UNIVERSIDADE FEDERAL DO RIO DE JANEIRO
INSTITUTO DE ECONOMIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA

ANDRÉ ALBUQUERQUE SANT'ANNA

ESSAYS ON ENVIRONMENTAL ECONOMICS AND THE POLITICAL ECONOMY OF INEQUALITY

Rio de Janeiro
2018

UNIVERSIDADE FEDERAL DO RIO DE JANEIRO
INSTITUTO DE ECONOMIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ECONOMIA

ANDRÉ ALBUQUERQUE SANT'ANNA

ESSAYS ON ENVIRONMENTAL ECONOMICS AND THE POLITICAL ECONOMY OF INEQUALITY

Tese de Doutorado apresentada ao Programa de Pós-Graduação em Economia da Indústria e Tecnologia, Instituto de Economia, Universidade Federal do Rio de Janeiro, como requisito parcial à obtenção do título de Doutor em Economia.

Orientador: Rudi Rocha de Castro (IE/UFRJ)

Rio de Janeiro
2018

FICHA CATALOGRÁFICA

S231 Sant'Anna, André Albuquerque.
Essays on Environmental Economics and the Political Economy of Inequality / André Albuquerque Sant'Anna.- 2018.
161 p. ; 31 cm.

Orientador: Rudi Rocha de Castro.
Tese (doutorado) – Universidade Federal do Rio de Janeiro, Instituto de Economia, Programa de Pós-Graduação em Economia da Indústria e Tecnologia, 2018.
Bibliografia: f. 127 – 147.

1.Desigualdade social. 2. Economia política. 3. Economia do meio-ambiente. I. Castro, Rudi Rocha de, orient. II. Universidade Federal do Rio de Janeiro. Instituto de Economia. III. Título.

CDD 339.2

ANDRÉ ALBUQUERQUE SANT'ANNA

Essays on Environmental Economics and the Political Economy of Inequality

Tese de Doutorado apresentada ao Programa de Pós-Graduação em Economia da Indústria e Tecnologia, Instituto de Economia, Universidade Federal do Rio de Janeiro, como requisito parcial à obtenção do título de Doutor em Economia.

Aprovado em: Rio de Janeiro, 26 de Fevereiro de 2018.

Prof. Dr. Rudi Rocha de Castro (IE/UFRJ) (Orientador)

Prof. Dr. Arthur Bragança (PUC-Rio)

Prof. Dr. Filipe R. Campante (Harvard University)

Prof. Dr. Romero C. B. Rocha (IE/UFRJ)

Prof. Dr. Dimitri J. Szerman (PUC-Rio)

Rio de Janeiro
2018

Dedico este trabalho aos meus amores: Bê, Cla e Paulinha.

AGRADECIMENTOS

Nenhum trabalho é individual. Nem mesmo aqueles que levam o nome de apenas uma pessoa, como uma tese de doutorado. A construção desta tese é fruto de trocas com muitas pessoas, a quem devo meu agradecimento.

Agradeço ao Rudi. Orientação baseada em troca de ideias, parceria, leitura atenta e conselhos para manter o foco. Ao mesmo tempo, teve a sensibilidade em compreender que eu precisava de um tempo voando...

O ambiente no IE mudou nesses mais de dez anos de interregno entre mestrado e doutorado. Conheci novos professores e reencontrei alguns antigos. Gostaria de registrar meu agradecimento à Valéria, por comprar minhas ideias a ponto de virar co-autora. Eduardo Pontual, Fábio Freitas e Marta Castilho lecionaram disciplinas importantes para minha formação. Agradeço ao Cadu, professor e amigo. Me acolheu no Grupo de Economia do Meio-Ambiente (GEMA), onde pude conhecer a nova geração que vem por aí: Camilla, Gabi, Lucas e Marcos. Obrigado pelas inestimável ajuda para montar bases de dados e ensinamentos sobre o *QGis*. Essa galera vai longe. Aos colegas da pós, agradeço pelas trocas de ideias e convívio bacana em distintos momentos desse doutorado. Agradeço ao pessoal da Secretaria da Pós, sempre dispostos a ajudar.

Agradeço aos meus amigos, que acompanharam esse momento e partilharam os diversos momentos bons e os poucos sofridos.

Agradeço ao BNDES por ter me dado a oportunidade de fazer esse doutorado com licença. Sem essas condições, esta empreitada seria impossível.

À minha família, só posso dizer que cada um, a seu modo, tem grandes contribuições para o cumprimento dessa jornada. Agradeço à minha mãe, por ter, desde cedo, me mostrado o valor desse mundo da pesquisa. Ao meu pai, pelo incentivo e orgulho com minhas escolhas. Anne e Aline, minhas queridas irmãs. Obrigado por toda a parceria e torcida. Marta, Luiz Rodolfo e André, por estarem sempre por perto.

A Renata, Filipe, Sofia, Marina e Isabel, pelo imenso carinho e disponibilidade para me acolher. Foram 20 dias de intenso trabalho e participação na vida dessa linda família.

Para as três pessoas que moldam minha vida. Paulinha, minha companheira querida. Seus olhos brilhantes que me inspiram a seguir em frente, sempre. Sem seu incentivo, não teria embarcado nesse projeto. Obrigado por tanta parceria! Meus filhos, Clarice e Bernardo. Vocês representam momentos de redefinição de rumos. Poder de mudar enquanto se permanece no caminho. Tive a imensa felicidade de acompanhá-los de perto nesses últimos três anos. A vocês, dedico este trabalho.

RESUMO

Sant'Anna, André Albuquerque . **Essays on Environmental Economics and the Political Economy of Inequality**. 2018. 147 f. Tese (Doutorado em Economia) - PPGE, Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2018.

Esta tese apresenta três ensaios em economia do meio-ambiente e economia política da desigualdade. Como fio comum, os ensaios trazem a temática da desigualdade, em distintas dimensões - bens públicos, terra, renda, por exemplo.

O primeiro ensaio - "Do natural disasters lead to electoral sanctions?" - aborda as seguintes questões: o que acontece com políticos incumbentes quando ocorre um desastre natural? A resposta eleitoral é heterogênea à provisão local de bens públicos? O ponto de partida deste artigo é o reconhecimento que desastres de natureza hidrológica - isto é, desastres relacionados a precipitação extrema - não são exógenos ao conjunto de políticas públicas escolhido. Políticas como, por exemplo, remoção de moradias em encostas, saneamento básico, drenagem de rios, podem afetar a disposição a votar no político incumbente, a despeito de seus efeitos sobre a ocorrência de desastres naturais. Desse modo, ao reconhecer a possibilidade de endogeneidade, o artigo também faz uso de estimação por variável instrumental, de modo a obter um estimador consistente do efeito de desastres sobre desempenho eleitoral. Os principais resultados encontrados mostram que os eleitores, em resposta à ocorrência de desastres, (i) comparecem menos às urnas e (ii) votam menos no político incumbente.

O segundo ensaio - "Land inequality and deforestation in the Brazilian Amazon" - foi publicado em 2017, na revista científica *Environment and Development Economics*. O artigo investiga a relação entre distribuição de terra e desmatamento na Amazônia Brasileira. Para tal, um arcabouço conceitual é desenvolvido, onde o baixo acesso a terra decorrente da concentração fundiária condiciona as escolhas ocupacionais. Nesse cenário, há um incentivo à decisão de desmatar na fronteira agrícola. Baseado em dados municipais com desmatamento positivo entre 2002 e 2011, a fim de contornar possíveis problemas de endogeneidade, estimou-se um modelo com variáveis instrumentais. Os resultados apontam para a evidência estatística de que há uma relação positiva entre desigualdade de terra e desmatamento. Os resultados são mais fortes para o período 2002-2005. Tal fato pode estar relacionado às políticas de comando e controle que aumentaram significativamente o custo de desmatar a partir de meados da década de 2000.

O terceiro ensaio - "The Threat of Communism during Cold War: a constraint to income inequality?" -, em co-autoria com Leonardo Weller, trata da seguinte questão: a ameaça comunista representou uma força capaz de manter a desigualdade em níveis baixos nos países desenvolvidos, durante a Guerra Fria? Para testar essa hipótese, foi criada uma variável que mede a intensidade da ameaça comunista, a partir da distância geográfica de eventos relacionados à propagação do comunismo - revoluções, invasões da União Soviética. A estimação se deu por um modelo de painel com efeitos fixos para o período 1950-1990. O artigo fornece uma contribuição para a literatura recente sobre desigualdade, que salienta a importância de instituições domésticas e mesmo das duas Guerras Mundiais, mas não trata do papel da Guerra Fria na manutenção da desigualdade em níveis relativamente baixos. Os resultados apontam para uma relação robusta e negativa entre desigualdade e a proximidade de eventos comunistas. Esses resultados sugerem que o temor de propagação do comunismo promoveu acordos entre elites e trabalhadores, de modo a manter a desigualdade em níveis historicamente baixos.

Palavras-chave: Desigualdade , Meio-Ambiente , Mudança Climática, Desastres Naturais, Desmatamento, Eleições .

ABSTRACT

Sant'Anna, André Albuquerque . **Essays on Environmental Economics and the Political Economy of Inequality**. 2018. 147 f. Tese (Doutorado em Economia) - PPGE, Instituto de Economia, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2018.

This thesis presents essays on environmental economics and the political economy of inequality. As a common thread, the papers bring into light the discussion on inequality under different dimensions.

The first essay - "Do natural disasters lead to electoral sanctions?" - considers the following questions: what happens to incumbent politicians when a natural disaster strikes? Does the electoral response is heterogeneous to the local provision of public goods? The departing point of this paper is to acknowledge that hydrological disasters - that is to say, disasters related to extreme rainfall - are not exogenous to the choices of the policy set. Public policies - for instance, removal of dwellings located at hillsides, sanitation, rivers' drainage - may affect the willingness to vote in the incumbent politician, despite its effects on natural disasters. Thus, in recognizing the possibility of endogeneity, this first essay makes use of estimation by instrumental variable, in order to obtain a consistent estimator of the effect of disasters on electoral performance. The main results show that voters, in response to the occurrence of disasters, (i) appear less at the polls and (ii) vote less on the incumbent politician.

The second essay - "Land inequality and deforestation in the Brazilian Amazon" - has been published in the *Environment and Development Economics* journal, in 2017. The paper investigates the relationship between land concentration and deforestation in the Brazilian Amazon. A conceptual framework is developed, which relates occupational choices under low access to land, as a consequence of land inequality, and the decision to clear land at the agricultural frontier. This model implies that land inequality affects deforestation positively. Based on data from municipalities with positive deforestation from 2002 to 2011, a model has been estimated to test this theoretical prediction. By making use of an instrumental variable, results show that there is statistical evidence to support the existence of a direct relationship between land inequality and deforestation. Results are stronger for the period 2002-2005. This might be due to command and control policies that have significantly increased the cost of clearing land since mid 2000s.

The third essay - "The Threat of Communism during Cold War: a constraint to income inequality?" -, co-authored by Leonardo Weller, considers the following question: Did the threat of communism influence income distribution in developed

capitalist economies during the Cold War? In order to test this hypothesis, this article addresses this question by testing whether income inequality in OECD countries is related to events linked to the spread of communism – revolutions, USSR invasions - around the world. We run a fixed effects panel for the 1950-1990 period, controlling for institutional and economic conditions and provide additional robustness tests. This paper provides a contribution to the recent literature on inequality, which stresses the importance of domestic institutions and the two World Wars but fails to address the role of the Cold War in keeping income inequality at low levels. We find a robust and negative relationship between top income shares and the distance to communist events. The results suggest that the spread of communism fostered deals between domestic elites and workers that redistributed the gains from capital in favour of labor.

Keywords: Inequality, Environment, Climate Change, Natural Disasters, Elections, Deforestation.

LISTA DE FIGURAS

Figura 2.1: Global distribution of flood mortality risk 14
Figura 2.2: Mean slope by municipality 17
Figura 2.3: Probability of intense rainfall - summer 18
Figura 2.4: Polling stations and census tracts 20
Figura 2.5: Census tracts used with a 5-km buffer 21
Figura 2.6: Hydrological disasters by census tract between 2005 and 2016 . . 25
Figura 2.7: Rainfall Stations and Census Tracts 28

Figura 3.1: Theoretical relationship between land inequality and deforestation 65
Figura 3.2: Deforestation Rate: 2002-2005 and 2006-2011 75
Figura 3.3: Composed Land Gini: 1996 and 2006 76

LISTA DE TABELAS

Tabela 2.1: Descriptive Statistics 33
Tabela 2.2: Difference in means between census tracts with and without disasters 34
Tabela 2.3: OLS (Conley), Reduced Form and Second Stage 39
Tabela 2.4: Heterogeneous effects: 2SLS 43
Tabela 2.5: Expenditures as mechanisms: 2SLS 47
Tabela 2.6: Turnout and Share of Invalid Votes 49
Tabela 2.7: Alternative measures for disasters 52
Tabela 2.8: Effects from lagged and forward disasters 53

Tabela 3.1: Descriptive Statistics 74
Tabela 3.2: OLS: Different measures of inequality 78
Tabela 3.3: OLS Estimation: 2002-2005 79
Tabela 3.4: OLS Estimation: 2006-2011 80
Tabela 3.5: IV Estimation 82
Tabela 3.6: Robustness Checks: IV with additional controls 85
Tabela 3.7: Robustness Checks: Different Time Spans 87
Tabela 3.8: Robustness Checks: Panel with IV 89

Tabela 4.1: Communist-led Violent Events of the Cold War 104
Tabela 4.2: Summary Statistics 108
Tabela 4.3: Effects of Cold War on Inequality: Economic Controls 111
Tabela 4.4: Effects of Cold War on Inequality: Political Economy 113
Tabela 4.5: Contemporaneous and Lagged Independent Variables 115
Tabela 4.6: Dynamic Panel 117
Tabela 4.7: Alternative Measures of Inequality 119
Tabela 4.8: Alternative Measures of Communist Threat 121

SUMÁRIO

1 INTRODUCTION 1

2 DO NATURAL DISASTERS LEAD TO ELECTORAL SANCTIONS? 5
2.1 Introduction 5
2.2 Literature Review and Empirical Context 8
2.2.1 Literature Review 8
2.2.2 Empirical Context 14
2.3 Data 19
2.3.1 Dependent Variables 22
2.3.2 Independent Variables 23
2.3.3 Instrumental Variable 26
2.3.4 Heterogeneity: provision of public services 29
2.3.5 Mechanisms 30
2.3.6 Descriptive Statistics 32
2.4 Empirical Strategy 34
2.5 Results 38
2.5.1 Heterogeneous effects and possible mechanisms 41
2.5.2 Political participation and electoral competition 49
2.5.3 Robustness 50
2.6 Conclusion 53

3 LAND INEQUALITY AND DEFORESTATION IN THE BRAZILIAN AMAZON 55
3.1 Introduction 55
3.2 Related Literature 58
3.3 A Simple Model of Land Distribution and Deforestation 61
3.3.1 Setup 61
3.3.2 Occupational Choices 62
3.3.3 Introducing Land Inequality 64
3.3.4 Empirical Implications 68
3.4 Data and Descriptive Statistics 68
3.5 Empirical Model 75
3.5.1 Identification Strategy 76
3.6 Results 78
3.6.1 Robustness checks 83

3.7 Conclusion 90

4 THE THREAT OF COMMUNISM DURING COLD WAR: A CONSTRAINT TO INCOME INEQUALITY? 92
4.1 Introduction 92
4.2 Conceptual discussion 94
4.3 Related Historical literature 98
4.3.1 Case studies 100
4.4 Data description and descriptive statistics 102
4.5 Empirical Strategy 108
4.6 Results 109
4.6.1 Robustness checks: alternative variables 117
4.7 Conclusion 121
4.8 Appendix 122

REFERÊNCIAS 127

1 INTRODUCTION

Climate change and high levels of inequality constitute the main challenges for policymakers in the 21st century.[1] The choice of policy instruments to deal with climate change depend fundamentally on the costs of the potential damages involved and the extent to which future generations will need to bear these costs. Therefore, the choice of the discount factor is of paramount importance for policy decisions regarding climate change.[2] This implies that climate change policies can be seen as redistributive policies between distinct generations. Hence, policies that deal with climate change and inequality represent, respectively, inter and intragenerational redistributive policies. It is safe to say that these challenges, if not treated properly, may lead to disruptive changes, menacing the very form of organization of today's societies, especially Western societies, which are based on representative democracy (BURKE; HSIANG; MIGUEL, 2015; CHANCEL; PIKETTY, 2015; MILANOVIC, 2016).[3]

These challenges have not been ignored by economists. Indeed, there is a growing interest that leads to increased economic research on both themes. Moreover, there is also an increasing attempt to reach a broader public with the publication of reports and policy proposals based on recent research.[4]

[1] Even the World Economic Forum has recognized these phenomena as global challenges: https://www.weforum.org/agenda/2015/01/inequality-and-climate-change-twin-challenges-of-2015/

[2] See STERNER; PERSSON (2008) for a discussion on the the choice of the discount factor and an interesting insight into the role of relative prices. Moreover, another call for immediate action lies in people's distate for uncertainty, also known as ambiguity aversion (MILLNER; DIETZ; HEAL, 2013).

