weapons and include clear plate siding to see the internals functioning (Taurus International Interview, 2014). Overall, the company has built a reputation for innovating in regards to reliable safety systems, the production of lighter and compact models, the use of polymer-based materials, and the introduction of light materials such as titanium and composites (Dreyfus 2010 p. 66).

Taurus has been commended for the improved quality of its weapons in the form of positive reviews, numerous awards, and increased sales and market share. The positive reviews generally point to higher quality in both materials and workmanship. Additionally their newer weapons are seen as reliable and accurate. These positive marks have translated into numerous awards for the company. For example, the most important publication of the National Rifle Association (NRA), the American Rifleman, presented Taurus with the honor of *Golden Bullseye Handgun of the Year* three times (2005, 2008, 2011) based on weapon design, function, comfort, and ease of concealment (NRA Staff, 2010). Since 1997 The NRA, Field and Stream, and numerous other small arms authorities have also recognized Taurus for excellence in innovation for a wide array of categories such as Factory of the Year, Best of the Best, International Trade, and Editor's Choice (Taurus n.d.).

These awards and positive reviews are merely a reflection of a more important metric to the company—sales and production. Taurus' ability to innovate and create a niche in the US market has lead the company to grow to one of the largest small arms manufacturers responsible for developing 39 revolver and 18 pistol models (Dreyfus, 2010, p. 42). This growth is explored more thoroughly in subsequent sections.

## 4.4   Importance of Taurus to US

Clearly Taurus' rise has resulted in the company securing a strong position in the US market. This section highlights the extent to which Taurus has become a major player in the important US small arms market. The company ranks among the top five in pistol production and top ten in small arms. According to Taurus' own website it ranks as one of the three largest firearms producers in the world (Taurus n.d.).

Taurus' growth was rather rapid when compared to the twenty largest pistol makers in the world. For example, Taurus International showed relatively stable position within the United States varying between the nation's 12th and 17th largest pistol producer. However, in 2010 Taurus International jumped to number five asserting itself as a clear leader in pistol production producing 128,160 (Brauer, 2013 p 54 and Shootingindustry.com n.d.). Table 25 shows Taurus' relation position among

the top 10 *handgun* manufacturers in the United States.

Table 25 – Top 10 US Handgun Manufacturers, 2010.

| Rank | Manufacturer | Pistols | Revolvers | Total |
|---|---|---|---|---|
| 1 | Sturm, Ruger & Co. | 473,479 | 192,475 | 665,954 |
| 2 | Smith & Wesson | 352,969 | 228,814 | 581,783 |
| 3 | SIG SAUER | 266,316 | | 266,316 |
| 4 | Beretta U.S.A. | 133,397 | | 133,397 |
| 5 | *Taurus Intl.* | 128,160 | | 128,160 |
| 6 | Kel-Tec CNC | 104,116 | | 104,116 |
| 7 | Burbak Machine | 93,841 | | 93,841 |
| 8 | Kimber Mfg. | 85,991 | | 85,991 |
| 9 | Beemiller (Hi-Point) | 79,900 | | 79,900 |
| 10 | Heritage Mfg. Inc. | | 53,805 | 53,805 |

Data Source: www.shootingindustry.com.

Taurus International's handgun production also earned it a spot among the largest US manufacturers for all types of all small arms to include pistols, revolvers, rifles, and shotguns. Table 26 shows Taurus International's ranking as the overall ninth largest small arms manufacturer in the United States (Brauer 2013 p. 36 and Shootingindustry.com n.d.)

Table 26 – Top 10 US Small Arms Manufacturers, 2010.

| Rank | Manufacturer | Pistols | Revolvers | Rifles | Shotguns | Total |
|---|---|---|---|---|---|---|
| 1 | Sturm, Ruger & Co. | 473,479 | 192,475 | 236,616 | 1,398 | 903,968 |
| 2 | Smith & Wesson | 352,969 | 228,814 | 100,051 | | 681,834 |
| 3 | Remington Arms | 11,017 | | 263,934 | 280,843 | 555,794 |
| 4 | Mossberg/Maverick Arms | | | 66,938 | 393,284 | 460,222 |
| 5 | SIG SAUER | 266,316 | | 29,764 | | 296,080 |
| 6 | Marlin Firearms | | | 253,521 | 492 | 254,013 |
| 7 | Savage Arms | | | 171,472 | | 171,472 |
| 8 | Beretta U.S.A. | 133,397 | | | 5,191 | 142,798 |
| 9 | *Taurus Intl.* | 128,160 | | | | 128,160 |
| 10 | Henry RAC Holding Corp. | | | 124,701 | | 124,701 |

Data Source: www.shootingindustry.com.

The rise of Taurus to become a major player in the US weapons industry can greatly be attributed to its ability to fill a niche in the US market for an affordable but reliable weapon:

"We (Taurus) produce a quality product tailored for the "Average Joe." We make a quality weapon for someone in the middle class that lives paycheck to paycheck. We want to make sure we can still get that person an affordable fire arm that is just as good." (Taurus International Interview, 2014)

One other reason that explains Taurus' rise in the US market is that it was the first manufacturer to offer a life-time warranty on its weapons. Taurus markets their weapons as striking a balance between

quality and affordability, and judging by its growing market share, it seems to have found an equilibrium. The above metrics demonstrate Taurus' rise to prominence at the world scale and that the company has clearly arrived to become a major force within the United State's small arms industry.

## 4.5   Importance of US Market to Taurus

As shown in the previous section Taurus has grown to become an important player to the US market. However, the relationship between the U.S. and Taurus is two-way: while Taurus has become an important player in the US market, the US market is also extremely important to Taurus. This section explains the importance of the US market to Taurus primarily using two metrics. The first details the role that exports, primarily to the United States, play in Taurus' overall business model. The second explains this dependence by analyzing the movements of Taurus' common stock and finds that returns are more correlated with the US market than the Brazilian market.

### Taurus and Exports to the United States

The importance of exports to the Brazilian arms industry and Taurus is hard to overstate. As direct information about the number raw number of exports are unavailable, Dreyfus et al. (2010 p 54) analyze financial statements of Brazilian small arms firms, using sales as a proxy for exports. Sales were broken into three categories: the domestic civilian market, Brazilian public bodies (with includes the military and police), and the foreign market (exports). These figures show unquestionably that the Brazilian arms industry is evermore dependent upon foreign sales.

But simply noting that the market is dependent on foreign sales fails to capture one key component of these exports–chiefly that an extremely disproportionate amount of these weapons are bound for the United States. As see in Figure 29 the contrast between Brazil arms sales to the United States and the rest of the world is striking[8]. For example in 2007 total Brazilian sales to just the United States topped USD 100 million, while all other regions hovered around USD 1 to 8 million (Dreyfus 2010 p. 57). For the Brazilian arms industry the United States truly is a behemoth.

As Taurus is the largest and most important company in the the Brazilian small arms market it follows that the company would also be extremely dependent upon exports–particularly exports to the United States. Figure 30, highlights Taurus' breakout of net sales in three different market segments: exports, government, and civilian sales.

The figure shows that from 1983 to 2006 the percent of exports of Taurus' total sales has increased and represents the dominate portion of sales. From 2000 to 2006 exports consistently accounted for around 60 percent of Taurus' total business. It seems that while government and civilian domestic sales still form a solid base for Taurus, representing a combined 30 to 40 percent, these sales are dwarfed when compared to exports.

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[8]   All the following figures taken from Dreyfus et al Small Arms Survey Special Report on Brazil, 2010

Sources: CACEX (1988); SECEX (2007); analysis by Viva Rio
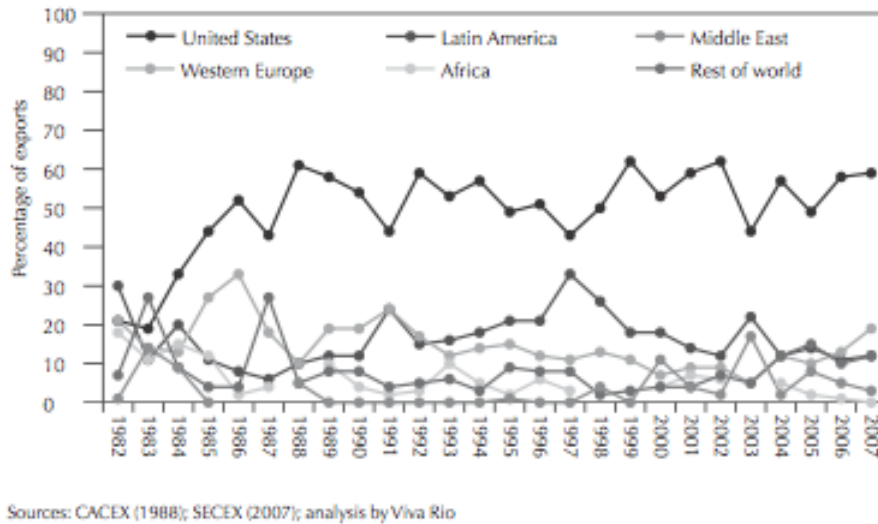
Figure 29 – Brazil: small arms exports, as percentage, by world region, 1982-2007. Figure borrowed from Dreyfus et al (2010)



Note: Data about small arms from IANs and about sales from DFPs.

Source: CVM (1995a; 1995b; 2006a; 2006b); analysis by Viva Rio
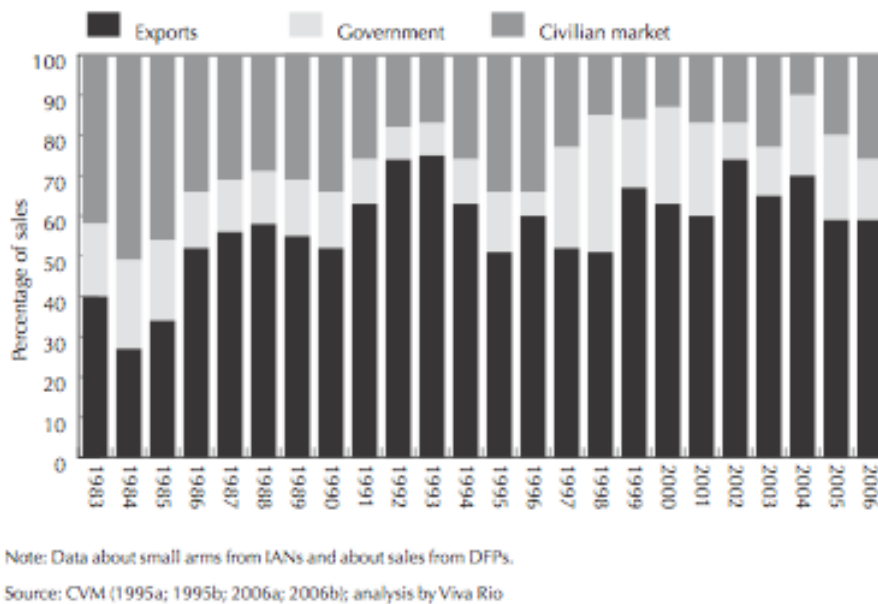
Figure 30 – Forjas Taurus: net sales by market segment, 1983-2006. Figure borrowed from Dreyfus et al (2010) using data from Taurus IANs ( (*Informações Anuais*) and DFPs (*Demonstrações Financeiras*)

The presence of the Taurus International branch in Florida reflects the importance of this relationship. The primary function of this branch of the Taurus Group is to create a fixed presence in the United States to facilitate importation and distribution of weapons. The vast majority of weapons distributed in the U.S. are manufactured and assembled in Brazil. Some notable exceptions are the

PT-22 and PT-25 automatic pistol models that are made exclusively in the United States. These US models create a marketing advantage, allowing the company to tout *Made in the USA* on certain firearms (Taurus International Interview, 2014).