[3] Interestingly, TIROLE (2017) treats climate change as a major macroeconomic challenge and inserts inequality within the discussion of the moral limits of the market.

[4] See e.g. the World Inequality Report (http://wir2018.wid.world/files/download/wir2018-full-report-english.pdf) on inequality and GOLLIER; TIROLE (2017) on climate change.

As far as environmental degradation is concerned, this interest encompasses more than climate change. There is a growing empirical literature on environmental economics that deals with local rather than global issues such as air and water pollution (CURRIE; NEIDELL, 2005; ZIVIN; NEIDELL, 2013). In fact, there is an interface between research on inequality and environmental economics that is now being explored empirically. CURRIE (2011), for instance, explores this link by examining whether the claims of the "Environmental Justice" literature are based on sound empirical evidence. HSIANG; OLIVA; WALKER (2017) provide a general framework for analyzing the distribution of environmental damages. The latter authors apply this framework to understand the economic effects of deforestation, air pollution and climate.

The present thesis includes essays on environmental economics and the political economy of inequality. As a common thread, these papers highlight the discussion on inequality from varied perspectives. The first two papers focus on a relationship between environmental economics and political economy, whereas the third article discusses the relationship between the emergence of state capacity under external threats and how it may be conducive to a framework of low income inequality.

The first essay - "Do natural disasters lead to electoral sanctions?" - considers the following questions: what happens to incumbent politicians when a natural disaster strikes? Is the electoral response to the local provision of public goods heterogeneous? This paper provides an answer to these questions in the context of a developing country. More specifically, I have built a detailed dataset on disasters and extreme rainfall covering the period 2005-2016 in the state of Rio de Janeiro - a hotspot when it comes to hydrological disasters - that is to say, disasters related to extreme rainfall. The point of departure of this paper is to acknowledge that hydrological disasters are not exogenous to the choices of the policy set. Public policies - for instance, the removal of dwellings located at hillsides, sanitation, river drainage - may affect voters' willingness to opt for the incumbent politician, despite the effects

of public policies on disasters. Thus, in recognizing the possibility of endogeneity, this first essay makes use of an estimation using an instrumental variable approach, in order to obtain a consistent estimator of the effect of disasters on electoral performance. The main results show that voters, in response to the occurrence of disasters, (i) appear less at the polls and (ii) vote less for the incumbent politician.

The second essay - "Land inequality and deforestation in the Brazilian Amazon" - was published in the *Environment and Development Economics* journal, in 2017. The paper investigates the relationship between land concentration and deforestation in the Brazilian Amazon. A conceptual framework is developed, which relates occupational choices under low access to land, as a consequence of land inequality, to the decision to clear land at the agricultural frontier. This model implies that land inequality affects deforestation positively. Based on data from municipalities that had positive deforestation from 2002 to 2011, a model has been estimated to test this theoretical prediction. By making use of an instrumental variable, results show that there is statistical evidence to support the existence of a direct relationship between land inequality and deforestation. Results are stronger for the period 2002-2005. This might be due to command and control policies that have significantly increased the cost of clearing land since the mid 2000s.

The third essay - "The Threat of Communism during Cold War: a constraint to income inequality?" -, co-authored by Leonardo Weller is under revise and resubmit process at the *European Journal of Political Economy*. The paper considers the following question: Did the threat of communism influence income distribution in developed capitalist economies during the Cold War? In order to test this hypothesis, this article addresses this question by testing whether income inequality in OECD countries is related to events linked to the spread of communism – revolutions, USSR invasions - around the world. We ran a fixed effects panel for the 1950-1990 period, controlling for institutional and economic conditions and provide additional robustness tests. This paper provides a contribution to the recent litera-

ture on inequality, which has stressed the importance of domestic institutions and the two World Wars but has failed to address the role of the Cold War in maintaining income inequality at low levels. We find a robust and negative relationship between top income shares and the distance to communist events. The results suggest that the spread of communism fostered deals between domestic elites and workers which, in turn, redistributed the gains from capital in favor of labor.

2 DO NATURAL DISASTERS LEAD TO ELECTORAL SANCTIONS?

2.1 Introduction

Natural disasters affect millions of people. Between 2000 and 2015, disasters related to extreme rainfall, such as landslides and floods, are estimated to have killed 295,000 people and left 23 million homeless worldwide (EM-DAT, 2010). In Brazil, 2600 deaths occurred in the same period, including 900 in the disaster in the mountainous region of Rio de Janeiro in 2011 alone (World Bank, 2012). Given the prediction that climate change tends to increase the intensity of extreme weather events (SENEVIRATNE et al., 2012), the concern with natural disasters and their effects on the population has become a priority issue.[1]

Because environmental policies emerge from a political balance between voters and lobby groups (AIDT, 1998), the political participation of the population plays a key role in the adoption of more restrictive environmental policies (FREDRIKSSON et al., 2005). Thus, the effects of disasters on voters' voting decisions have the potential to rewrite the political balance toward the adoption of appropriate policies for adaptation to climate change. Accordingly, it is fundamental to understand how the population has reacted from an electoral standpoint to the more frequent and intense occurrence of these events.

In this article, the effects of natural disasters on the political participation of the population, measured both by turnout and by votes for incumbents, are studied. Several studies assessing the effects of natural disasters on electoral results have been published. This literature is part of the theoretical tradition of retrospective

[1]NOY (2015) documents a significant increase in lives lost annually as a result of natural disasters from 1980 to 2012.

voting. This theory assumes that voters, even without all relevant information for decision making, effectively hold incumbents accountable by focusing on simple performance metrics (FIORINA, 1981; HEALY; MALHOTRA, 2013). Accordingly, natural disasters function as one of these simple metrics.

Although extreme weather events are a key risk factor for the occurrence of disasters, this relationship is not necessarily unequivocal.[2] A set of public policies may prevent the extension of damages related to natural disasters or even mitigate their occurrence (World Bank and United Nations , 2010). Accordingly, KAHN (2005) reports that rich countries, despite experiencing just as many natural disasters, have a lower number of deaths related to natural disasters because investments in infrastructure and appropriate land-use zoning reduce the risk associated with extreme weather events BOUSTAN; KAHN; RHODE (2012).

Based on the premise that natural disasters have an endogenous character, this article aims to consistently identify their effects on the political participation of the electorate and the electoral performance of incumbent politicians. Furthermore, this study aims to identify public policies with the potential to reduce the effects of extreme weather events and to understand how the population assesses these policies when casting their vote. That is, mapping heterogeneous effects of disasters makes it possible to establish the relationship between the reaction of the electorate and the local supply of public goods.

To investigate the relationship between disasters and elections, this article builds a database of natural disasters and elections for Rio de Janeiro – note that 66% of deaths due to hydrological disasters between 2000 and 2014 occurred in this state. This database geographically identifies, based on documents from the Brazilian Ministry of National Integration, which is responsible for managing the National System of Civil Protection and Defense (Sistema Nacional de Proteção

[2]In fact, in 2012 the IPCC published a report on adaptation to climate change focused on addressing risks of extreme events (FIELD, 2012).

e Defesa Civil - SINPDEC), the occurrence of landslides, floods and flash floods between 2005 and 2016, by census tract, in the state of Rio de Janeiro.[3] These data are cross-referenced with voting information for mayors, by polling station, for 2008, 2012 and 2016, thereby creating a panel database of census tracts and electoral years that makes it is possible to assess, to the largest geographical breakdown possible, the effects of natural disasters on the electoral performance of incumbent politicians and voter turnout.

The electoral effects of disasters are estimated based on the fact that census tracts are heterogeneously affected. Thus, an empirical strategy based on a Difference-in-Differences model is adopted to estimate the causal effect of natural disasters that occurred during the mandate of incumbents on their share of votes when running for re-election and on voter turnout by census tract.

Nevertheless, disasters are not exogenous to unobservable characteristics that vary in time. Policies such as removing houses from slopes, basic sanitation and river dredging, for example, may affect the willingness to vote for mayors running for re-election, despite the effects of these measures on natural disasters. Thus, by recognizing the possibility of endogeneity, this study also uses instrumental variable estimation to obtain a consistent estimator of the effect of disasters on electoral performance.

This article is part of the literature that analyzes electoral effects related to natural disasters. Its main contribution is providing an identification strategy that eliminates estimation problems when disregarding that disasters have an endogenous component. Furthermore, this study investigates how heterogeneity in the provision of public infrastructure affects voters' perceptions of disasters. Finally, in line with the study by HEALY; MALHOTRA (2009) of counties in the United States, this

[3]Census tract is the smallest territorial area used by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE) in the interpretation of census data (IBGE, 2011).

study tests how the electorate reacts to disaster prevention and response policies. Thus, this article allows for a detailed mapping of the relationship between natural disasters and electoral performance of politicians in re-election campaigns.

To investigate these relationships, this article is structured into six sections, in addition to this introduction. In section 2, this article is framed within the literature on the political economy of natural disasters, and the purpose of the study is explained based on the empirical context used in the article, notably the state of Rio de Janeiro. In section 3, the data used are presented, describing in detail the construction of the database of this project, in addition to descriptive statistics. Section 4 describes the empirical strategy. In section 5, the results are presented and discussed. Section 6 presents the main conclusions of the study.

2.2 Literature Review and Empirical Context

2.2.1 Literature Review

In a context of climate change, one of the most striking features is the inability of governments to coordinate their actions on a subject with global consequences. Part of the literature highlights the coordination difficulties stemming from the different historical responsibilities of countries and the costs associated with those responsibilities (FRIMAN; STRANDBERG, 2014; PAUW et al., 2014). TIROLE (2012) highlights issues related to free-riding and to the strategic positioning of countries in future negotiations.[4]

In addition to these issues, a key point concerns the impact of domestic policy on climate change decisions. DIETZ; MARCHIORI; TAVONI (2012) argue that the

[4]In this case, the author argues that climate change negotiations should be understood under the framework of the incomplete contract theory: incentives to invest in a low carbon economy are low because they reduce the chances of a country obtaining a good deal in future negotiations.

theory of international environmental agreements considers that governments perform a cost-benefit analysis based on collective interests. However, the authors argue that domestic policies play a crucial role in the stance taken by governments in international negotiations. Accordingly, DIETZ; MARCHIORI; TAVONI (2012) show how domestic interest groups may influence the international position of a country. HABLA; WINKLER (2013) analyze the influence of lobby groups on emissions trading mechanisms. The authors argue that the international policy adopted depends on two factors: the influence of interest groups on incumbent politicians and the actions of national governments in the international arena.[5]

Thus, environmental policies clearly derive from the political balance in force. However, according to FREDRIKSSON et al. (2005), the political participation of the population, understood as participation in elections,[6] plays a key role in the adoption of more restrictive environmental policies.

In fact, assessment of the performance of those in power at the polls functions as an important mechanism of political accountability in democracies (ASHWORTH, 2012). Thus, given the role of democratic participation in shaping policies, the effects of natural disasters on the population's voting decisions may sway the political balance towards adopting suitable policies for adaptation to climate change. Accordingly, FAIR et al. (2017) show that the voters most affected by the great flood of 2010-2011 in Pakistan were more likely to participate politically.

Climate change is a complex phenomenon whose causes are unclear to the population (MILLNER; OLLIVIER, 2016).[7] The most striking expression of climate change is the more frequent and intense occurrence of extreme weather events

[5]It is worth noting that the effects of the policy need not be driven only by special interests. As RODRIK (2014) argues, the ideas of politicians should be considered in political economy analyses.

[6]Note that there are complementary ways of participating in political democracy other than voting. In this sense, CAMPANTE; CHOR (2014) show how protests, driven by a more educated population with no economic opportunities, were central to the Arab Spring.

[7]According to LEE et al. (2015), educational level and local dimensions, such as the perception of temperature, are key factors in the perception of climate risk by the public.

(SENEVIRATNE et al., 2012).[8] Thus, the performance assessment of incumbent politicians regarding climate change will presumably be based primarily on the occurrence and extension of damages resulting from natural disasters.

The literature assessing the effects of natural disasters on electoral results is based on the premise that the response of incumbents to disasters is a simple performance metric of the incumbent. A possible interpretation for this type of voter behavior, according to HEALY; MALHOTRA (2013), is based on the idea that it is virtually impossible to process the entire set of information and that individuals thus use their limited cognitive resources on a relevant subset of information.[9]

ABNEY; HILL (1966) started this line of research when assessing the effects of floods caused by hurricane Betsy, which hit the American state of Louisiana in 1965. The authors compared the electoral results from 1962 and from 1966 in flood-affected and unaffected districts and found no significant difference in electoral performance. ACHEN; BARTELS (2012) analyzed the effects of a series of shark attacks on the New Jersey coast and show how president Woodrow Wilson was punished in the affected locations, although the attacks were outside the purview of his public policies. MALHOTRA; KUO (2008) show how voters blamed officials of the opposite party for the damages caused by hurricane Katrina. According to the authors, they primarily blamed president George W. Bush. Regarding the same event, SINCLAIR; HALL; ALVAREZ (2011) show evidence of decreased electoral participation after hurricane Katrina.

These ambivalent results may reflect the fact that voter assessment depends on the response of incumbent politicians to natural disasters. Accordingly, HEALY; MALHOTRA (2009) show that voters reward spending on disaster assistance *ex post*,

[8] SPENCE et al. (2011) show that the population that suffered from flooding in England is more concerned with climate change and consumes less energy than the unaffected population.

[9] In this sense, the theory approaches "Salience theory", proposed in BORDALO; GENNAIOLI; SHLEIFER (2012).

whereas spending on disaster prevention has no effect on the electoral performance of incumbents, and that this occurs despite the efficacy of prevention spending in reducing damages.[10] More specifically, the authors show that spending on individual disaster assistance determines the electoral reward of incumbents.

Similarly, CHEN (2013), assessed the effects of federal aid to Florida residents after the 2004 hurricane season and demonstrates that disaster relief funds benefited the incumbent party by reducing the participation (turnout) of voters of the opposite party and by increasing the participation of its voters. ERIKSSON (2016) also examines municipal variation in the exposure to a storm that hit half the Swedish territory in 2005: the inaction of the Swedish Social-Democratic Party had long-lasting effects. The party lost its electoral base in the affected places in the 2006, 2010 and 2014 parliamentary elections. GALLEGO (2012) analyzed the effects of landslides and floods resulting from extreme rainfall that hit part of Colombia in 2010 and found a positive effect on the probability of mayors' reelections in the country. The author associates this positive result with patronage, whereby voters are more likely to sell their votes and incumbents have larger budgets to buy votes.[11] FUCHS (2014) also finds positive results when analyzing Mexican drought relief payments and the performance of the incumbent president. The analysis is based on the discontinuity in payments slightly deviating from a pre-established rainfall threshold that determines federal aid to estimate the effects on electoral results. BODET; THOMAS; TESSIER (2016) use a flood that occurred in June 2013, four months before the elections, in the city of Calgary, Canada, to assess the effects on the electoral performance of the incumbent mayor. The authors argue that the mayor's response was perceived as exemplary, and he even won the 2014 World Mayor Award. Nevertheless, BODET; THOMAS; TESSIER (2016) estimate, using difference in differences, that when controlling for observable socioeconomic

[10]HEALY; MALHOTRA (2009) show that each US$ 1 spent on prevention results in a US$ 15 reduction in future damages.

[11]COOPERMAN (2017) discusses how drought declarations in the Brazilian Northeast are motivated by the political agenda of mayors.

characteristics of the voting areas, there was no difference in voting for the incumbent mayor between treatment and control areas.

In general, this literature examines natural disasters as exogenous events. Although the risks derive from nature,[12] disasters should not be regarded as exclusively natural events (World Bank and United Nations , 2010). Ultimately, the choice of public policies, such as investments in infrastructure, affects the extent and even the occurrence of disasters and is related to the quality of the incumbent politician (ASHWORTH; MESQUITA; FRIEDENBERG, 2016). Thus, this article is also related to the literature that discusses the effects of economic development on natural disasters. In a comparison between countries, ANBARCI; ESCALERAS; REGISTER (2005) argue that higher income levels and equity are important for establishing stricter construction standards to reduce the effects of earthquakes. Similarly, KAHN (2005) show that richer countries do not suffer fewer disasters than poor countries. However, the number of deaths are much lower. KELLENBERG; MOBARAK (2008) present a non-linear relationship between the extent of damage related to various types of natural disasters and per capita income. The authors argue that some policies change with the income level. Finally, a part of the natural sciences literature discusses the importance of extreme rainfall as a trigger for disasters and the importance of public infrastructure and forest cover as determinants of the occurrence and intensity of landslides and floods (VASANTHA KUMAR; BHAGAVANULU, 2008; LIAO et al., 2012). Accordingly, omitted variable bias may occur when the endogeneity between disasters and votes is disregarded.

If the relationship between natural disasters and public policies is understood by the population, institutional improvement and enhanced ability of the State to promote development may be induced (BESLEY; PERSSON, 2011). Accordingly, KAHN (2007) show how some environmental catastrophes (e.g., Exxon Valdez,

[12]These exogenous events are considered locally. In a global perspective, this would not be valid, since the frequency of events of this type is related to climate change (SENEVIRATNE et al., 2012).