To understand both the presence of Taurus in the Brazilian export market as well as its ties to the United States, consider Figure 31. In absolute terms Taurus exports a great deal to the United States. In relative terms, Taurus represents a high percentage of all small arms exports destined for the U.S..
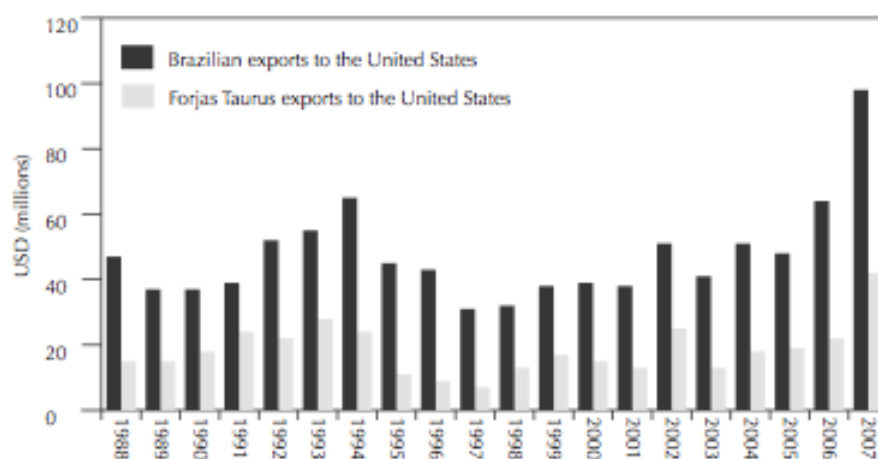


Note: Data about small arms from IANs and about sales from DFPs.

Sources: CACEX (1988); SECEX (2007); CVM (1995a, 1995b, 2006a, 2006b); value updated based on Implicit Price Deflator US–GDP for 2007 (USBEA, 2008) and IGP–DI for 2007 (BCB, 2008); analysis by Viva Rio

Figure 31 – Brazil and Taurus: small arms exports to the United States, in USD millions (2006 constant), 1988-2006. Figure borrowed from Dreyfus et al (2010)

For example in 2007 Taurus represented approximately 40 percent of the approximately USD 100 million in total value of exports. In both relative and absolute terms it is clear that the United States represents *the* crucial market for both Taurus and Brazil such that over the years Taurus has transitioned from a strong relationship with the North American to near complete dependence.

## Taurus' stock returns relative to US and Brazilian Markets

One other way to demonstrate the importance of the US market to Taurus is by analyzing its stock returns and co-movements relative to the US and Brazilian markets. As noted in the previous section this study finds evidence that Taurus is extremely dependent upon the US market and relatively less so on its domestic market. Given this relationship, one would expect that Taurus stock would be more correlated with the United States market than the Brazilian market.

The beta statistics presented in this section lend support to this intuition by showing that Taurus is indeed more sensitive to changes in the North American market than the Brazilian market. Figures

32(a) and 32(b) shows Taurus's beta statistics with the Brazilian IBOVESPA and the S&P 500 stock indices[9] where the beta statistic measures the sensitivity of Taurus stock returns relative to the market.
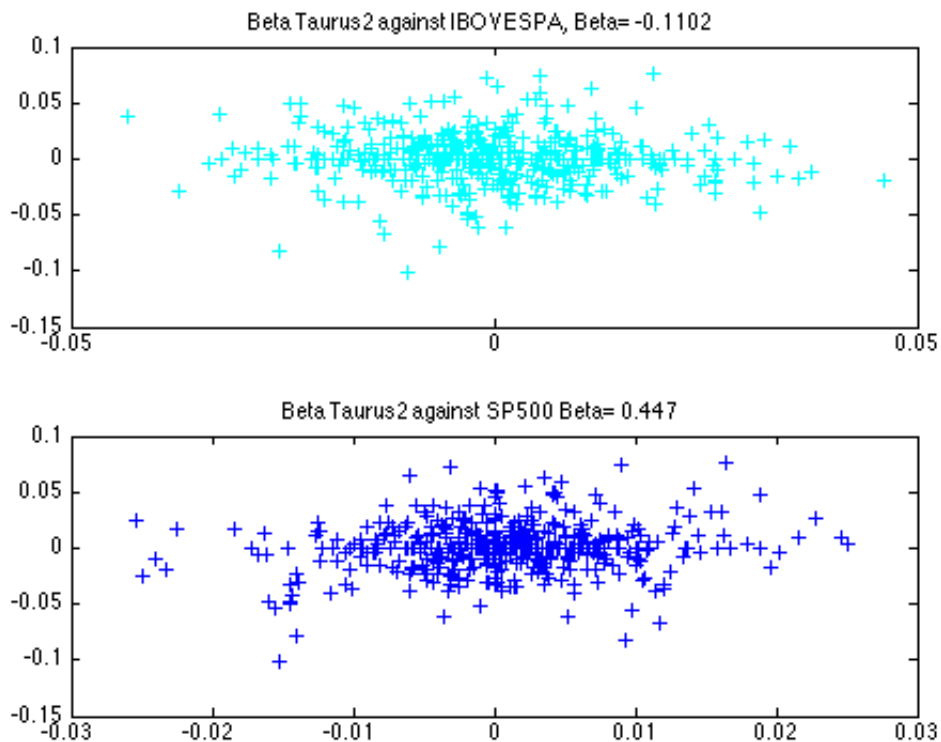


Figure 32 – Brazilian arms maker Taurus' Beta statistic shows its relative sensitivity to the movements of major stock indices. The top graphic shows its Beta relative to the Brazilian IBOVESPA index while the lower to the US S&P500 index, January 2012-October 2013. Figure generated by author.

As shown, Taurus has a small and negative beta of $-0.110$ with the Brazilian index. The smaller magnitude of the statistic implies that Taurus does not respond strongly to movements in the Brazilian market while the negative sign implies that *increases* in the stock index are matched by *decreases* in Taurus. In contrast, the beta between Taurus and the US market is larger and positively correlated at $0.447$. This relationship implies that the Brazilian arms manufacturer reacts more to changes in the US market than the Brazilian.

These results lend validation to two underlying factors of the Taurus business model. The first is consistent with the facts already presented; the US market is crucial to Taurus's business. The second highlights the declining importance of the domestic Brazilian market to Taurus. As previously presented, several laws, chiefly the 2003 *Estatuto do Desarmamento* (Disarmament Statute), greatly restricted the ability to purchase and port arms in Brazil.

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[9]    Daily stock prices gathered from Yahoo! Finance

While the co-movements and beta statistics between companies and indices are by no means conclusive in explaining market dependence, they nonetheless provide one more metric in evaluating the behavior of a company. In this case, these co-movements suggest a higher degree of dependence between Taurus and the U.S. than Taurus and Brazil.

## 4.6   Conclusions

The violent acts that lead to Brazil's high rates of armed violence were largely carried out by domestically produced Brazilian firearms. Furthermore, the same decade that saw a dramatic rise in violence also saw a production boom in Brazilian small arms production (Dreyfus 2010). These two facts motivated this study to explore any possible link between weapons production and violent outcomes. To this end, this study analyzed the Brazilian small arms industry and its chief weapons manufacturer Taurus and finds evidence that government and military policies enabled the production of domestically produced weapons to flourish.

To some extent it is plausible that weapons proliferation and violence are related. Evidence of the proliferation of Taurus weapons was found on the streets of Brazil. For example, of all the weapons apprehended from criminals by the police in the state of Rio de Janeiro between 1990-1999, Taurus accounted for 27.1 percent. Rossi accounted for an additional 23.5 percent of the weapons apprehended showing that the Taurus/Rossi partnership represented the majority of all the weapons recovered (SAS 2001 Chap 4 p 23). In this sense, Taurus left a clear mark on the panorama of Brazilian violence.

However, this is not to say that Taurus should be held accountable for the high homicide rates of Brazil. A rise in violent crime coupled with a rise in weapons manufacturing does not imply causality. There are a host of other factors that contribute to violent outcomes. One possible reason for these weapons to arrive en masse on the streets could be attributed to "chronically inefficient" gun control and accountability regulations in Brazil (Dreyfus, 2010, p 84) or the aforementioned policies that protected and encouraged small arms production. Other reasons that may explain increases in violence in addition to, or in lieu of access to small arms could be related to increased drug use, the effects of urbanization (Glaeser and Sacerdote, 1999), poverty, inequality, or law enforcement.

It is beyond the scope of this paper to consider all the factors that contribute to violence. The goal of this paper was more limited and aimed only to consider the "armed" in "armed-violence." Put differently, this work considers some of the forces that may contribute to the weapons arriving in the hands of violent criminals, or the transmission of violence. To this end, this study analyzed Taurus and its role within Brazil's small arms industry affirming that a better understanding of the Brazilian arms industry will further the overall understanding of the panorama Brazilian violence. In this sense, understanding the arms industry, and thus the origin of the weapons used to perpetrate this violence, may prove helpful in understanding armed violence in Brazil.

Violence has reached critical levels earning it a spot among the top challenges Brazil must face on its path toward development and prosperity. This study aims to increase the collective understanding of Brazilian violence by analyzing the Brazilian arms industry and the factors such as government support, foreign technology, and trade that led to its current position one of the world's major producers of small arms. The paper also analyzed Taurus, Brazil's largest and most important manufacturer, by considering the foreign, global, and innovating forces that influenced the company's development and rise to prominence. The final contribution of this work highlights the important relationship between Taurus and the United States where Taurus filled an important niche in the US market to become a major player in the small arms trade. At the same time, Taurus was shown to be critically dependent upon the United States as evidenced by its high level of exports as well as the relatively strong correlation between Taurus stock returns and the US market.

# Final Considerations

Brazilian violence is more than its ensemble of sobering statistics that show the staggering amounts of lives lost and astronomically high homicide rates. More than the numbers, violence represents one of Brazil's greatest challenges—social, economic, or otherwise—that leaves in its wake the loss of life, broken families, and a fearful population. It is an undercurrent that touches nearly all facets of society to hamper Brazil's goals to achieve development and prosperity. Given the acuteness and severity of this problem, active measures must be taken not only better understand the nature of this violence, but also to reduce and eliminate it.

With this in mind, this dissertation intends to add to existing literature in hopes that an improved understanding of violence can help Brazil embark on a new trajectory toward greater safety, security, and prosperity. The main contribution of this research is the development of new methods to measure, analyze, and identify trends and patterns in violence, as well as the application of these tools to understand the patterns and factors that explain violent outcomes and define its nature.