Chernobyl) led to stricter environmental regulations in the United States.[13]

As described above, literature findings are unclear and indicate the need for understanding the mechanisms linking natural disasters to electoral performance. The present study contributes to this literature by providing an identification strategy that eliminates estimation problems when the endogenous component of disasters is disregarded. For this purpose, instrumental variable estimation will be used to isolate the exogenous component of the hydrological disasters studied. The instrument used will be a measure of extreme rainfall at the census tract level. The main contribution of this article, therefore, is to consistently identify the effects of natural disasters on the electoral performance of incumbent politicians.

Furthermore, this article evaluates possible mechanisms that help to understand how disasters can affect voters' voting decisions. The adoption of public policies for natural disaster prevention and assistance is frequently used in the literature to understand the mechanisms that relate natural disasters to the electoral performance of incumbents (HEALY; MALHOTRA, 2009; GALLEGO, 2012; CHEN, 2013). In addition to those policies, this study tests how public policies not directly related to natural disasters have heterogeneous effects on the occurrence of natural disasters and on the response of the electorate at the polls. For this purpose, variables related to public infrastructure – for example, basic sanitation, urban drainage and garbage collection as well as land use and healthcare provision are used, which allows for a more comprehensive mapping of the relationship between natural disasters and the electoral performance of incumbents.

[13]It is worth noting that these catastrophes, unlike the natural disasters evaluated in this project, were the result of human action.

2.2.2 Empirical Context

Estimates indicate that, between 2000 and 2015, natural disasters related to landslides, floods and storms caused the death of 295,000 people and left 23 million people homeless worldwide (EM-DAT, 2010). In Brazil alone, according to the same database from the EM-DAT (The International Disasters Database), 2,600 deaths occurred and 600,000 people were left homeless in the same period. Regarding economic losses, CEPED/UFSC (2016) estimates that hydrological disasters have caused losses of R$ 72 billion at 2014 prices, from 1995 to 2014. This is equivalent to losses of R$ 3.6 billion per year.

As shown in Figure 2.1, which indicates the risk of flood-related mortality, some areas of Brazil – particularly the South and Southeast regions – are among the highest risk areas on the planet.

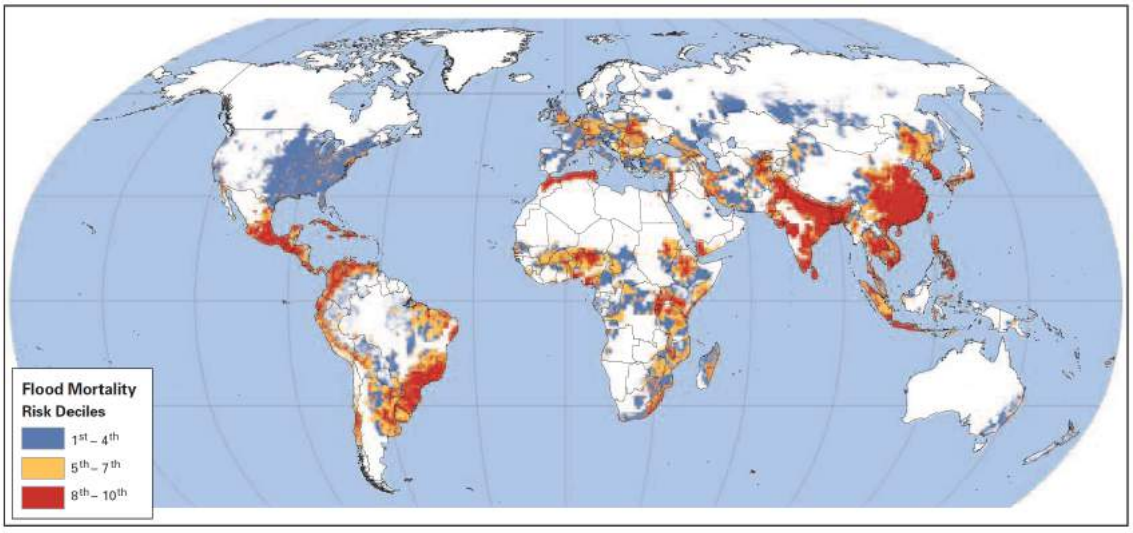

Figura 2.1: Global distribution of flood mortality risk
Source: DILLEY (2005)

A significant portion of these regions is in the highest risk deciles, which is

particularly worrisome considering the high population density. Furthermore, the number of hydrological disasters has increased in recent years. According to a survey conducted by CEPED/UFSC (2016), since 2008, the extent of damage was above average in 1995-2014. This pattern may be related to the predicted effects of climate change on extreme weather events (LEHMANN; COUMOU; FRIELER, 2015).[14]

In this region, the state of Rio de Janeiro has experienced a significant number of natural disasters related to mass movements, flash floods and floods. Although its area accounts for only 0.5% of the national territory, the state of Rio de Janeiro concentrated, from 1990 to 2010, 4% of flash floods and 31% of mass movements occurring in Brazil during this period (CEPED, 2012). Thus, local factors that increase the susceptibility of Rio de Janeiro to intense rainfall must be understood in more detail.

The risk of the occurrence of a disaster is related to the vulnerability of a given location and to the level of risk (in the case in question, extreme rainfall) to which the specific location is exposed (HALLEGATTE et al., 2016). The concept of vulnerability is defined as the set of conditions determined by physical, social, environmental and economic factors that increase the susceptibility of a community to the impact of extreme weather events GENCER (2013). Hazards are defined as natural phenomena that cause economic, environmental and health damages, according to the Hyogo Framework for Action (HFA).[15]

Among Brazilian states, Rio de Janeiro is particularly prone to hydrological disasters, such as landslides, flash floods and floods. This also translates into exten-

[14]Natural disasters cause harm to the population, not only through deaths directly linked to them but also through subsequent harm to the health of the inhabitants of affected areas.CARMO; ANAZAWA (2014) analyze the mortality pattern related to natural disasters.GUIMARÃES et al. (2014) and PEREIRA et al. (2014) find, respectively, a positive association between disasters and diseases such as leptospirosis and dengue fever.

[15]The Hyogo Framework for Action is a plan designed to reduce losses from disasters. This framework was developed after the World Conference on Disaster Reduction coordinated by the United Nations in 2005.

sive economic losses. According to estimates by CEPED/UFSC (2016), the state of Rio de Janeiro lost R$ 10.8 billion from 1995 to 2014, or 15% of the national losses due to hydrological disasters.[16] Furthermore, according to numbers from the Brazilian Ministry of Health, 66% of deaths due to natural disasters from 2000 to 2014 occurred in Rio de Janeiro.[17]

Given the clear predisposition of Rio de Janeiro to be hit by extreme weather events, it is important to understand how vulnerability and natural phenomena combine to make the region a global hotspot for hydrological disasters, as shown in Figure 2.1.

The state of Rio de Janeiro stretches from the 20.5 to the 23.5 latitude of the southern hemisphere and between the 41 West and 45 West meridians. The state comprises mountainous and lowland regions. Three mountain ranges cross the state in an east-west direction (Serra do Mar, Serra da Bocaina and Serra da Mantiqueira). The lowlands are located to the south of the mountains and have a high population density (e.g., Baixada Fluminense). The eastern most part of the state also includes the Baixada Campista.

From this combination of relatively high mountains – their highest point reaches 2,971 meters above sea level – and lowlands, a rugged terrain emerges, with several locations with high terrain slope. In fact, Rio de Janeiro has the highest altitude standard deviation/mean ratio of all Brazilian states. Furthermore, as shown in Figure 2.2, the state has the highest terrain slope values of the country.

[16] This estimate considers only *direct* losses.
[17] http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sim/cnv/ext10uf.def

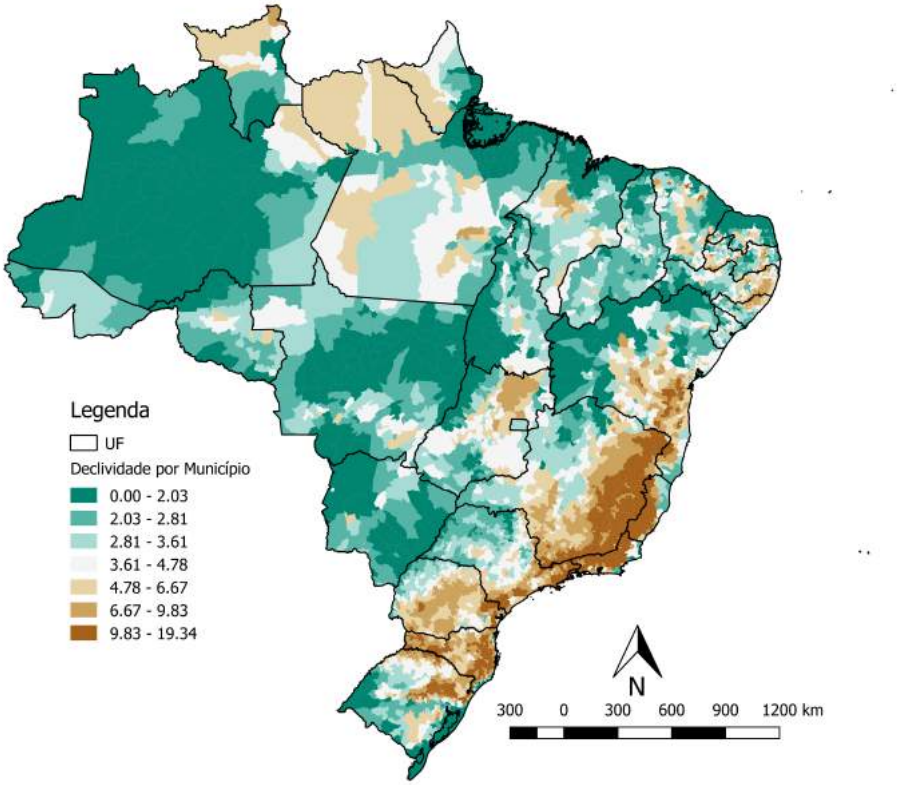

Figura 2.2: Mean slope by municipality
Source: IBGE

From the standpoint of its geomorphological features, Rio de Janeiro has a combination of factors that make it a place of high vulnerability to climatic events. Moreover, socio-economic factors contribute to increasing this vulnerability. The type of land use is particularly important in this context. Throughout the state, slopes are deforested and used for housing. According to BAHIA SCHLEE (2013), this type of occupation pattern plays a key role in reducing the resilience of cities in the state of Rio de Janeiro. Accordingly, in a report commissioned by the Brazilian Ministry of the Environment on the tragedy of the Serrana Region,[18] SCHÄFFER

[18]In January 2011, seven municipalities in the Serrana Region of Rio de Janeiro were hit by extreme rains, which caused landslides, leading to the death of more than 900 people and affecting more than 300,000 inhabitants of the region.

et al. (2013) argue that non-compliance with the Forest Code, particularly regarding the maintenance of Permanent Preservation Areas, played a key role in the scale of this disaster. The literature on the risk profile related to floods and landslides highlights the importance of factors such as terrain slope, land use type and soil type in the ability to predict the vulnerability of a location (DAPPLES et al., 2002; KAMP et al., 2008; VASANTHA KUMAR; BHAGAVANULU, 2008; LIAO et al., 2012).

The combination of high vulnerability with climatic characteristics renders the state highly prone to hydrological disasters. As shown in Figure 2.3, based on climatic data from 1981 to 2000, the state of Rio de Janeiro has a relatively high probability of experiencing heavy rainfall (>25mm/day) during the summer.

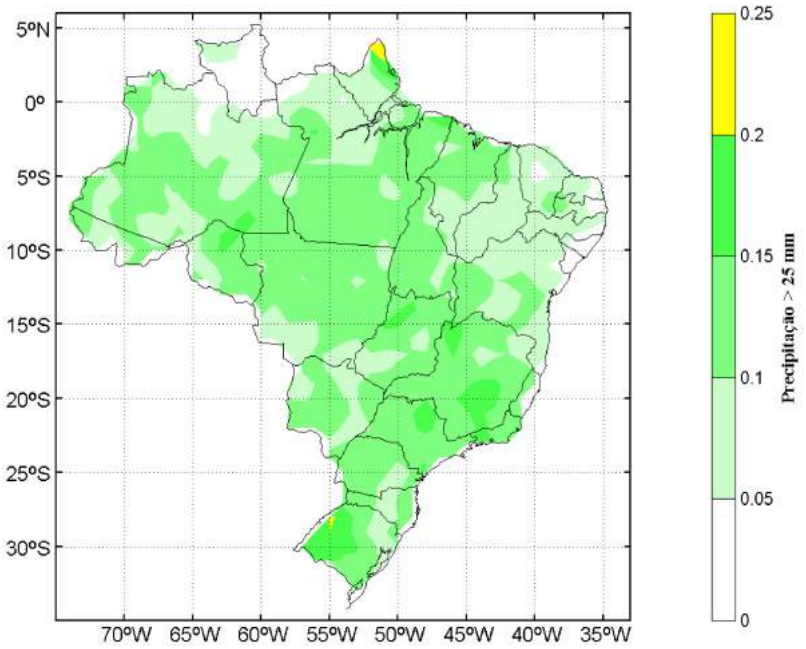

Figura 2.3: Probability of intense rainfall - summer
Source: OBREGON; MARENGO (2007)

Thus, the state of Rio de Janeiro has geographic and socio-economic factors

that lead to a situation of high vulnerability. In addition, Rio de Janeiro is exposed to extreme weather events more frequently than other Brazilian states. Considering this combination between vulnerability and natural hazards, the reason why the state is hit by numerous landslides, flash floods and floods is clearly understood. In fact, in an analysis of the vulnerability to expected increases in the number of landslides and floods, DEBORTOLI et al. (2017) classify Rio de Janeiro as one of the regions most vulnerable to the effects of climate change. After discussing the empirical context contextualizing the susceptibility of Rio de Janeiro to the occurrence of natural disasters, the following section presents and describes the data used in this study.

2.3 Data

The basic unit of analysis used in this study is the urban census tract that includes the polling station. The sample will be based on census tracts of the state of Rio de Janeiro, excluding the capital, for the 2008, 2012 and 2016 electoral years. The city of Rio de Janeiro, the state capital, was excluded from the sample for two reasons. First, only one natural disaster, in 2010, was registered in the Integrated Disaster Information System (Sistema Integrado de Informações de Desastres – S2ID) maintained by the Brazilian Ministry of National Integration. Thus, there is no temporal variation allowing for panel data analysis. Furthermore, the geographic quality of the 2010 disaster information is unsuitable for the purposes of this study because only neighborhoods were identified, and each neighborhood has, on average, 65 census tracts in the city of Rio de Janeiro.

Data on elections are originally collected at the polling station. Information on urban infrastructure is retrieved from the Population Census, which defines the census tract as the smallest territorial area used for census data interpretation. Thus, information on disasters, rainfall and forest remnant areas were analyzed at

the census tract level. Finally, considering that election information is based on polling stations and the other information is based on census tracts, geographical matching is required. The state of Rio de Janeiro, excluding the capital, has 5,548 addresses with polling stations and 17,702 census tracts. Figure 2.4 shows the map of polling stations and census tracts of the state of Rio de Janeiro. As shown, polling stations are distributed in only a few census tracts: 2.956 or 16.7% of the total.

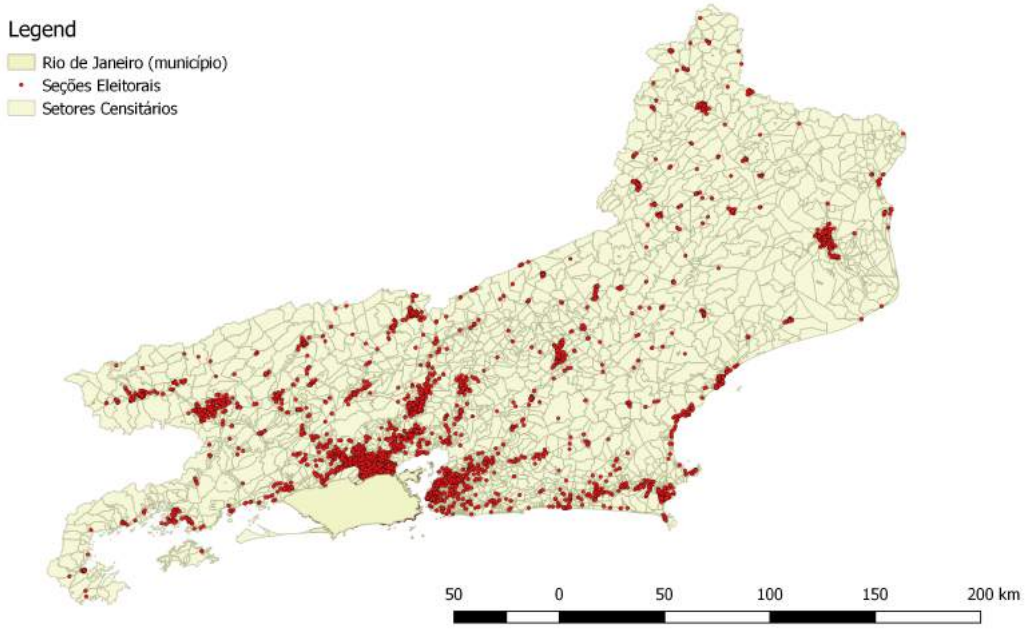

Figura 2.4: Polling stations and census tracts
Source: TSE and IBGE

Moreover, polling stations are concentrated in more urbanized locations, and the mean number of polling stations per census tract is 4.75. Thus, because the basic unit of analysis is the census tract, data on all polling stations within a given census tract were grouped to create an electoral database by tract.