As in the nature of most research, for each question answered several more are raised. It is in this sense that this dissertation forms the basis for future research. In Chapter 1, "Perceptions of Violence and Fear in Brazil," measures were developed to analyze how perceptions and fear have propagated throughout Brazil. However, further analysis is required still to explain the other factors at work that caused certain regions to realize excess levels of fear. In the case of Chapter 2, "The Interiorization of Brazilian Violence," methods were developed to measure and quantify the diffusion of crime. Going forward, these methods can be applied to analyze not only patterns in violence, but also other types of crimes, both inside and outside of Brazil. In both Chapter 2 and Chapter 3, "Armed Violence and Weapons," correlations, and not causality, are presented to highlight the interplay between violence and two key variables. However, further research is required to determine if, in fact, increased spending on public security is causal in diffusing violence to the countryside, or if a robust arms industry caused increases in violence. Much work is left to be done in the future on the path toward understanding and reducing violence in Brazil. But given the severity and urgency of the problem, it is a task that must be undertaken now.

# Resumo Estendido

## 6.1 Introdução e Contexto

A violência é tanto uma causa como um reflexo das inúmeras questões sociais e desafios que o Brasil enfrenta. É uma tendência que influencia a forma como os indivíduos tomam decisões e mudam suas percepções sobre segurança e proteção. Os efeitos da violência são particularmente graves em lugares mais urbanos e com maiores desigualdades sociais. A taxa de violência é desproporcionalmente elevada em relação aos jovens do sexo masculino. Os fatores que determinam esses resultados violentos são tão complexos quanto os impactos que os mesmos provocam na sociedade. O presente estudo tenta desvendar um pouco dessa complexidade para entender melhor essa a violência e de que forma afeta à sociedade. Principalmente, esta pesquisa fornece duas contribuições principais para a literatura da violência. A primeira contribuição é o desenvolvimento de novos métodos para medir e avaliar os efeitos da violência. A segunda é a aplicação desses novos métodos para entender melhor as forças que geram os padrões e percepções associados com a violência.

### 6.1.1 Motivação

A violência é particularmente grave no Brasil e continua devastando as comunidades, colocando-a entre os principais desafios do país. O Brasil está classificado entre os lugares mais sangrentas do mundo e devido a diferentes características é ainda mais violento do que zonas de guerra atuais. Outras estatísticas mostram que o Brasil possui a dúbia distinção de ser um dos poucos lugares onde as taxas de homicídios, na verdade, superam as taxas de mortalidade de trânsito. Além disso, o peso dessa violência armada recai desproporcionalmente sobre os ombros dos jovens do sexo masculino (Waiselfisz 2011, 2012).

Os efeitos drásticos da violência levaram à insatisfação generalizada e ao discurso nacional. Os políticos consideram a legislação e o financiamento de propostas destinadas à violência, enquanto os cidadãos tomam medidas para aumentar sua própria segurança pessoal. Em resposta a esse problema, uma abundante literatura abrangendo múltiplas disciplinas foi escrita para uma melhor compreen-

são dessa violência e, finalmente, para tentar reduzir seus impactos sobre a sociedade. A presente dissertação tem como objetivo acrescentar essa literatura através da identificação, discussão e desenvolvimento de novas formas de avaliar a violência e seus efeitos por meio da análise quantitativa. Devido ao fato de que a maioria da literatura geralmente oferece análises qualitativas de violência, esta pesquisa tem a intenção de criar um nicho para explorar a violência de forma quantitativa e através da aplicação de técnicas econométricas e empíricas.

Além de uma noção geral de que a violência é um problema nacional grave, a motivação para este estudo nasceu, em grande parte, das histórias apresentadas pelos meios de comunicação com o objetivo de explicar os padrões e as percepções da violência junto com conversas com os brasileiros sobre suas impressões em relação à violência e segurança pessoal. A constante cobertura da mídia sobre a violência levanta questões sobre como os brasileiros realmente percebem a sua segurança pessoal em relação aos atuais níveis de violência homicida. Outro tema em destaque na imprensa, e também apresentado por Waiselfisz (2011), é o padrão observado de que a violência está fugindo das cidades bem policiadas para alvos mais fáceis no que costumava ser uma tranquila área rural. Por exemplo, algumas gangues foram presas roubando caixas eletrônicos em cidades pouco povoadas e com baixo policiamento e centenas de quilômetros dos centros urbanos. Esta pesquisa tem como objetivo entender melhor esses padrões e os fatores por trás dos mesmos. Um último fator que motiva esta pesquisa é o debate altamente controverso sobre as restrições de armas e o papel que o acesso às mesmas pode jogar para contribuir com resultados violentos. Em particular, o debate sobre o controle das armas recebeu uma considerável atenção em 2003, quando o Estatuto do Desarmamento foi convertido em lei e o acesso geral da população às armas foi bastante reduzido.

Esses capítulos subsequentes são enquadrados dentro de um ciclo de violência em que numerosas características tais como os fatores sociais, a aplicação da lei, a implementação de políticas e o acesso às armas contribuem para resultados violentos. Essa violência medida pela taxa de homicídios, por sua vez, dá origem a numerosas respostas e resultados na sociedade. Os resultados relacionados ao aumento dos gastos com segurança por parte do governo e dos indivíduos, a criação de novas leis e políticas para a redução da violência e os elevados níveis de medo e insegurança na sociedade são reações em contra da violência. O ciclo se completa quando esses resultados interagem com os mesmos fatores que influenciam as consequências originalmente violentas.

Esses capítulos exploram a violência através de varias lentes e usando variáveis-chave. A principal variável comum em todo o estudo é a taxa de homicídios, que é assumida para captar mais de perto o verdadeiro efeito dessa violência. O uso da taxa de homicídios para representar a mesma é justificada usando o raciocínio do Waiselfisz, 2007. A primeira afirmação para justificar o uso dos homicídios e representar a violência geral é que a morte revela a violência na sua forma mais grave. Nesse sentido, relacionar a violência com os homicídios é semelhante aos estudos da saúde pública que medem o efeito de uma epidemia pela taxa de mortalidade, embora existam formas menores de violência como o assalto à mão armada. A segunda justificativa de que os homicídios sejam a melhor medida da violência é uma questão pratica pois, simplesmente, há poucas alternativas para serem utilizadas. Dados

confiáveis e abrangentes sobre formas menores de violência são serialmente subrelatados, relatados de forma deturpada, classificados incorretamente e estão propensos à heterogeneidade e incoerências entre as microrregiões. Contudo, os homicídios são mais fáceis de classificar e mais propensos a serem relatados. Dadas essas justificativas, a taxa de homicídios é a representação mais adequada da violência. Outras variáveis importantes também são exploradas em cada capítulo. O próximo capítulo relaciona os homicídios com os gastos em segurança privada para medir as percepções de medo na sociedade. O terceiro capítulo aborda a relação entre os gastos em segurança pública e a taxa de homicídios. O quarto capítulo discute a correlação positiva entre a fabricação de armas nacionais e os homicídios no âmbito de uma robusta indústria nacional de armas portáteis.

Uma aplicação lógica do presente estudo é para incentivar a discussão sobre as políticas destinadas a lidar com a epidemia da violência. O objetivo implícito dessas políticas é, naturalmente, a redução global da violência. No entanto, essas políticas estão muitas vezes além dos seus objetivos. Na verdade, em vez de reduzir a violência, as políticas podem apenas atenuar seus efeitos ou transferir a mesma para outro lugar. Em outras palavras, as políticas muitas vezes tratam os sintomas da violência ou deslocam a mesma para outro lugar ao invés de tratar suas causas profundas. Por exemplo, no Capítulo 2, o subproduto da violência é o medo e as pessoas que aumentam a segurança privada em suas propriedades. O Capítulo 3 considera os padrões da violência que, em vez de ser reduzida em todos os sentidos, é simplesmente transferida para as áreas menos povoadas e menos protegidas. No Capítulo 4 e sobre a indústria de armas brasileiras, as políticas tais como o Estatuto do Desarmamento foram promulgadas com o apoio popular e com o objetivo final da redução global da violência. No entanto, e apesar dessa legislação, a violência continuou sem mudanças. Os capítulos são analisados com mais detalhes na seguinte seção.

## 6.1.2   Visão Geral dos Capítulos

A presente tese é composta por três capítulos. Cada um deles explora o panorama da violência brasileira a partir de ângulos diferentes. Enquanto todos os capítulos estão relacionados, cada um deles é também independente e pode ser publicado como um artigo separado desta tese. Esta seção descreve cada capítulo, bem como os pontos de intersecção e uniformização em relação ao tema geral da tese. Cada artigo é apresentado em um capítulo próprio nas seguintes páginas:

## 6.1.3   Capítulo 2: Percepções da violência e do medo no Brasil

Este capítulo enfoca as percepções do medo em relação à violência no Brasil. Embora seja claro que a violência muda negativamente a percepção do medo e da segurança de uma sociedade, fica menos claro como essas percepções podem ser medidas quantitativamente. Este estudo tem como objetivo abordar essa questão. O primeiro passo para medir a percepção do medo da violência na sociedade é modelar os fatores que determinam o emprego na segurança privada. Aqui, as participações da se-

gurança privada servem como uma representação para o medo no sentido de que os indivíduos mais temerosos são propensos a contratar mais segurança privada. O segundo passo é a construção de um Índice de Medo que relacione o emprego na indústria de segurança privada com níveis contra factuais de emprego na ausência hipotética de violência homicida. Esta relação destaca a quantidade de segurança privada contratada exclusivamente para combater os efeitos da violência homicida. Por fim, o medo de uma microrregião é comparado com as atuais taxas de homicídios para identificar como se classificam as microrregiões mais populosas, temidas e violentas do Brasil em relação ao espectro do medo e da violência.

### 6.1.4 Capítulo 3: A interiorização da Violência Brasileira: O Aumento da Violência no Campo está Relacionada com o Aumento das Despesas em Segurança Pública nas Grandes Cidades? •

Este capítulo explica e analisa um padrão que redefine o cenário de violência no Brasil: a propagação ou interiorização das áreas urbanas historicamente mais violentas para as áreas rurais que costumavam ser mais tranquilas. Assim, o mesmo contribui com a literatura sobre violência de duas formas principais. A primeira é a introdução de uma nova abordagem para analisar essa difusão da violência utilizando medidas de desigualdade. Os índices de Gini e Hoover são calculados para aproximar esses padrões e demonstrar o efeito equalizador da violência testemunhada através dos estados brasileiros. Além disso, a representação dessa redistribuição da violência em uma variável única facilita a análise empírica desses padrões, permitindo a comparação direta entre esses padrões e outras variáveis explanatórias. A segunda contribuição explora se os gastos do governo em segurança pública estão correlacionados com essas mudanças da violência. Em outras palavras, esta pesquisa tem como objetivo verificar se o aumento dos gastos governamentais em áreas mais urbanas estão relacionados com a fuga da criminalidade das cidades para as áreas rurais menos policiadas. Este artigo encontra evidências de uma forte correlação entre os gastos de segurança pública e a dispersão da violência para as regiões rurais. Contudo, é necessária uma análise mais aprofundada para determinar se o aumento da segurança pública em áreas urbanas está causando, na verdade, essa redistribuição da violência.