Finally, natural disasters may have occurred in any of the 17,702 census tracts and not just in those with polling stations. To incorporate this information, radii of different distances (1, 2, 3, 4 and 5 kilometers) were drawn from the centroids of tracts with polling stations.[19] Thus, the independent variables incorporate information from all census tracts that are inside a predefined radius of the unit of analysis. Figure 2.5 shows the map with census tracts used in the sample. A 5-km radius was drawn around these tracts. The method used to construct the variables is detailed below.

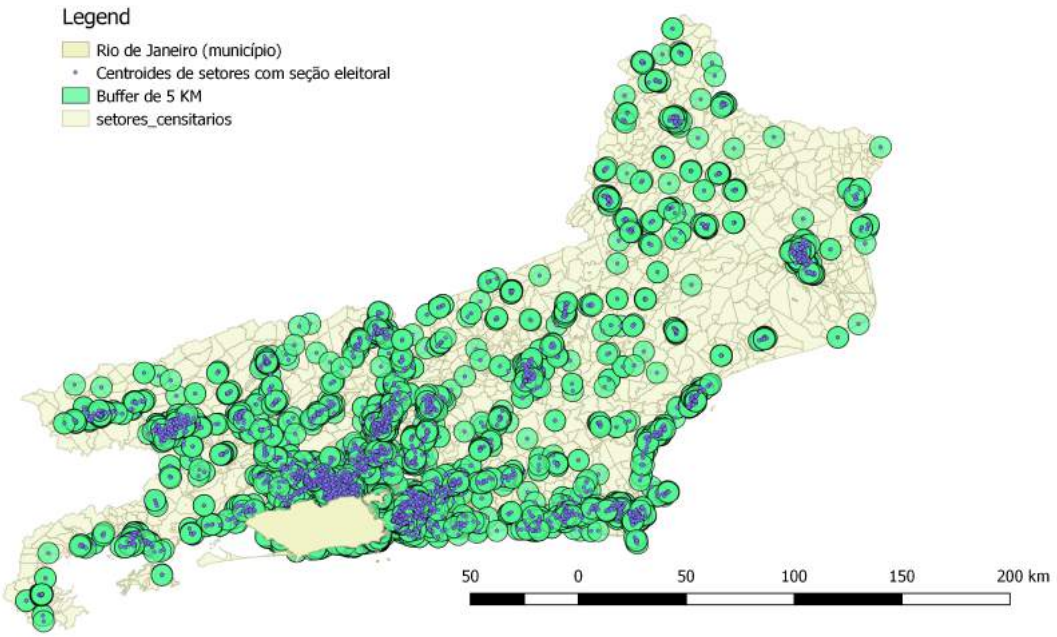

Figura 2.5: Census tracts used with a 5-km buffer
Source: TSE and IBGE

[19]The choice of a maximum buffer of 5 km is due to the fact that 96.9% of the urban census tracts are within this radius.

2.3.1 Dependent Variables

The database of voting by polling station of the Superior Electoral Court (Tribunal Superior Eleitoral – TSE) is available online.[20] A voting machine is allocated to each polling station, by which votes are recorded. Accordingly, the polling station represents the most disaggregated level of electoral data in Brazil.

Based on this information, data on the 2008, 2012 and 2016 mayoral elections in the state of Rio de Janeiro were compiled. Because the objective is to understand the effect of disasters on the performance of incumbent politicians, the main dependent variable used is the percentage of votes for the incumbent in the primary election race, in the polling stations of each census tract with a polling station i, in election year t. This variable captures the performance of the incumbent candidate locally, thereby capturing spatial heterogeneities that analyses at more aggregate levels cannot. It should also be noted that politicians who already completed their second term were excluded from the analysis because in Brazil incumbents are only allowed to run for re-election once. Thus, polling stations of municipalities in which the incumbents could not run for reelection, in electoral year t, are excluded from the sample.

In addition, a variable that measures the percentage of invalid votes (blank and null) in the primary, by census tract i, in election year t, will be used to assess whether possible voter dissatisfaction with the incumbent translates into votes for rivals or into invalid votes: because the sum of invalid votes for the incumbent and for rivals must total 100%, understanding the effects on votes for incumbents and invalid votes sheds light on voter response to the occurrence of natural disasters. Finally, voter turnout, measured by the variable $Turnout_{it}$, is a measure that translates how political participation is affected (CHEN, 2013).

[20] http://www.tse.jus.br/eleicoes/estatisticas/repositorio-de-dados-eleitorais

2.3.2 Independent Variables

The Ministry of National Integration maintains the S2ID.[21] This system gathers all information on official records of state and municipal calls for a declaration of a state of emergency or state of public calamity by the federal government. This documentation is filled out by municipalities affected by natural disasters and is a legal requirement for disaster declaration by the federal government. These documents have a rich set of information that includes type of disaster and its causes, area affected, number of people affected, financial losses and economic sectors affected. Regarding the areas affected, which is the most relevant information for this study, the level of detail varies by municipality, although the affected streets are commonly identified.

Once a disaster is declared, upon publication in the Diário Oficial da União (Official Journal of the Union), the municipality is entitled to request financial aid, which can be used for rebuilding and response measures.[22] Thus, because the documentation is part of the institutional framework required for the release of resources – from the Federal Government, which can only be used in initiatives related to the disaster – problems related to under-reporting of natural disasters are expected to be minor.[23]

From the consultation of this document base, a database of hydrological disasters (landslides, floods and flash floods) georeferenced by census tract that occurred in the state of Rio de Janeiro from 2005 to 2016 was created. For such purpose, a Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e

[21] http://s2id.mi.gov.br/

[22] Response actions are emergency measures to rescue and transport victims, provide humanitarian assistance and re-establish essential services. Rebuilding actions aim to rebuild areas destroyed by disasters. For more details see http://www.mi.gov.br/web/guest/defesa-civil/solicitacao-de-recursos

[23] Nevertheless, it is possible that municipalities with less institutional capacity tend to register fewer natural disasters. In any case, this will not be a problem since in the empirical part, the estimation will be performed with fixed-effects of the census sector.

Estatística – IBGE) census tract shapefile layer was added to the software QGis. Thus, each address mentioned in the municipal documents can be searched for and georeferenced by census tract. It should be noted that the quality of data reported by municipalities varies widely. Some municipalities even report the street where the disaster occurred, whereas others only present aggregate data, requiring the use of secondary sources of information.[24]

After creating this database, the variable of interest for this study could be constructed. The variable $Disaster_{it}$ is a dummy that indicates whether some disaster occurred in the census tract – with a polling station – i, in a four-year election cycle, which ends in the election year t. Figure 2.6 shows the map with hydrological disasters by census tract that occurred from 2005 to 2016. The red areas are census tracts hit by at least one disaster during the entire period.

[24]These cases occur, in general, when only the Ministerial Ordinance is disclosed. Often, the ordinances disclose only the name of the municipalities where a state of emergency was declared. In these cases, municipal documents or even newspaper reports were used to obtain information that would spatially segregate the places where disasters occurred.

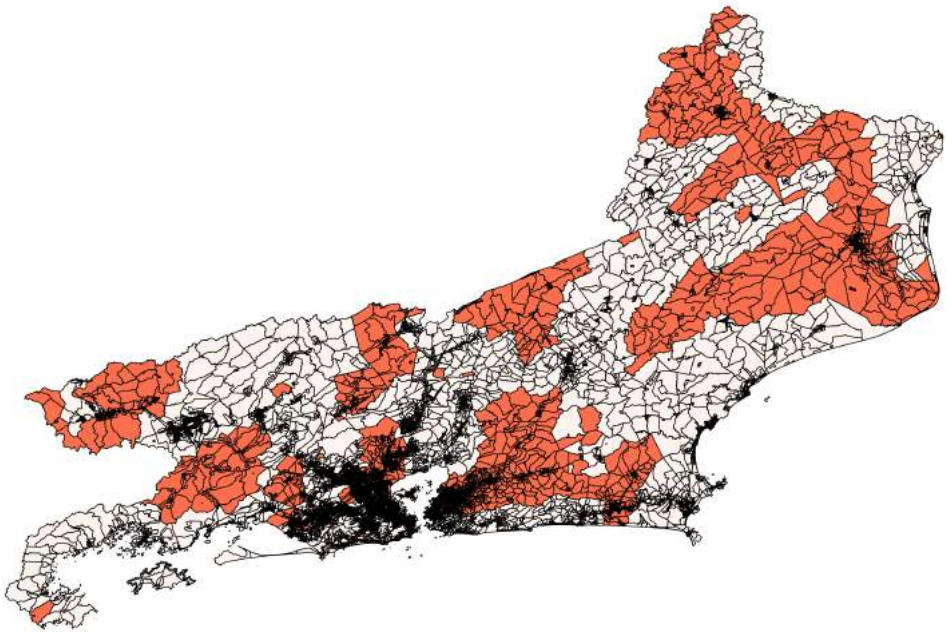

Figura 2.6: Hydrological disasters by census tract between 2005 and 2016
Source: Ministry of National Integration and IBGE

As described at the beginning of this section, the basic unit of analysis is the census tract i with a polling station. Hence, the disaster-related variable is constructed so as to consider only disasters that occurred in census tracts that are within a previously established radius from the census tract i with a polling station. Thus, the variable $Disaster_{it}$ is defined so that:

$$Disaster_{it} = 1\, if \sum_{j} \mathbf{1}(D_{ij} < B) Disaster_{jt} = 1,\ and\, 0\, otherwise$$

where $Disaster_{jt}$ is a dummy that measures the occurrence of natural disasters in any census tract j of the state of Rio de Janeiro, over the four-year period that ends in election year t. The term $\mathbf{1}(D_{ij} < B)$ is a function that indicates whether the distance D_{ij} between the census tracts i having a polling station and the census tracts j is shorter than B kilometers.[25] The estimates use five values for B: 1, 2, 3,

[25]This method is used in (MONTEIRO; ROCHA, 2017).

4 and 5 km.

Two other alternative variables will be used in this study to capture the effects of recurrence and election proximity on the electoral performance of incumbents. The variable $NumDisasters_{it}$ measures the number of disasters that occurred *buffers* around census tract i, in the four-year electoral cycle, which ends in election year t. This variable allows for understanding the effects of disaster recurrence and, accordingly, may help elucidate retrospective voting mechanisms after a natural disaster. Locations where disasters occur recurrently may also lack infrastructure, for example. The other variable, $Weighted\ sum\ Disasters_{it}$, calculates a weighted sum, with greater weight for years closer to elections. This measure is used to capture the effects of election proximity on voter behavior.[26]

2.3.3 Instrumental Variable

As discussed in the previous section, hydrological disasters are not fully exogenous. Even considering fixed effects, there may be unobservable characteristics that vary in time, making it necessary to introduce instrumental variables.

The occurrence of high levels of rainfall concentrated in a period of time is the main triggering factor of natural disasters such as landslides, flash floods and floods (HONG; ADLER; HUFFMAN, 2007; VAN WESTEN; CASTELLANOS; KURIAKOSE, 2008). Regarding landslides and flash floods, excess water, particularly in places with low natural protection, such as areas without forest cover and with irregular occupations, soaks and erodes the soil and leads to the occurrence of landslides (TOMINAGA; SANTORO; AMARAL, 2009). Regarding floods, heavy rains tend to increase the likelihood of soil flooding, particularly in locations with silted rivers and lowland areas (BRADSHAW et al., 2007).

[26]MIRON-SHATZ; STONE; KAHNEMAN (2009) find that individuals, when performing retrospective evaluations, exaggerate the effects of intense pain, which would indicate possible divergence between experience and memory.

Although the literature on the rainfall threshold above which the risk of hydrological disasters increases is inconclusive (GUZZETTI et al., 2008), OLIVEIRA et al. (2016) show that, under strict criteria, the threshold of 100mm/24h rainfall is relevant for the occurrence of catastrophic disasters in Rio de Janeiro. Similarly, PAULAIS (2012) reports the same level of rainfall as a limit after which the risk of hydrological disasters with significant damage increase.

Thus, the instrumental variable used in this article, $Extreme\ Rainfall_{it}$ considers the number of days in a year with rainfall above 100mm/day, weighted by the difference between the calculated value and the 100 mm/day threshold, so that:

$$Extreme\ Rainfall_{it} = \sum_{1}^{365} \frac{x}{100}\ if\ Rainfall/day = x > 100mm/day$$

Data on daily rainfall were collected from 137 rainfall stations located in the state of Rio de Janeiro and bordering states, from 2005 to 2016. Three different sources were used to collect data: National Water Agency (Agência Nacional de Águas – ANA), National Institute of Meteorology (Instituto Nacional de Meteorologia – INMET) and Alerta Rio, the meteorological institute of the municipality of Rio de Janeiro.[27] Figure 2.7 shows the map of Rio de Janeiro, divided by census tracts, and the rainfall stations used for data interpolation.

[27] Although the city of Rio de Janeiro was not included in the sample, its rainfall information was considered in order to obtain a more reliable data interpolation.

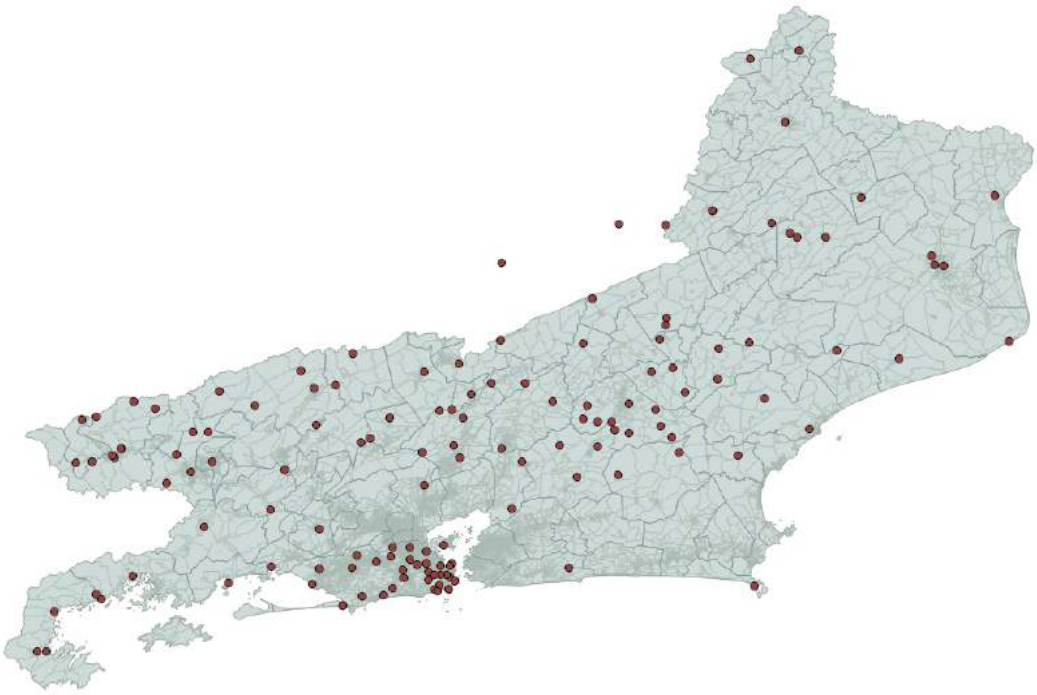

Figura 2.7: Rainfall Stations and Census Tracts
Source: ANA, INMET, Alerta Rio and IBGE

After computing the variable *Extreme Rainfall* at the rainfall station level, the data were interpolated using the Inverse Distance Weighting (IDW) method to obtain data on extreme rainfall by census tract i and calendar year a.[28] Next, to calculate the number of weighted days of extreme rainfall per electoral period t, the number of days of extreme rainfall in the four-year electoral cycle were added. Finally, the variable *Extreme Rainfall* had to be established for the basic unit of analysis, census tract i with polling station. For this purpose, the maximum value of *Extreme Rainfall* among the census tracts within the defined distance radius was considered.

[28]This method is used by CURRIE; NEIDELL (2005) to interpolate atmospheric pollution data. CHEN; LIU (2012) use the IDW for rainfall.

2.3.4 Heterogeneity: provision of public services

Urban infrastructure is crucial for reducing vulnerability related to extreme weather events (ANDREW, 2012). Thus, the effects of those events may be heterogeneous, depending on some characteristics of the census tracts. More specifically, the adequate provision of public service, such as adequate sewage and garbage collection and urban drainage, may be important in reducing the effects and even the occurrence of hydrological disasters because they affect erosive processes and river siltation (TOMINAGA; SANTORO; AMARAL, 2009).

To assess the heterogeneous effects of the provision of public services, three variables related to urban infrastructure are used: $Sewage_i$, which refers to exposure to open sewage; $Garbage_i$, which refers to exposure to garbage in vacant lots and $Drainage_i$, which refers to the existence of storm drains connected to underground waterways. The three variables reflect the percentage of street fronts in the census tracts located within the area circumscribed by each distance buffer from the census tract i with polling station. All of these variables are available online by census tract, for 2010, at the IBGE website (IBGE, 2011).

In addition to urban infrastructure, land use plays a key role in risk distribution related to extreme weather events. The literature on landslides and floods shows the important role of forest cover in defining terrain risk (DAPPLES et al., 2002; KAMP et al., 2008; VASANTHA KUMAR; BHAGAVANULU, 2008; LIAO et al., 2012). Regarding landslides, DAPPLES et al. (2002) argue that vegetation suppression reduces slope stability by increasing erosive processes. GENTRY; LOPEZ-PARODI (1980) argue that deforestation also increases the probability of floods because less vegetation implies less water retention. Accordingly, to estimate the effects of forest remnants on the occurrence of disasters, the variable $Forest_i$, which reflects the percentage of the area covered by forest remnants of the census tracts within the respective distance buffers from census tract i, will be used. For

this purpose, the shapefile of Atlantic Forest remnants, in 2012, provided by the non-governmental organization SOS Mata Atlântica, was used.

Another issue related to land use relevant to developing countries is urban occupation regulation. As discussed in the previous section, the state of Rio de Janeiro is characterized by a high percentage of its population living in substandard settlements. The IBGE registers census tracts classified as substandard according to the following definition: set with more than 50 housing units without deeds and (i) irregularities in traffic lanes and in the size and shape of lots and/or (ii) lack of essential public services (such as garbage collection, public lighting, sewerage and water and electricity) (IBGE, 2010). SMYTH; ROYLE (2000) analyze how the growth of slums affects environmental degradation, particularly considering slope occupation, thereby increasing the risks related to hydrological disasters, primarily due to increased soil erosion. Accordingly, the variable $Substandard_i$, which represents the area occupied by substandard settlements of the census tracts within the defined distance radius from the unit of analysis, will be used.

2.3.5 Mechanisms

The literature discusses possible mechanisms that may reveal how disasters affect the electoral performance of incumbents. HEALY; MALHOTRA (2009) and GALLEGO (2012) demonstrate the positive effects of disaster assistance policies on the performance of incumbents. To test this type of effect, this article will use data on transfers of resources to municipalities and states from the Brazilian Ministry of National Integration. These transfers are performed by the National Secretariat of Civil Protection and Defense (Secretaria Nacional de Proteção e Defesa Civil – SEDEC) and aim to help federal agencies conduct prevention, rebuilding and response. Resources for prevention are provided through voluntary agreements or transfers. In such cases, the municipality or state must actively search for resources. For

rebuilding and response measures, the institutional framework ensures mandatory transfers of resources once the federal government has decreed and recognized the emergency situation.

The variable $Prevention_{mt}$ indicates the volume of resources per capita transferred and effectively spent on prevention initiatives in municipality m, in term t of the incumbent government. Similarly, the variable $Response_{mt}$ indicates the volume of resources per capita transferred and spent on response and rebuilding initiatives in municipality m. The purpose is to test whether and which type of transfer affects electoral performance.

Both variables are measured at the municipal level and not at the census tract level because the allocation of transferred resources cannot be identified geographically. Thus, the variables are defined as:

$$Prevention_{mt} = Ln(1 + \frac{Prevention\ Costs_{mt}}{Population_{mt}})$$

Wherein $Prevention\ Costs_{mt}$ represents the total expenditure on prevention by municipality m and by term t and $Population_{mt}$ represents the average municipal population during term t. The same applies to response and rebuilding expenses.

Other public policies may also affect voter response to natural disasters. FREITAS et al. (2014) analyze various possible effects of disasters on human health. The authors estimate that from 1991 to 2010, hydrological disasters in Brazil led to 1,567 deaths and 309,529 sick and minor and severely injured. Thus, close proximity to primary care units, such as emergency room hospitals and emergency care units that ensure a rapid response, can function as a cooling mechanism of negative assessments of incumbent mayors. Hence, the variable - $Health_{it}$ – which relates the number of health units (per 100,000 inhabitants) around – as previously defined –the census tract i, in term t, will be used.

2.3.6 Descriptive Statistics

Table 2.1 outlines the descriptive statistics of the sample of census tracts used in this study. As previously mentioned, electoral performance variables are measured at the level of census tracts with polling stations. The remaining variables, except for response and prevention expenditures, are grouped and weighted and refer to all census tracts within a 5-km (maximum distance) radius from the census tracts with polling stations. Expenditure variables are measured at the municipal level and are available only for the first two years of the sample – 2008 and 2012.

The mean percentage of votes obtained by incumbents is 34 %, with a wide range of variation, from 0.3% to 86.8%. The mean turnout is 83.7%, whereas the percentage of invalid votes is 11.1%.[29] The statistics on disasters show that 32.1% of the sample census tracts, or their surroundings (this equals an area of 78.5 square kilometers),[30] were hit by at least one landslide or flood event during the electoral cycles. The number of days (weighted) in the year with rainfall higher than 100mm/day is, on average, 3.5. However, it reached 16.5 days in the census tract of the municipality of Cachoeira de Macacu during the 2012 election year.

[29]The percentage of invalid votes shows an increasing trend over time: 8.6% in 2008, 10.4% in 2012 and 14.3% in 2016, while the turnout shows a decreasing trend. The combination of both shows less political participation in the state of Rio de Janeiro over the years.

[30]This area corresponds to a circle with a 5 km radius.

Tabela 2.1: Descriptive Statistics

VARIABLES	(1) mean	(2) sd	(3) min	(4) max	(5) N
A. Electoral Performance					
Share of votes for the incumbent	33.99	17.26	0.306	86.76	4,836
Share of invalid votes s	11.06	5.479	0.901	37.79	4,836
Turnout	83.70	4.691	53.03	100	4,836
B. Natural Disasters and Extreme Rainfall					
(Dummy) Disaster	0.321	0.467	0	1	4,836
Disaster (unweighted sum)	0.364	0.566	0	3	4,836
Disaster (weighted sum)	0.182	0.314	0	2.250	4,836
Extreme Rainfall	3.545	2.689	0.002	16.52	4,836
C. Heterogeneous Effects and Mechanisms					
Open sewage	5.988	10.95	0	92.80	4,836
Garbage in Vacant Lots	0.759	2.368	0	35.82	4,836
Lack of Drainage	43.07	30.78	0	100	4,836
Forest Cover	5.407	13.02	0	85.74	4,836
Substandard Settlement	4.318	14.957	0	100.0	4,836
Health Unit (per 100,000 inhab)	25.86	98.46	0	4,545	4,836
(Ln) Expenditures per capita - Response	0.784	1.547	0	6.655	3,158
(Ln) Expenditures per capita - Prevention	0.355	0.991	0	5.583	3,158

Note: sample include election years 2008, 2012 and 2016. Observations comprise census tracts that exclude the state capital.

The means comparison is shown in Table 2.2, with the sample divided into tracts with and without natural disasters. Overall, the differences between means are significant, except for the main dependent variable – Share of incumbents. The other electoral performance variables indicate significant differences, with an increased number of invalid votes and decreased turnout in locations with natural disasters. The mean number of weighted days of extreme rainfall differ significantly (2.675 and 5.395), indicating that the instrumental variable chosen is appropriate.

Regarding the provision of public services, unsurprisingly, more census tracts with poor garbage collection, lower forest cover, more substandard settlements and lower primary care coverage are found in locations where disasters occurred. This

reinforces the view that landslides and floods are related to infrastructure and land use, as discussed above.

Tabela 2.2: Difference in means between census tracts with and without disasters

	No Disaster		*Disaster*		
	(1)	(2)	(3)	(4)	(5)
VARIABLES	mean	sd	mean	sd	diff
Share of votes for the incumbent	34.19	17.11	33.56	17.56	0.629
Share of invalid votes	10.87	5.86	11.43	4.53	-0.561***
Turnout	83.77	4.77	83.54	4.50	0.226*
Extreme Rainfall	2.675	1.941	5.395	3.085	-2.719***
Open sewage	6.000	11.00	5.954	10.83	0.051
Garbage in Vacant Lots	0.675	2.105	0.937	2.837	-0.263***
Forest Cover	5.689	13.38	4.810	12.22	0.878**
Substandard Settlement	4.120	14.73	4.737	15.40	-0.617*
Lack of Drainage	44.82	31.19	39.39	29.56	5.421***
Health Unit (per 100,000 inhab)	27.23	96.07	22.94	103.29	4.287*
(Ln) Expenditures per capita - Response	0.603	1.315	1.039	1.796	-0.436***
(Ln) Expenditures per capita - Prevention	0.285	0.937	0.454	1.054	-0.169***

Note: sample include election years 2008, 2012 and 2016. Columns (1) and (2) provide descriptive statistics the census tracts that did not suffer any disaster in the whole period and columns (3) and (4) provides descriptive statistics for the census tracts that did suffer at least one natural disaster in the period analyzed. Column (5) provides the difference between the means. Observations comprise census tracts that exclude the state capital, as the main results of the paper are presented. *** p<0.01, ** p<0.05, * p<0.1.

2.4 Empirical Strategy

To understand the type of relationship established between natural disasters and the electoral performance of politicians, this article examines the 2008, 2012 and 2016 elections for mayors.

Thus, the sample comprises a panel with census tracts with at least one polling station in the 2008, 2012 and 2016 election years. Because the database is organized into a panel of census tracts by electoral year, the effect of natural disasters on the electoral performance of incumbents can be assessed. For such purpose, the

following equation will be estimated:

$$Incumbent\ Share_{it} = \beta_0 + \beta_1 Disaster_{it} + \alpha_t + \lambda_i + \varepsilon_{it} \quad (1)$$

wherein $Incumbent\ Share_{it}$ is the vote share of the incumbent in census tract i, in election year t. The variable of interest, $Disaster_{it}$, is a dummy that indicates whether a natural disaster occurred in census tract i during term t of the incumbent, that is, 2005-2008, 2009-2012 and 2013-2016. The term α_t is a time fixed effect, which captures trends common to census tracts, λ_i is the census tract fixed effect, which captures effects of unobservable and invariant variables in time of census tract i. The model error term is ε_{it}. In addition to the equation above, similar equations will be estimated, albeit with other dependent variables and with the alternative natural disaster variables.

Although the triggering factor for a hydrological disaster, controlled for census tract fixed effects, is random (e.g., storms, extreme temperatures or any other weather event), the occurrence of the disaster itself depends on local characteristics, such as infrastructure, institutions and income level (HEALY; MALHOTRA, 2009). Thus, the first identification strategy to be adopted will be using a panel with time and census tract fixed effects, thereby enabling solving endogeneity problems regarding time-fixed unobservable variables of the census tracts.

Nevertheless, natural disasters may not be exogenous to unobservable characteristics that vary in time. Accordingly, policies such as removing homes from slopes, basic sanitation and river dredging, for example, may affect the willingness to vote for the incumbent mayor, despite their effects on natural disasters. Furthermore, as reported by COOPERMAN (2017), the disaster declaration itself may depend on the quality of the mayor. Because these characteristics of census tracts may vary in time and are unobservable,[31] an alternative strategy is needed to address this

[31] Some of these characteristics are observable for only one point in time - 2010 - and, therefore, will be object of heterogeneity analysis of the results.

possible endogeneity. In addition, as discussed in the data description, the disaster georeferencing data have a heterogeneous quality. Accordingly, the instrumental variable is also crucial to correct problems related to measurement errors.

The occurrence of intense and time-concentrated rainfall is the main trigger for the natural disasters discussed in this article. (STANLEY; KIRSCHBAUM, 2017). To credibly identify the effects of hydrological disasters on electoral outcomes, an estimation strategy based on an instrumental variable is used. Accordingly, this study uses a measure of concentrated rainfall intensity to define an instrumental variable for natural disasters. The variable $Extreme\ Rainfall_{it}$, defined in the previous section, will be used to identify the effects of disasters on electoral performance.

The first stage equation is defined by:

$$Disaster_{it} = \gamma_0 + \gamma_1 Extreme\ Rainfall_{it} + \alpha_t + \lambda_i + \epsilon_{it} \quad (2)$$

Where, in addition to the variables described above, $Extreme\ Rainfall_{it}$ represents the weighted number of days with rainfall higher than 100mm/day in term t of the incumbent, by census tract i. The instrument is validated based on the premise that the exclusion constraint suffices. That is: the variable $Extreme\ Rainfall_{it}$ cannot affect voters' decisions in ways other than through the occurrence of natural disasters. From the reverse causality standpoint, the exogeneity of the instrumental variable is guaranteed because politicians cannot affect nature.[32] However, as discussed by COLE; HEALY; WERKER (2012) regarding India, deviations from the optimal rainfall level affect electoral results and agricultural production. Because the effects on agricultural production and voter behavior may be associated, the exclusion constraint may become invalid. To address this issue, only urban cen-

[32]On a global scale, mitigation policies can affect the climate. However, on a local scale, politicians can only rely on "magic"forces. In this sense, the city of Rio de Janeiro maintained a contract with a foundation that claims to be able to control the weather: http://oglobo.globo.com/rio/cobrada-pelo-mau-tempo-fundacao-cacique-cobra-coral-diz-que-nao-falhou-19894579

sus tracts are considered in the estimations. Moreover, the municipal agricultural production value is added as a control. Finally, the use of detailed data at the census tract level allows for a more accurate identification of census tracts affected by extreme weather events.

The second stage of the estimation using an instrumental variable is given by:

$$Incumbent\ Share_{it} = \beta_0 + \beta_{IV} \hat{Disaster}_{it} + \alpha_t + \lambda_i + \varepsilon_{it} \quad (3)$$

As discussed above, when assessing the effects of natural disasters on the electoral performance of incumbent politicians, the possible retrospective voting mechanisms and the heterogeneity of some census tract characteristics must be analyzed. Hence, two-stage least squares (2SLS) regression analysis will be performed to examine the interaction between natural disasters and variables related to local heterogeneity.

The variables $Disaster_{it}$ and $Extreme\ Rainfall_{it}$ potentially have spatial correlation problems. To overcome spatial correlation problems in the independent variable, standard errors are adjusted using the procedure proposed by CONLEY (1999), HSIANG (2010) and FETZER (2014). Regarding rainfall measurements, there is spatial dependence by definition. Ultimately, the original data is collected at the level of the rainfall stations and then interpolated to obtain results by census tract. Thus, the variable that measures extreme rainfall at the census tract level is related to extreme rainfall measurements from the nearest rainfall stations. In this case, the attribution of values by census tract is clustered. Furthermore, because interpolation is calculated by the inverse of distance, the treatment is heterogeneous between census tracts within the same cluster. In these cases, as emphasized by ABADIE et al. (2017), the standard errors must be adjusted, even when the estimate considers fixed effects. Hence, the inference of standard errors for the rainfall measurement will be performed with clusters per rainfall station, which is the original source of variation in the rainfall measurement.[33]

[33] ANGRIST; PISCHKE (2008) discuss the need to use clustering when the data structure is not

2.5 Results

The main results from this study are outlined in Table 2.3. Columns (1) to (5) refer to the different distance buffers used, as explained in section 3. The table is divided into four panels. The results based on Ordinary Least Squares (OLS) estimation with location and time fixed-effects are shown in panel A. Thus, time-constant unobservable variables can be controlled for, in the case of location fixed-effects, and for common shocks between census tracts, in each period, in the case of time fixed-effects. Moreover, considering the spatial correlation in the data structure, standard errors are corrected using the method proposed by CONLEY (1999). In this case, it is considered that there is a correlation between different units in the covariance matrix up to a distance limit (in this study, from 1 to 5 km). Abbreviated results are shown in panel B. Thus, the effects of extreme rainfall events on electoral outcomes can be estimated. The results from the second stage of instrumental variable estimation are shown in panel C. Finally, the results from the first stage of instrumental variable estimation are shown in panel D. As discussed in the previous section, the OLS estimation coefficient is inconsistent because natural disasters are subject to measurement error and omitted variable bias. To overcome spatial correlation problems, clusters at the rainfall station level are used.

---

independent.

Tabela 2.3: OLS (Conley), Reduced Form and Second Stage

VARIABLES	(1) 1 KM	(2) 2 KM	(3) 3 KM	(4) 4 KM	(5) 5 KM
	Panel A: OLS with Conley correction - Dep. Var: Incumbent Share				
(Dummy of) Disaster	-0.598	-0.659	-0.659	-0.561	-0.570
	(0.965)	(1.469)	(1.846)	(2.092)	(2.272)
	Panel B: Reduced Form - Dep. Var: Incumbent Share				
Extreme Rainfall	-1.975**	-1.973**	-1.971**	-1.973**	-1.983**
	(0.963)	(0.964)	(0.964)	(0.964)	(0.966)
	Panel C: Second Stage - Dep. Var: Incumbent Share				
(Dummy of) Disaster	-17.247*	-17.170*	-17.134*	-17.112*	-17.275*
	(9.265)	(9.218)	(9.211)	(9.189)	(9.253)
	Panel D: First Stage - Dep. Var: (Dummy of) Disaster				
Extreme Rainfall	0.114***	0.115***	0.115***	0.115***	0.114***
	(0.025)	(0.025)	(0.026)	(0.026)	(0.025)
Observations	3,888	3,888	3,888	3,888	3,888
Number of Census Tract	1,657	1,657	1,657	1,657	1,657
Census tract FE	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y
Sanderson-Windmeijer first stage F	20.08	20.27	20.33	20.42	20.11
Number of clusters	70	70	70	70	70
Cluster	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station
Mean of Share of Incumbent	33.99	33.99	33.99	33.99	33.99
Mean of (Dummy of) Disaster	0.3180	0.3201	0.3201	0.3207	0.3209

Note: sample include election years 2008, 2012 and 2016. All regressions include period and census tract fixed effects. OLS estimates include, as proposed by HSIANG (2010) and FETZER (2014), Conley corrected standard errors for spatial dependence, with distance cutoffs similar to the buffers utilized. Instrumental variable: Extreme Rainfall. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

The results shown in panel A and estimated by OLS show a negative relationship, albeit non-significant, between the occurrence of at least one natural disaster during the electoral cycle, in the area defined by the distance buffer, and the share of votes for the incumbent politician. As discussed in the previous section, it is not possible to assume that the covariance between the share of votes for the incumbent

and the residual is equal to zero. Therefore, a strategy of instrumental variable estimation is used. In Panel B, the abbreviated results show a negative and significant ($p < 0.05$) relationship between extreme rainfall and votes for the incumbent. The relationship remains stable in different radii of distance from the census tract centroids in the sample. This result, similar to COLE; HEALY; WERKER (2012), shows that voters tend to punish incumbents when extreme weather events occur.