### 6.1.5 Capítulo 4: A Violência Armada e a Produção de Armas: Uma Análise do Fabricante de Armas Portáteis Brasileiras Taurus

A motivação por trás do último capítulo se origina a partir de dois padrões observados e que se relacionam com as armas portáteis e a violência homicida. O primeiro fator de motivação destaca que a grande maioria dos atos violentos perpetrados no Brasil foram realizados por armas de fogo produzidas no país, em vez de armas portáteis de fabricação estrangeira e de estilo militar. O segundo fator motivador destaca que a indústria de armas leves brasileira passou por um boom de produção nos mesmos períodos em que o país experimentou um aumento dramático da violência. Esses padrões

não implicam uma relação causal entre a indústria de armas brasileira e os altos níveis de violência. Diversos fatores dão forma aos resultados violentos. No entanto, esta pesquisa analisa a indústria de armas brasileiras com mais cuidado e devido às correlações anteriores. Particularmente, este trabalho considera a possibilidade de que a robustez da indústria de armas portáteis brasileira pode estar relacionada, pelo menos até certo ponto, com esses níveis elevados de violência. Para ter uma visão sobre a indústria de armas brasileira, este estudo analisa a maior e mais importante empresa fabricante de armas de pequeno porte do Brasil, a Forjas Taurus. Vários fatores tais como a história da empresa, a participação estrangeira e o apoio do governo são considerados para compreender não só as forças que moldaram a mesma, mas também a indústria de armas como um todo. Aumentando a compreensão da indústria de armas no Brasil, este artigo pretende desvendar um pouco da complexidade do panorama da violência brasileira.

### 6.1.6   Semelhanças e Contribuições

Embora cada capítulo possa ser utilizado como um artigo independente e publicável, todos os capítulos da tese formam uma análise geral da violência no Brasil. Uma das semelhanças é que os padrões observáveis forneceram a motivação para cada um dos capítulos. No caso do primeiro capítulo sobre percepções e medo, o curioso padrão do emprego na segurança privada ultrapassando drasticamente as taxas regulares do emprego motivou a presente pesquisa. O segundo capítulo foi motivado pela observação de um padrão do aumento da violência em áreas rurais e sua diminuição nas áreas urbanas, tudo apesar dos aumentos maciços nos gastos com segurança pública, em especial, nas grandes cidades. O capítulo final demonstra o padrão entre o aumento da produção nacional na fabricação de armas de pequeno porte e os aumentos dos homicídios. Com esse padrão, a pesquisa procura entender melhor a indústria de armas que, finalmente, forneceu a maioria das armas usadas para perpetrar a violência através da empresa Taurus que é a maior fabricante de armas do Brasil.

Uma segunda semelhança que unifica esses capítulos é o desenvolvimento de novas medidas para auxiliar na análise da violência homicida. No caso do Capítulo 1, uma forma inovadora foi desenvolvida para analisar quantitativamente os efeitos da violência homicida através da criação do Índice de Medo para captar as percepções de violência do individuo. No Capítulo 2, as medidas de desigualdade de Hoover e Gini forma usadas para explicar a redistribuição de violência dentro dos Estados. Embora o uso de medidas de desigualdade seja quase uma novidade para a ciência econômica, a aplicação delas para analisar as tendências na dispersão da violência é realmente uma novidade. Finalmente, o Capítulo 3 tem como objetivo compreender alguns fatores possivelmente relacionados com a violência homicida, explorando a história e as circunstâncias que levaram o Brasil a tornar-se um grande produtor de armas de pequeno porte. O desenvolvimento de medidas inovadoras para analisar os efeitos da violência na sociedade brasileira não é apenas um traço unificador dos capítulos, mas também uma importante contribuição para a pesquisa em geral.

A semelhança final dos três capítulos é a aplicação dessas novas ferramentas para analisar as tendên-

cias da violência brasileira. No caso dos capítulos 1 e 2, modelos robustos são desenvolvidos para explorar como os gastos em segurança privada ou pública se relacionam com a taxa de homicídios. No capítulo 1, o investimento em segurança privada aparece como significativamente relacionado com a taxa de homicídios, bem como uma série de outras variáveis de controle. No capítulo 2, correlações significativas são encontradas entre a propagação da violência para o campo e os gastos em segurança pública. Enquanto o Capítulo 3 não analisa empiricamente a relação entre as armas de pequeno porte e os homicídios, o mesmo investiga a indústria responsável pela fabricação das armas usadas para cometer crimes violentos.

## 6.2    Resumos dos capítulos

### 6.2.1    Capítulo 2: Percepções da Violência e do Medo no Brasil

Resumo:

Considerado como um dos lugares mais violentos do mundo, incluindo as atuais zonas de guerra, os impactos da violência na sociedade brasileira são muito graves. Esses efeitos são medidos de várias formas, incluindo não somente a perda da vida, mas também os gastos com a segurança pública e privada. Embora seja claro que os homicídios afetam negativamente o modo como a sociedade percebe a violência e a segurança, existem algumas medidas para captar quantitativamente essas percepções. Este estudo tem como objetivo preencher essa lacuna na literatura. Usando a estimativa Zero Inflated Poisson (ZIP) e os dados de painel em todas as 558 microrregiões brasileiras, desde 2008 até 2011, esta pesquisa formula os fatores que determinam o emprego na segurança privada. Utilizando a segurança privada como um exponente do nível de segurança percebido pela sociedade, este estudo constrói um Índice de Medo que relaciona o emprego na indústria da segurança privada com os níveis contra factuais de emprego na ausência hipotética de violência homicida. Maiores índices de valores implicam maiores níveis de medo e uma menor segurança relativa. Assim, esse índice é utilizado para analisar a relação entre o medo e a violência. A principal contribuição deste trabalho é a identificação de como as regiões mais violentas, temíveis e populosas do Brasil avaliam o espectro do medo e da violência. De um modo geral, o medo aumenta com a violência de uma forma previsível. No entanto, algumas microrregiões desafiam essa relação prevista e apresentam níveis excessivos de medo. A identificação dessas regiões serve como ponto de partida para identificar e analisar fatores tais como a violência homicida responsável pelo aumento do medo na sociedade.