The results from the instrumental variable estimation are shown in panels C and D. The results from the second stage of instrumental variable estimation are shown in panel C. As shown, when controlling for endogeneity of the variable that measures the occurrence of natural disasters, a negative and significant ($p < 0.1$) correlation is found between the occurrence of hydrological disasters and the electoral performance of incumbent politicians in mayoral elections. The estimated coefficient represents a significant mean treatment effect: approximately 17 percentage points of vote share loss in each census tract used as unit of analysis. These results suggest that voters strongly react at the local level.[34] Finally, the results from the first stage are presented in Panel D. As shown, there is no difference in estimated coefficients between different buffers due to the stability of the variable regarding the occurrence of natural disasters: as shown in the last row, the variation in the mean of the disasters dummy is very small throughout the columns.[35] In all estimates, the values of the partial F statistic, measured as proposed by SANDERSON; WINDMEIJER (2016), are satisfactory.

Because instrumental variable estimation identifies the effects resulting from the exogenous variation of natural disasters, the results suggest that the impact

[34] As BARDHAN (2016) indicates, municipal elections have a more local agenda than elections for governor or president and therefore electoral sanctions due to disasters may be expected to occur more at the municipal level. In Brazil, the three levels of the Executive Branch - Federal, State and Municipal Governments - have distributed and well-defined Civil Defense responsibilities. The responsibility of municipalities is to identify risks and provide the first response when a disaster occurs.

[35] The sample with the 1-km buffer comprises 5.1 census tracts, while the sample with the 5-km buffer comprises 5.9 census tracts on average.

of extreme weather events – in the specific case, extreme rainfall – on votes occur through disasters. Because these weather events are random and highly salient, the electoral sanction may be related to the introduction of new and relevant information on the managerial quality of the politician (ASHWORTH; MESQUITA; FRIEDENBERG, 2016).

In this context, it is important to understand which factors affect voter assessments. For this purpose, the analysis is subdivided into two types: first, heterogeneous effects are assessed using stock variables. Basically, the objective is to understand how public infrastructure and forest cover, key variables in defining local vulnerability, can affect voter behavior. Next, the goal is to understand the possible mechanisms of transmission of accountability political to incumbents using flow variables and, therefore, how response and prevention expenditures affect electoral results by analyzing expenditures under mayors' control.

2.5.1 Heterogeneous effects and possible mechanisms

The results outlined in Table 2.3 indicate the need to understand how the heterogeneity of characteristics of census tracts can affect voter responses. Moreover, the response of those in power as well as prevention measures is also relevant determinants of voter behavior. It should be noted that Table 2.2 shows that census tracts hit by natural disasters have, on average, the worst provision of public services and are located in municipalities with higher expenses related to natural disasters.

The variables related to public infrastructure, as detailed in the section describing the data, are from the 2010 Census. In turn, the forest cover and health coverage variables are from 2012. Thus, they are all observable variables only at one point in time. Therefore, 2SLS estimation is used to assess their effects. The two first-stage equations regress extreme rainfall and its interaction with the variables related to public infrastructure in disasters and disasters interacting with public

infrastructure. Thus, the first stage equations are defined by:

$$Disaster_{it} = \gamma_0 + \gamma_1 Extreme\ Rainfall_{it} + \gamma_2 Extreme\ Rainfall_{it} * X_i + \alpha_t + \lambda_i + \epsilon_{it} (4)$$

$$Disaster_{it} * X_i = \mu_0 + \mu_1 Extreme\ Rainfall_{it} + \mu_1 Extreme\ Rainfall_{it} * X_i + \alpha_t + \lambda_i + \epsilon_{it} (5)$$

Where X_i is a vector with the variables of interest: sewage and garbage collection, forest cover, urban drainage and presence of primary care units and of substandard urban settlements. The other variables are the same as those presented in the empirical strategy section.

The second-stage equation for the 2SLS estimation is defined as:

$$Incumbent\ Share_{it} = \beta_0 + \beta_{2SLS} \hat{Disaster}_{it} + \beta_2 \hat{Disaster}_{it} * X_i + \alpha_t + \lambda_i + \varepsilon_{it} \quad (6)$$

Thus, it will be possible to capture heterogeneities in voters' responses to disasters conditioned by public policy variables. The results outlined in the tables of this section refer to the benchmark distance buffer of 5 km.

The results for heterogeneous effects, considering some characteristics of the census tracts (and their surroundings) relative to public infrastructure and land use are outlined in Table 2.4.[36] Panel A shows the results estimated for the second stage, whereas Panel B shows the results for the first-stage equation. Column (1) presents results for the effects from the disasters (Panel A) and extreme rainfall (Panel B) interaction with the percentage of households that dump garbage in empty lots. Column (2) shows the effects of the interaction with the variable relating to open sewage disposal. Column (3) shows the heterogeneous effects of the variable relating to the absence of urban drainage. These first three variables refer to measures of provision of public services. Columns (4) and (5), which show the effects of the area occupied by substandard urban settlements and by forests, respectively, refer to land use. In column (6), the effects of the presence of primary care units are

[36]It is worth noting that the variables in point are defined by the weighted mean of the area or total households of each census tract belonging to the area defined by the 5-km radius.

shown. Finally, column (7) outlines the results when all variables are considered together.

Tabela 2.4: Heterogeneous effects: 2SLS

VARIABLES	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS
	Panel A: Second stage - Dep. Var: Incumbent Share						
(Dummy of) Disaster	-18.736*	-20.965**	-25.794***	-16.026	-14.659	-17.249*	-23.770***
	(9.563)	(9.452)	(8.492)	(9.751)	(9.195)	(9.231)	(8.957)
Disaster X Garbage	0.809***						0.343
	(0.180)						(0.341)
Disaster X Open Sewage		0.371***					0.171*
		(0.078)					(0.100)
Disaster X Lack of Drainage			0.210***				0.221**
			(0.062)				(0.086)
Disaster X Substandard Settlement				-0.137			-0.162
				(0.118)			(0.149)
Disaster X Forest Cover					-0.611*		-0.765*
					(0.352)		(0.392)
Disaster X Health						0.014	0.013
						(0.030)	(0.028)
	Panel B: First Stage - Dep. Var: Disaster						
Extreme Rainfall	0.111***	0.109***	0.109***	0.115***	0.119***	0.114***	0.107***
	(0.026)	(0.025)	(0.030)	(0.027)	(0.026)	(0.025)	(0.030)
Extreme Rainfall X Garbage	0.003***						0.003***
	(0.001)						(0.001)
Extreme Rainfall X Open Sewage		0.001**					0.001
		(0.000)					(0.000)
Extreme Rainfall X Lack of Drainage			0.000				0.000
			(0.000)				(0.000)
Extreme Rainfall X Substandard Settlement				0.000			0.000
				(0.000)			(0.000)
Extreme Rain X Forest Cover					-0.001***		-0.002***
					(0.000)		(0.000)
Extreme Rain X Health						0.000	0.000
						(0.000)	(0.000)
Observations	3,888	3,888	3,888	3,888	3,888	3,888	3,888
Number of Census Tract	1,657	1,657	1,657	1,657	1,657	1,657	1,657
Census Tract FE	Y	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y	Y
SW first stage F for Disaster	23.70	33.09	21.14	18.75	24.46	23.79	24.88
SW first stage F for Disaster*X	244.2	131.4	55.19	69.60	13.45	34.31	
Number of clusters	70	70	70	70	70	70	70
Cluster	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station

Note: sample include election years 2008, 2012 and 2016. All regressions include period and census tract fixed effects. Instrumental variable: Extreme Rainfall and its interactions shown in Panel B. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

The first stage (Panel B) shows that the interactions between extreme rain-

fall and poor garbage (Column (1)) and sewage (Column (2)) collection conditions as well as decreased forest cover (Column (5)) increase the likelihood of occurrence of natural disasters and that an increase in one standard deviation in the above variables leads to variations of 0.7, 1.0 and -1.1 percentage points in the probability of a hydrological disaster occurring during an electoral cycle, respectively. Accordingly, these results confirm the hypothesis of vulnerability to extreme weather events (BLUNDELL, 2011). The results outlined in columns (3), (4) and (6) are non-significant. That is, census tracts with poor drainage, substandard settlements and primary care units are not more prone to hydrological disasters after an extreme rainfall event. The analysis of Column (7) shows that the most relevant characteristics are forest cover and garbage collection quality.

The results from the second-stage 2SLS estimation (Panel A) remain similar regarding the isolated effect of natural disasters on the electoral performance of incumbents: a negative and, except for the regressions that consider the interactions with substandard settlements and forest cover, significant effect is observed.[37] The results outlined in columns (1), (2), (3) and (5) of Panel B show that the poor provision of public services attenuates the electoral sanction. This effect, although it may seem paradoxical, because those locations are precisely the most vulnerable, may be related to the fact that "communities with inadequate levels [of public services] tend to develop a certain political resignation and discouragement" (KERSTENETZKY, 2012, p.274). Thus, where vulnerability is higher and the occurrence of natural disasters more common, this problem becomes less salient from the standpoint of the local electorate (PAVAO, 2015). Although the effects of natural disasters on substandard settlements and on locations with a higher level of coverage of primary care units are non-significant, they have the opposite direction to that discussed above: higher punishment in places with a greater share of substandard settlements and

[37] Although the variable resulting from the interaction between extreme rainfall and lack of drainage is not significant for the *Disaster* variable, the result is distinct when the dependent variable is the $Disaster * Lackof\ Drainage$ interaction. In this case, the coefficient is positive and significant at 1 %.

more votes for the incumbent in locations with better health coverage. The results outlined in Column (7) corroborate the previous analysis, except for the coefficient of interaction between natural disaster and garbage collection quality. In this case, the coefficient remains positive, albeit non-significant.

The heterogeneity results refer to stock variables, measured at a specific point in time. Therefore, they result from public investments and policies that may have been conducted also by mayors prior to the incumbent. Thus, a more accurate discussion of retrospective voting mechanisms after a natural disaster requires an analysis of variables directly under incumbent control.

Accordingly, the results regarding the effects of expenditures on disaster prevention and response are outlined in Table 2.5. As discussed in the section describing the data, these expenditures originate from federal government transfers and are only available for the first two electoral cycles, that is, 2005-2008 and 2009-2012.[38] Unlike the interaction variables in Table **??**, the data on expenditures vary in time but are aggregated at the municipality and not at the census tract level.

Both first-stage equations regress extreme rainfall and its interaction with the variables related to disaster response and prevention expenditures in natural disasters and the interaction between natural disasters and expenditure variables. Thus, the first-stage equations are defined as:

$$Disaster_{ijt} = \gamma_0 + \gamma_1 Extreme\ Rainfall_{ijt} + \gamma_2 Extreme\ Rainfall_{ijt} * X'_{jt} + \gamma_3 X_{jt} + \alpha_t + \lambda_i + \epsilon_{ijt} \quad (7)$$

$$Disaster_{ijt} * X'_{jt} = \mu_0 + \mu_1 Extreme\ Rainfall_{ijt} + \mu_2 Extreme\ Rainfall_{ijt} * X'_{jt} + \mu_3 X_{jt} + \alpha_t + \lambda_i + \epsilon_{ijt} \quad (8)$$

The second-stage equation for 2SLS estimation is defined as:

$$Incumbent\ Share_{ijt} = \beta_0 + \beta_{2SLS} \hat{Disaster}_{ijt} + \beta_2 \hat{Disaster}_{ijt} * X'_{jt} + \beta_3 X_{jt} + \alpha_t + \lambda_i + \varepsilon_{ijt} \quad (9)$$

[38] For this reason, the census tracts coverage and, consequently, the number of clusters is smaller in this table in relation to the other tables presented throughout the article.

Where X_{jt} is a vector with the variables of interest at the municipal level. The other variables are presented in the empirical strategy section. In this case, the other variables are indexed in census tract i of municipality j in election year t.

Tabela 2.5: Expenditures as mechanisms: 2SLS

VARIABLES	(1) 2SLS	(2) 2SLS	(3) 2SLS
	Panel A: Second Stage		
(Dummy of) Disaster	-25.772**	-14.796	-19.182
	(10.957)	(14.949)	(11.985)
Disaster X Prevention	31.580***		28.419***
	(7.541)		(8.148)
Prevention	-20.777***		-17.794***
	(5.209)		(5.837)
Disaster X Response		39.942	45.149
		(27.277)	(31.813)
Response		-21.590	-24.611
		(18.438)	(21.462)
	Panel B: First Stage		
Extreme Rainfall	0.146***	0.115***	0.151***
	(0.022)	(0.027)	(0.023)
Extreme Rainfall X Prevention	0.066*		0.065*
	(0.034)		(0.033)
Prevention	-0.766**		-0.759**
	(0.334)		(0.333)
Extreme Rainfall X Response		0.060**	0.004
		(0.030)	(0.051)
Response		-0.021	0.074
		(0.055)	(0.095)
Observations	1,918	1,918	1,918
Number of census tract	959	959	959
Census Tract FE	Y	Y	Y
Period FE	Y	Y	Y
SW first stage F for Disaster	56.67	20.15	33
SW first stage F for Disaster*Response		1.964	1.777
SW first stage F for Disaster*Prevention	49.67		53.27
Number of clusters	48	48	48
Cluster	Rainfall Station	Rainfall Station	Rainfall Station

Note: sample include election years 2008, 2012. All regressions include period and census tract fixed effects. Instrumental variable: Extreme Rainfall and its interactions shown in Panel B. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Panel B of Table 2.5 shows the results from the first-stage 2SLS estimation. Column (1) outlines the effects of prevention expenditures – by level and its interaction with extreme rainfall – on the probability of occurrence of natural disasters. The analysis of the results shows a negative correlation between the levels of expenditures on prevention of disasters, which suggests the effectiveness of prevention expenditures. The interaction between extreme rainfall and prevention, in turn, has a positive sign. This suggests that the census tracts harder hit by extreme weather events remain more vulnerable, even after investments in prevention. The results of expenditures on response to natural disasters are outlined in column (2). The results considering both types of expenditures are outlined in column (3). The coefficients of prevention expenditures remain relatively unchanged, whereas the coefficients of expenditures on response to natural disasters change and are non-significant.

The second-stage results indicate the positive and significant effects of the interaction between natural disasters and prevention expenditures, as shown in Column (1) of Panel A. Thus, the populations of census tracts hit by natural disasters that observe investments in prevention recognize the incumbent's management. Column (2) shows that the interaction between expenditures on response to natural disaster and on prevention has a positive effect, albeit non-significant. The same pattern is repeated in Column (3), which considers both types of expenses. These findings corroborate HEALY; MALHOTRA (2009), who show how American voters respond to expenditures on response, but not on prevention.

The results outlined in Tables 2.4 and 2.5 indicate that voters (i) respond negatively to the occurrence of natural disasters; (ii) where infrastructure is chronically deficient, voters perceive the problem as more recurrent and, therefore, the punishment is smaller; (iii) voters recognize efforts to prevent new episodes.

2.5.2 Political participation and electoral competition

In addition to the effects that natural disasters may have on the predisposition to vote for the incumbent politician, natural disasters may also affect the political participation of the electorate. Accordingly, similar to FAIR et al. (2017), this study will examine how natural disasters affect turnout. Furthermore, the fact that natural disasters decrease the incumbent's share of votes does not necessarily mean more votes for the opponents. Thus, analyzing the effects on the share of invalid votes and turnout will make it possible to outline a general scenario of what also occurs in terms of electoral competition and political participation.

Table 2.6 outlines the effects of natural disasters on turnout and on the share of invalid votes. Similar to Table 2.3, both OLS and 2SLS estimation results are shown.

Tabela 2.6: Turnout and Share of Invalid Votes

VARIABLES	(1) Turnout OLS	(2) Turnout 2SLS	(3) Invalid Share OLS	(4) Invalid Share 2SLS
(Dummy of) Disaster	-0.395***	-1.844**	0.376	-2.985
	(0.119)	(0.875)	(0.293)	(1.999)
Observations	3,888	3,888	3,888	3,888
Census Tract FE	Y	Y	Y	Y
Period FE	Y	Y	Y	Y
Number of Census Tract	1,657	1,657	1,657	1,657
SW first stage F		20.11		20.11
Number of clusters		70		70
Cluster		Rainfall Station		Rainfall Station

Note: sample include election years 2008, 2012. All regressions include period and census tract fixed effects. Instrumental variable: Extreme Rainfall. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

The results indicate that census tracts hit by disasters in their surroundings (considering the 5-km buffer) showed a decrease in turnout of 1.8 percentage points (Column (2)). The results of the share of invalid votes indicate no effect different from zero. Accordingly and also considering the previous results, the occurrence of disasters leads to (i) a lower level of political participation and (ii) stronger punishment of incumbent politicians.

2.5.3 Robustness

To test the robustness of the results, two tests are performed. First, two additional disaster measures are introduced. These variables are the unweighted sum of natural disasters occurring over the electoral cycle per census tract - *Unweighted Disaster* - and the weighted sum of natural disasters, where events closest to elections have a greater weight than events more distant in time - $Weighted\ Disaster$. The benchmark measurement of natural disasters records only occurrences of at least one disaster per electoral cycle, whereas the weighted and unweighted sum measures allow for capturing the effects of the recurrence of natural disasters at a specific location. As shown in Table 2.1, some tracts were hit by up to three natural disasters in the same electoral cycle. The results of the estimations with these variables are outlined in Table 2.7. Next, a placebo test is performed, which assesses the impacts of natural disasters that occurred in other electoral cycles (in *t-1* and *t+1*) on electoral performance variables.

Table 2.7 outlines the results for alternative variables of natural disasters. The results of OLS estimations, with Conley correction for spatial correlation, are shown in Panel A, whereas the results of instrumental variable estimations are shown in Panel B. The results of the unweighted sum of natural disasters are outlined in columns (1) to (3). The columns show results for the three dependent variables previously used: *Incumbent Share, Turnout and Invalid Share*, respectively. The

results of the weighted sum are shown in columns (4) to (6).

The results show that the *Unweighted Disaster* coefficients – the sum of natural disasters during the incumbent's term – are quite similar to the main variable – *Disaster* –, particularly in instrumental variable estimations. The results in columns (4) to (6), particularly the results of the instrumental variable estimations, have higher values. The comparison between the pairs of coefficients (1) and (4), (2) and (5) and (3) and (6), in addition to those outlined in Tables 2.3 and 2.6, show that the occurrence of natural disasters closer to elections result in stronger punishment of incumbents and lower political participation because the *Weighted Disaster* coefficients are more than double the coefficients of the variables *Unweighted Disaster* and *Disaster*. However, the *Weighted Disaster* results, shown in panel B, fail the strength test of their instrumental variable. As shown by the Sanderson-Windmeijer F-statistic for the first stage, the low result ($F<10$) indicates that the instrument is weak. Thus, the results for *Weighted Disaster* in the instrumental variable estimation should be interpreted with caution.

Tabela 2.7: Alternative measures for disasters

VARIABLES	(1) Incumbent Share	(2) Turnout	(3) Invalid Shares	(4) Incumbent Share	(5) Turnout	(6) Invalid Share
	Panel A: OLS					
Unweighted Disaster	-2.441	-0.240**	0.503**			
	(1.853)	(0.093)	(0.199)			
Weighted Disaster				-5.519*	-0.377**	1.343***
				(3.281)	(0.169)	(0.336)
	Panel B: Second Stage					
Unweighted Disaster	-17.323*	-1.849*	-2.994			
	(9.130)	(0.989)	(2.260)			
Weighted Disaster				-40.808*	-4.357*	-7.052
				(23.359)	(2.579)	(5.880)
Observations	3,888	3,888	3,888	3,888	3,888	3,888
Number of census tract	1,657	1,657	1,657	1,657	1,657	1,657
Census Tract FE	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y
SW first stage F	11.42	11.42	11.42	6.320	6.320	6.320
Number of clusters	70	70	70	70	70	70
Cluster	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station	Rainfall Station

Note: sample include election years 2008, 2012 and 2016. All regressions include period and census tract fixed effects. Instrumental variable: Extreme Rainfall. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

The effects of the variable *Disaster* lagged and led by one electoral cycle are outlined in Table 2.8. The purpose is to conduct a placebo test because future disasters, by definition, cannot affect elections in the current electoral cycle. In addition, disasters in an earlier electoral cycle should affect earlier but not current elections. As shown, the effects are only contemporaneous. The results outlined in column (1), with lagged disasters, indicate that the current findings do not stem from pre-existing trends.

Tabela 2.8: Effects from lagged and forward disasters

VARIABLES	(1) IV	(2) IV	(3) IV
(Dummy of) $Disaster_{t-1}$	1.821		
	(13.979)		
(Dummy of) $Disaster_t$		-17.275*	
		(9.253)	
(Dummy of) $Disaster_{t+1}$			-11.137
			(11.752)
Observations	1,148	3,888	1,148
Number of Census Tract	574	1,657	574
Census Tract FE	Y	Y	Y
Period FE	Y	Y	Y
Sanderson-Windmeijer first stage F	9.578	20.11	5.228
Number of clusters	38	70	38
Cluster	Rainfall Station	Rainfall Station	Rainfall Station

Note: sample include election years 2008, 2012 and 216. All regressions include period and census tract fixed effects. Instrumental variable: Extreme Rainfall. Robust standard errors are clustered by rainfall station. Significance: *** p<0.01, ** p<0.05, * p<0.1.

2.6 Conclusion

This article examines the role of natural disasters on electoral accountability in municipal elections. The main findings show, in response to the occurrence of natural disasters, (i) decreased turnout; (ii) decreased votes for the incumbent; (iii) no increase in invalid votes and, therefore, increased votes for the incumbent's opponents.

In addition, when using spatial heterogeneity in land use and in the provision of public services, voters from more vulnerable locations punish incumbents less in response to natural disasters because, under those circumstances, these events partly lose their salience. That is, as highlighted by BORDALO; GENNAIOLI; SHLEIFER

(2012), natural disasters no longer attract the attention of voters because they do not bring new information to the set relevant to the voting decision (ASHWORTH; MESQUITA; FRIEDENBERG, 2016; PAVAO, 2015).

Finally, the results of the analysis of possible retrospective voting mechanisms show that prevention spending is rewarded at the polls, whereas disaster response spending is not. These results refute the hypotheses of other studies indicating voter myopia and patronage (HEALY; MALHOTRA, 2009; GALLEGO, 2012). However, it should be noted that these results are specific to the institutional and empirical contexts analyzed.

This study allows furthering the understanding of how highly visible events, such as natural disasters, affect the population's perception and the accountability it attributes to the political class. In addition, as noted above, most studies regard disasters as natural and therefore exogenous events. However, disasters and the extent of their damage arguably depend on the state's ability to prevent and to respond, in order to minimize the effects of extreme weather events. Accordingly, natural disasters, when raising electoral questions among the population, may induce institutional improvement that enables the adoption of more adequate policies for adaptation to climate change.

3 LAND INEQUALITY AND DEFORESTATION IN THE BRAZILIAN AMAZON

3.1 Introduction

In recent decades, there has been an increasing focus on the process of deforestation in the Amazon. This process has been viewed as a threat to the ecosystem with the greatest biodiversity. In addition, the role of the Amazon as an important carbon sink has led to increasing concern over the impacts of land-use change on climate change. The Amazon forest has a crucial role in maintaining a regular climate not only locally but across the whole of South America. The impacts of extreme events associated with climate change on both terrestrial and aquatic systems will be accentuated without the protection of native vegetation (NOBRE, 2014).

Deforestation in the Amazon is deeply rooted in the process of land property accumulation. Due to its abundant natural resources, especially forests, the expansion of agricultural production has steadily relied on the extensive expansion of the frontier, by clearing new plots of land. As a consequence, Brazil has lost almost of its Atlantic rainforest and large parts of both the Cerrado region and the Amazon have been reduced.[1]

In addition to the extensive occupation of the agricultural frontier as a means of expanding cattle and crop production, the pattern of land occupation in Brazil has another remarkable and historical feature: a highly skewed distribution of land. In fact, the existence of an elite based on land ownership and intense exploration of agricultural commodities remains as a historical trace in Brazil today (DEAN, 1971).

[1]DEAN (1997) offers a complete description of the process of occupation of the Brazilian territory and its consequences to Atlantic rainforest.

Despite the importance of deforestation and land inequality in the process of land occupation in Brazil, these two phenomena have scarcely been put together in a single framework. The literature on this theme is very sparse and even more so when the focus is the Brazilian Amazon. This, therefore, is the main contribution of this paper, namely, to establish a link between land inequality and deforestation in the last agricultural frontier in Brazil – the Legal Amazon.

As a starting point, a conceptual framework has been developed, in which agents, given endowments, prices and costs related to deforestation, choose their occupation. The agent must decide whether to become a farmer in an area which is already well established, or to be a rural worker, or to migrate to the frontier in search of economic opportunities and land to clear (TOLE, 2004) The set of parameters and initial endowments will drive decision-making. This is so because an appropriate way to understand the individual decision to clear land must lie on a framework of occupational (or asset composition) choice (YOUNG, 1997; TAKASAKI et al., 2000) Therefore, it is assumed that deforestation results from an economic reasoning that compares payoffs from farming and from clearing land at the frontier. As such, the amount of land available for farming may be seen as a crucial element of the decision-making.

Thus, the combination of low access to land, where the frontier is already well-established, and the economic opportunities associated with clearing land, creates a link between land inequality and deforestation. This is the main hypothesis which will guide the empirical analysis.

Based on this conceptual framework, this paper investigates whether land concentration has played a crucial role in the deforestation of the Amazon between 2002 and 2011. Analysis is based on a sample of municipalities with positive deforestation in the Legal Amazon. Because throughout this period there was a substantial shift in deforestation, the sample is divided into two periods: 2002-2005 and 2006-

2011. The dependent variable, annual deforested increment as a share of municipality area, is based on satellite images processed by the Brazilian National Institute for Space Research (INPE). The independent variable of interest is a constructed gini index of landholdings. Based on migration patterns a migration-weighted land gini has been constructed. Each original municipality of migrants contributes to the composed land concentration index of the municipalities in the Legal Amazon. In addition, this variable is lagged in order to assess reverse causality issues.

Thus, this measure of land concentration is both exogenous to deforestation and makes more sense within the conceptual framework: an individual chooses either to be a farmer in an already well-established place or to migrate to the agricultural frontier. In addition, in order to avoid any remaining omitted variable bias, an instrumental variable for the composed gini index has been included: a similarly migration-weighted variable of the amount of productive land kept idle as a share of total municipality area. Additionally, this instrument is measured ten years before the variable of land inequality utilized. The argument for using this variable lies in the fact that the mean size of farms that keep idle productive land is larger than farms that make agricultural use of most of their available productive land (ASSUNÇÃO, 2008). This leads to a high correlation between the amount of idle land and the gini index for landholdings.

Results point to a positive relationship between land inequality and deforestation in the Legal Amazon. Results are stronger for the period 2002-2005 than for 2006-2011. In order to avoid a conclusion relying on no more than the choice of time spans, a robustness check has been conducted, in which three different periods are considered 2002-2004; 2005-2008 and 2009-2011. Again, results show a decreasing effect as time evolves. A possible conjecture is that this might be related to important policy changes that were taken by the central government in 2004 and 2008.[2]

[2]See ASSUNÇÃO; GANDOUR; ROCHA (2015) for more details on these policies.

Another caveat might be linked to the validity of the instrumental variable. The major concern with the exclusion restriction is that the instrumental variable could be correlated with some push factors to migration that are contemporaneous to the pattern of land inequality, and, therefore, may have a direct effect on deforestation. Thus, in order to check for the validity of the instrument, I consider a number of variables in the municipalities of origin that could plausibly be correlated with both the instrumental variable and deforestation. Results in this exercise still point to a positive relationship between land concentration and deforestation.

The empirical findings suggest that when one takes into account the effects of land distribution on occupational choices and how they relate to deforestation, it is clear that there is substantial role for welfare improvements that may well lead to a situation with less deforestation and improved land use.

The remainder of this paper is organized in six sections, including this introduction. In Section 2, a brief revision of the related literature on land inequality and deforestation is provided. Section 3 develops a simple theoretical model that highlights how land inequality might affect both decisions to clear land and possible policy responses and impacts. Section 4 describes the data set and descriptive statistics. Section 5 includes the empirical strategy and discusses main results. Section consists of overall conclusions and positive implications.

3.2 Related Literature

Deforestation, in Brazil, is highly associated to economic incentives provided by the profitability of activities associated to with land use change (e.g. unsustainable logging, cattle ranching, cultivation). Moreover, as property rights are badly defined, the process of deforestation improves the chance of acquiring property rights over land; this, in turn, may often lead to land speculation processes that reinforce

even further land clearing (FEARNSIDE, 1992; SCHNEIDER, 1995; ALMEIDA; CAMPARI et al., 1995; YOUNG, 1997; ANGELSEN, 1999; MARGULIS, 2004). Some authors assign a role for the concentrated pattern of land occupation, as it results in exclusion in access to land as a motivation for deforestation (BECKER, 1990; FEARNSIDE, 1992; WALKER; HOMMA, 1996; FEARNSIDE, 2001)

Another major feature of the agricultural sector in Brazil is its remarkably high level of land inequality. Nevertheless, few authors provide empirical analysis regarding the relationship between land inequality and deforestation. Some authors - namely Caldas et al. (2005), SIMMONS (2005), ALSTON; LIBECAP; MUELLER (1999) - analyze related issues, including the role of land reform, violence and wealth in terms of deforestation. PACHECO (2009) analyses the effects of agrarian reform on both land distribution and deforestation.

TOLE (2004) analyzes explicitly the relationship between land distribution and deforestation, though in a (cross-country) perspective. In her framework, the degree of land accessibility is a function of rural population density and land inequality, where unequal systems do worse in accommodating population pressures than more egalitarian systems. Thus, in her view the pattern of land distribution shapes decisions regarding deforestation.

ASSUNCAO; GHATAK (2003) explain the documented inverse relationship between farm size and productivity with heterogeneity in farming skills. According to these researchers, the average farm size of skilled farmers is smaller than that of unskilled farmers. Additionally, ASSUNÇÃO (2008) shows that the mean size of farms that keep idle productive land is larger than farms that make agricultural use of most of its available productive land. This provides a useful insight to understand why land inequality leads to less land accessibility in the absence of rental and credit markets. Within such a framework, an increase in land inequality jointly decreases agricultural production and also tends to increase deforestation.

YOUNG; NEVES (2009), for instance, provide evidence, from an analysis of municipalities in Southeast and the Southern Brazilian Atlantic Forest, that there is no consistent correlation between deforestation and development. Although the authors do not propose a causal relation, it can be argued that if deforestation decreases development, it is another form of resource curse, where overexploitation of natural resources does not lead to development. FRANKEL (2010) highlights how poor institutions arise in rent-seeking and extractive states.[3] Thus, it may be argued that those municipalities which apply more successful governance schemes will demonstrate improved results for both deforestation and development.

According to ENGERMAN; SOKOLOFF (2002) poor institutions may be an outcome of factor endowments. Briefly, according to the authors, factor endowments are central to structural inequality (usually associated to land inequality), which is, in turn, a determinant of poorly managed institutions, low human capital investment and, therefore, underdevelopment.[4] NARITOMI; SOARES; ASSUNÇÃO (2012)provide evidence that those Brazilian municipalities associated to colonial rent-seeking episodes (sugar-cane and gold colonial cycles) display lower provision of public goods and lower income per capita.[5]

Although this paper focuses on no more than the relationship between land inequality and deforestation, it is arguable that land concentration affects development under different forms. However, this paper will concentrate exclusively on the link between land inequality and deforestation.

[3]MARCHAND (2016) demonstrates that institutions have a differential impact on deforestation according to their respective colonial legacies.

[4]There is a vast literature that builds on the Engerman and Sokoloff hypothesis. See, for instance, EASTERLY (2007) for a revision of the literature and for empirical results that confirm the hypothesis mentioned above.

[5]An interesting point made by the authors is that, as the analysis is within Brazil, a country that shares a single colonizer, a single language and is highly centralized, they are able to identify different *de facto* institutional arrangements that are associated with different factor endowments.

3.3 A Simple Model of Land Distribution and Deforestation

The model presented here describes a situation in which individuals have an occupational choice, where individuals maximize their expected utility by choosing what their occupation will be: a worker, a farmer or a migrant who will move to the frontier and clear land. The main argument is that what matters for an economic analysis of deforestation is the relative risk-adjusted payoff. This point is has also been argued for by TOLE (2004).

The key characteristic of this model is to address the effect of land concentration on deforestation, by reducing access to land. As land access is reduced, economic opportunities associated to deforestation at the frontier increase. Thus, *ceteris paribus*, higher land concentration leads to migration and promotes higher deforestation rates.

3.3.1 Setup

Consider an economy with infinite periods, overlapping generations and where individuals live for two periods. In each period, population with mass normalized to one is born and has a given wealth distribution $G_t(W)$. Initial wealth is received as a bequest.