Palavras-chave: Violência; Homicídios; Brasil; Segurança Privada.

## 6.2.2 Capítulo 3: A interiorização da Violência Brasileira: O Aumento da Violência na Zona Rural está Relacionado com o Aumento das Despesas em Segurança Pública nas Grandes Cidades?

Resumo:

As taxas de homicídio brasileiras estão entre as maiores do mundo, incluindo as atuais zonas de guerra. Contudo, o tipo de violência no Brasil está mudando. Os padrões emergentes mostram que as taxas de homicídios nas maiores cidades, consideradas tradicionalmente como os lugares mais violentos, estagnaram e declinaram enquanto as cidades menores e áreas rurais tiveram um aumento significativo das mesmas. A primeira contribuição deste trabalho é apresentar uma nova forma de analisar esse novo padrão de difusão da violência nas áreas rurais, utilizando as medidas de desigualdade. Para este fim, os índices de Gini e Hoover são calculadas em conjunto com as curvas de Lorenz que servem para aproximar essas tendências usando uma variável única. A segunda contribuição explora se os gastos do governo em segurança pública estão correlacionados com essas mudanças da violência. No caso do Brasil, usando os dados de painel nos 26 estados, entre 1995 e 2011, foi possível encontrar evidencias de uma forte correlação entre os gastos de segurança pública e a dispersão da violência para as áreas rurais.

Palavras-chave: Violência; Medidas de Desigualdade; Gastos em Segurança; Homicídio; Brasil; Segurança Pública.

## 6.2.3 Capítulo 4: A Violência Armada e a Produção de Armas: Uma Análise do Fabricante de Armas Pequenas Brasileiras Taurus

Resumo:

A violência armada tem um forte impacto na sociedade brasileira. Por várias razões, o Brasil está entre os lugares mais violentos do mundo. Tendo em conta que a grande maioria desses atos violentos é realizado através de armas de fogo produzidas no país, o presente estudo tenta contribuir com a literatura sobre a violência por meio de uma análise mais especifica da indústria de armas brasileira. A motivação para investigar a indústria de armas se origina em dois fatos principais: O primeiro cita que as armas produzidas no país foram usadas em uma esmagadora maioria de homicídios perpetrados no Brasil. O segundo menciona que o aumento dramático da violência coincidiu com um boom na produção de armas leves brasileiras. Está além do escopo deste artigo determinar se essa correlação implica um nexo causal entre a indústria de armas e os elevados níveis de violência no país. Inúmeros fatores desempenham um papel na determinação dos resultados violentos. No entanto, dada a correlação entre a violência e as armas de fogo produzidas no país, esta pesquisa tenta analisar mais de perto a indústria de armas de pequeno porte. Para ter uma visão sobre a indústria de armas brasileira, este artigo analisa a maior e mais importante empresa fabricante de armas de pequeno porte do Brasil, a Forjas Taurus. Diversos fatores que deram forma a essa empresa, bem como a indústria de armas

como um todo são considerados. Ao aumentar a compreensão da indústria de armas do Brasil, o presente trabalho pretende desvendar um pouco da complexidade sobre o panorama da violência brasileira.

Palavras-chave: Armas; Violência; Brasil.

## 6.3    Considerações Finais

A violência no Brasil é demonstrada pelas enormes quantidades de vidas perdidas e as astronómicas taxas de homicídio. Mais do que os números, essa violência representa um dos maiores desafios sociais e econômicos do Brasil e a mesma deixa no seu rastro a perda de vidas, famílias desfeitas e uma população temerosa. Ela é uma tendência que atinge quase todas as facetas da sociedade e dificulta as metas do país para alcançar o desenvolvimento e a prosperidade. Devido à acuidade e gravidade do problema, devem ser tomadas medidas ativas não só para compreender melhor a natureza dessa violência, mas também para reduzi-la e eliminá-la.

Portanto, este trabalho pretende adicionar à literatura existente na esperança de que uma melhor compreensão da violência possa ajudar o Brasil a embarcar em uma nova trajetória em direção a uma maior segurança e prosperidade. A principal contribuição da pesquisa é o desenvolvimento de novos métodos para medir, analisar e identificar tendências e padrões da violência, bem como a aplicação dessas ferramentas para poder entender os padrões e fatores que explicam os resultados violentos e definem sua natureza.

Como na natureza da maioria das pesquisas, para cada pergunta respondida outras são levantadas. Neste sentido, esta tese é a base para futuras pesquisas. No Capítulo 1, "Percepções da Violência e do Medo no Brasil" foram desenvolvidas algumas medidas para analisar como as percepções e os medos se propagaram em todo o Brasil. No entanto, uma análise mais profunda ainda é necessária para explicar os outros fatores que causaram em certas regiões a possibilidade de perceber os níveis excessivos do medo. No caso do Capítulo 2, "A Interiorização da Violência no Brasil", foram desenvolvidos métodos para medir e quantificar a difusão do crime. Daqui para frente, esses métodos podem ser aplicados para analisar não só os padrões de violência, mas também outros tipos de crimes, tanto dentro como fora do Brasil. Nos Capítulos 2 e 3, "Violência Armada e Armas", são apresentadas as correlações e não a causalidade para destacar a interação entre violência e duas variáveis-chave. Contudo, são necessárias mais pesquisas para determinar se, de fato, o aumento dos gastos em segurança pública se constitui em causa para a difusão da violência nas áreas rurais ou se uma forte indústria de armas causou o aumento dessa violência. Resta muito trabalho para ser feito, no futuro, em relação ao caminho da compreensão e a redução da violência no Brasil. Porém, devido à gravidade e urgência do problema, esta é uma tarefa que deve ser feita agora.

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