In period t, individuals decide what to do with their wealth. That is to say, they may buy a plot of land L at a price p, they may clear land – D - at the frontier at a cost c, with $c<p$, or they may decide to enter the labor market and receive a wage - w. In the following period, agents receive their revenues (wages and profits) and sell their land to the new generation that is born, in order to consume. Agents are risk neutral and preferences are given by their consumption and whatever is bequeathed to the next generation.

ASSUNÇÃO (2008)) has demonstrated that within this type of framework, expected utility may be a function of profits as well as the value of land sold. It is further assumed that there are no credit or land rental markets.[6] This means that $cD<W$ and $pL<W$. An important assumption to be made, as argued by TOLE (2004), is that accessible land is a function of land inequality.[7]

If an individual decides to become a farmer, profit will be revenues received from the sale of agricultural products – q – less the wage paid to employee – w. Therefore, it is assumed that there will be a production function with fixed technology in labor and land. In this case, there are no capital gains after land is sold. If the decision is to clear land, it is assumed that the individual does not need to employ labor and receives a profit – b.[8] As everyone is a price taker in land, there is a possibility of capital gains – p-c.[9] This point is crucial, since it is well known that deforestation follows a speculative motive that is linked with the "creation of property rights" (SANT'ANNA; YOUNG et al., 2010).[10]

3.3.2 Occupational Choices

Summing up, individuals can invest in a farm, engage in deforestation or become agricultural workers. Given the structure described above, expected final wealth will be:

[6] In Brazil, only 4.5% of total agricultural area was leased. This figure is even smaller in the Legal Amazon: 2.2% according to the Agricultural Census of 2006. Nor are credit markets for land purchases well developed (cited by ASSUNÇÃO (2008).

[7] Nonetheless, instead of assuming $L = L(i)$, it will be assumed later that there is a threshold, L^F that depends on the degree of land inequality.

[8] As a general rule, early settlers clear land and establish extensive cattle production that is not reliant on large-scale labor.

[9] However, these are simplifying assumptions that may be said to represent realistically the main features of the process of land occupation in the Amazon. For more on this process and how the present assumptions fit in relatively, see ALMEIDA; CAMPARI et al. (1995); CASTRO (2008)

[10] Reydon and Fernandes (2014, p.19) assert that "the most important mechanism to avoid deforestation is the elimination of land speculation".

$$E(W_{t+1}) = \begin{cases} W_t + w \\ (p+b)D \\ (p+q-w)L \end{cases} \qquad (1)$$

The occupational choice results from the comparison of the expected final wealth paths in (1). At this point, it assumed that land distribution is not binding on the size of L. Hence, individuals will choose to become farmers if their final wealth from farming is higher than from clearing land and being a worker:

$$r_L > g_D + r_D \; and \; W > \frac{w}{r_L} \equiv W_0 \qquad (2)$$

Where r_L is the return on farming: $\frac{(q-w)}{p}$; g_D is the capital gain from selling deforested area: $\frac{(p-c)}{c}$; and r_D is the return on activity after the land is cleared: $\frac{b}{c}$. Thus, in order to become a farmer it is necessary that the return from this activity is larger than that from clearing land and initial wealth must be larger than $\frac{w}{r_L}$. In order to clear land at the frontier, as compared to becoming a worker, initial wealth must be larger than:

$$W > \frac{w}{g_D + r_D} \equiv W_1 \qquad (3)$$

Assuming that there is up to that point constraint on the size of L, it follows that:

Lemma 1. If $r_L > g_D + r_D$, occupational choices will be restricted to becoming a farmer or a worker, depending on initial wealth. There is no room for deforestation.

Proof: If $r_L > g_D + r_D$, it is easy to see that $W_0 < W_1$. Therefore, if an individual has enough wealth for clearing land, (s)he also has wealth for being a farmer at the old frontier.

Thus, occupational choices are fully determined by initial wealth and by the relationship between returns from farming and from deforestation.

3.3.3 Introducing Land Inequality

Now, suppose accessibility to land is completely related to land inequality.[11] This is represented by assuming there is a limit on the size of land available to be used – $L^F(i) < L$. In addition, when an individual receives her/his initial wealth, if her/his option is to keep farming, a portion of his/her wealth will be allocated to an asset that does not provide any interest payment – m. That is to say: $W_t = pL^F + m$. Thus, occupational choices become:

$$E(W_{t+1}) = \begin{cases} W_t + w \\ (p+b)D \\ (p+q-w)L^F + m \end{cases} \qquad (4)$$

Comparing final expected wealth, the occupational choice pro clearing as compared to working and to farming land will occur if:

$$W > \frac{w}{g_D + r_D} \equiv W_1;\ W > \frac{r_L p L^F}{r_D + g_D} \equiv W_2 \qquad (5)$$

It is clear, from (5), that the extent of land inequality, as $L^F = L^F(i)$, is a major determinant of the occupational choice. Again, comparing payoffs between been a farmer and a worker, there is the following condition:

$$L^F > \frac{w}{q-w} \qquad (6)$$

[11] In order to assume this, ASSUNÇÃO (2008) dictum has been has been followed, which argue that unproductive farms are (weakly) larger than agricultural farms on average. If larger farms are kept idle, the land inequality is assumed to be positively related to accessibility to land.

Substituting (6) into farmer's expected final wealth given by (4):

$$W > (1 + \frac{1}{r_L})w + m \equiv W_3 \qquad (7)$$

Thus W_3 is the threshold that determines the minimum wealth level in order to be a farmer. As Figure 3.1 demonstrates, land inequality determines the amount of accessible land. The maximum of land that can be used for farming - ${}^{L}F$ -, in turn, is the determinant of the wealth threshold – W_2. Above that threshold, the individual will decide to clear land and not to farm.

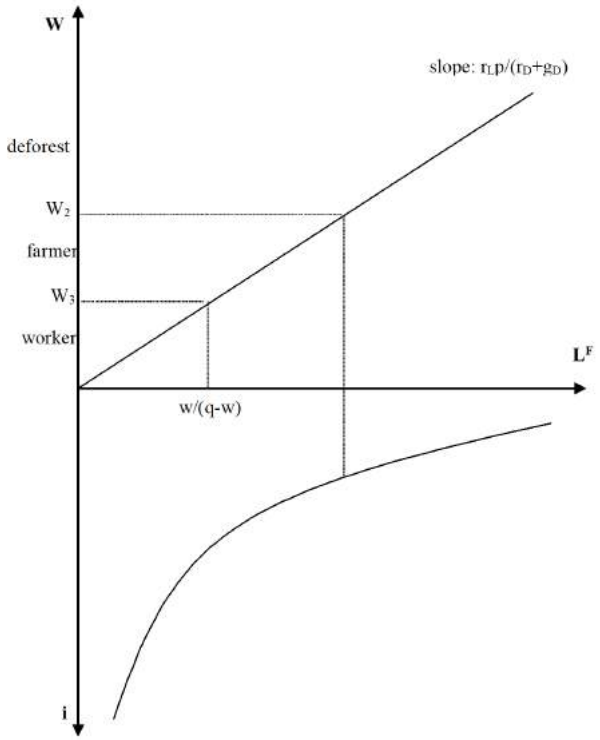

Figura 3.1: Theoretical relationship between land inequality and deforestation

From Figure 3.1, if land inequality increases, the wealth threshold W_2 moves down and, *ceteris paribus*, there is an increase in deforestation. If the relative

return of deforestation increases, the slope of the curve will decrease, leading to an increase in deforestation. Subsequently, these main results are presented within a more formal treatment.

Equilibrium

An equilibrium in the market for cleared land must equalize the aggregate demand and the supply of deforested land. Condition (5) determines that every individual with wealth greater than W_2 demand $\frac{W}{c}$ units of cleared land. Therefore, the equilibrium condition can be arranged as:

$$\int_{W_2}^{\infty} W dG(W) = cD \qquad (8)$$

Thus, the amount of cleared land within a world with land inequality is given by:

$$D = \frac{\int_{W_2}^{\infty} W dG(W)}{c} \qquad (9)$$

The result above leads to the following proposition:

Proposition 1: Deforestation is positively related to land inequality (i); land prices (p); cattle ranching profits (b); and negatively related to cost of deforestation (c); and agricultural prices and yields (q). As for wages, the effect is ambiguous.

Proof: The effects on deforestation are driven by the effects on the wealth threshold – W_2. A higher W_2 implies less demand for deforestation. Thus, it is sufficient to analyze the determinants of W_2. Record that:

$$W_2 = \frac{r_L p L^F}{r_D + g_D} = \frac{c(q-w)L^F}{p - c + b} \qquad (10)$$

It is therefore, straightforward that

$$\frac{\partial W_2}{\partial L^F} > 0; \frac{\partial W_2}{\partial q} > 0; \frac{\partial W_2}{\partial c} > 0; \frac{\partial W_2}{\partial p} < 0; \frac{\partial W_2}{\partial b} < 0; \frac{\partial W_2}{\partial w} < 0$$

On the other hand,

$$W_1 = \frac{w}{g_D + r_D}$$

As wage increases, there will be a point where $w > rL_pL^F$. If such a situation occurs, the relevant wealth threshold becomes $W1_.$ At that point, the effect of wages on deforestation is negative.

From the definition of W_2, it is expected that land inequality, land prices and profitability at the frontier should exert a positive influence on deforestation. On the other hand, profitability of farming and the cost of deforestation should decrease incentives for clearing land. Regarding wages, there are mixed signals: since they reduce the incentive to farming they should have a positive influence on deforestation, by reducing W_2. Nevertheless, wages also represent an opportunity cost and as this increases W_1, incentives to clearing land are also reduced.[12] Thus its influence on deforestation cannot be defined *a priori*.

The equilibrium in the labor market is defined by the aggregate demand for labor that results from farming decisions and supply of labor:

$$\int_{W_3}^{W_2} W dG(W) = wG(W_3) \qquad (11)$$

The equilibrium wage rate is determined by the endowments of the economy and the wealth distribution.

[12]In recent years, the deforestation rate has significantly decreased. This fact may be related to real minimum wage gains and, generally, improvements in the labor market conditions in recent years. As such, this is as an interesting hypothesis to be explored in later studies.

3.3.4 Empirical Implications

In accordance with the previous section, as inequality reduces access to land individuals become more prone to clear land at the frontier. Therefore, deforestation will be positively affected by land inequality. The effect of land concentration need not be in the same municipality. Instead, it may be possible that inequality in the access to land works as a push factor leading to migration from one municipality to another in the agricultural frontier. This possibility will be fully explored in the empirical approach.

3.4 Data and Descriptive Statistics

The empirical analysis is based on a cross-section of municipalities that belong to Legal Amazon covering the 2002 to 2011 period. The sample includes only municipalities that had new deforested areas. All of Legal Amazon states are represented in the sample: Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins.

The analysis is split in two periods: from 2002 to 2005 and from 2006 to 2011. This division is due to two reasons. First, deforestation has significantly decreased since 2005. Another shift in its trend occurred in 2008.[13]Thus, it may not make sense to analyze two distinct periods in a single cross-section regression setting. Second, data for land concentration are only available from Agricultural Census, with editions published in 1996 and 2006, with data related to December of its respective previous years. Hence, it is not feasible to use panel data estimations based on annual data. Therefore, the option was to use cross-sections in two distinct periods in order to estimate the effects of land concentration on deforestation. The

[13]ASSUNÇÃO; GANDOUR; ROCHA (2015) relate these shifts in trend to policies adopted by the Brazilian government.

following subsections describe the main variables used in this paper.

Deforestation

The National Institute for Spatial Research (INPE) produces publicly available data on deforestation by municipality in the Brazilian Legal Amazon, through the Project for Monitoring Deforestation in the Legal Amazon (PRODES). PRODES processes satellite images in order to establish the amount of forested and deforested area in a given municipality. Deforestation is the increment in deforested area in a municipality between August of year t-1 and July of year t. The analysis is based on this periodicity because July and August are the least cloudy months in the region, minimizing measurement error problems.

Deforestation is defined as:

$$D_{it} = ln(\frac{Def_{it}}{Area_i})$$

Where Def_{it} is the total deforestation occurred in period t, t is defined as the period 2002-2005 for the first set of regressions and 2006-2011 for the second group, $Area_i$ is the total area of the municipality. Therefore, D_{it} is the normalized deforested area, since there is a substantial variability in total area and deforestation in the Legal Amazon.

Land Concentration

The Brazilian Institute of Geography and Statistics (IBGE) publishes a detailed Agricultural Census, on a decennial basis, which permits the computation of Gini index for landholdings. As the censuses were published in 1996 and 2006, referring to land ownership on 31st December of the previous years, data is only available for these years. Therefore, the analysis rests on the assumption that land inequality affects deforestation with a time lag. Furthermore, land concentration is quite stable. Therefore, it can be assumed that inequality from 1995 affects the

pattern of deforestation in the period 2002-2005 and that inequality in landholdings in 2005 affects deforestation process in the period 2006-2011, especially when one considers a gini index based on the pattern of migrants, as explained below.

Land concentration may act as a push factor, expelling workers without opportunities to access land in a given municipality.[14] Thus, it is expected that land concentration in municipality j affects deforestation in municipality i. In order to account for this spatial pattern, a variable has been used that considers these effects of land inequality in other localities. The measure of migration-weighted land concentration for municipality i is based on the municipalities of origin of its migrants. In order to do so, this is computed from populational censuses, published by IBGE, the number of adult population in municipality i that come from other municipalities. A person is defined as a migrant if (s)he lives in the municipality for less than five years.[15]

Thus, the measure of land concentration is an unweighted average of the municipalities' gini where the migrants came from:

$$Composed\, Gini_{it-h} = \sum_{j=1}^{n} n^{-1} * Gini_{jt-h}$$

Where n is the total number of municipalities that supplied migrants to municipality i, irrespective of the number of migrants, $Gini_{jt}$ is the land gini index of municipality j at period t-h. Here, t-h is 1995 for the first group of regressions and 2005 for the second group.

It is also possible to define an alternative way of weighting land inequality by considering the share of migrants that each municipality j contributed to the

[14] I would like to thank one of my referees for highlighting this point.

[15] As populational censuses were carried out in 2000 and 2010, and agricultural censuses in 1995 and 2005. It is assumed that land inequality affected migration during these five years.

population of municipality i. In that case, the second measure of composed gini becomes:

$$Gini\ Migrants_{it-h} = \sum_{j=1}^{n}(\frac{Migrants_{jit-z}}{Total\ Migrants_{it-z}})$$

Where $Migrants_{jit-z}$ is the number of migrants that have gone from municipality j to i in the previous five years. $TotalMigrants_{it-z}$ is the total in-migrant population of municipality i in the previous five years.

As the formula takes into consideration the number of migrants, this second measure of land inequality may lead to an endogeneity problem: migration patterns may be affected by other factors as the availability of roads. As roads connecting two cities reduce the cost of transport, it is expected to raise migration opportunities. Therefore, in this case it is harder to disentangle the effects of land concentration on deforestation. Thus, this variable will only be used as a robustness check to results with the preferred variable: $ComposedGini_{it-h}$.

It is worth noting that ARIMA et al. (2011) and RICHARDS; WALKER; ARIMA (2014) use a similar approach to estimate the indirect effect of agricultural sector, especially soybean production, on land use in Amazonia.

Rural Credit

The Brazilian Central Bank compiles information about every contract of rural credit. Using this rich database, ASSUNÇÃO et al. (????) constructed a dataset of rural credit by municipality in the Legal Amazon. Here, the total amount of real rural credit normalized by the municipality area is used:

$$Credit_{it} = ln(\frac{rural\ credit_{it}}{area_i})$$

Data on rural credit is available from 2003 to 2011. Subsequently the mean of loans between 2003 and 2005 is taken for the first group of regressions, as well as the mean of rural credit between 2006 and 2011 for the second set of estimations.

Cattle prices

A well-established result in the Brazilian Amazon is related to the importance of the expansion of cattle ranching to explain the pattern of deforestation. As this process is driven by the profitability of the activity, a proxy for cattle prices has been computed in each municipality following ASSUNÇÃO; GANDOUR; ROCHA (2015). These authors argue that prices cannot be considered in the Legal Amazon because this could lead to endogeneity problems. Thus, they consider prices at the southern state of Paraná as exogenous indicators. The prices are deflated to 2010 Brazilian Reais.

In order to have prices for each municipality, ASSUNÇÃO; GANDOUR; ROCHA (2015) will be followed and a weighted real price calculated according to:

$$CP_{it} = CPPR_t * \frac{cattle\ head_{it-x}}{area_i}$$

Thus, prices in Paraná are weighted for each municipality at the Legal Amazon according to its intensity in cattle ranching as measured by the ratio of the number of cattle heads and total municipality area, considering a lag to avoid endogeneity issues.[16] The period t-x is considered as equal to the average of cattle heads in 2000-2001 and 2004-2005, according to the respective groups of estimations. In Three, the means of the natural logarithms of CP_{it} is taken for (in) the periods 2002-2005 and 2006-2011.

Settlements

[16]Using the total area minus area occupied by cities and water does not change results.

The Brazilian Institute for Applied Economic Research (IPEA) gathers data on different kinds of information, important for applied economic research and publicizes it through a website – IPEADATA. There, one can find data on rural settlements for agrarian reform, originally informed by the National Institute of Colonization and Agrarian Reform (INCRA). Based on this a measure of settlements was constructed for land reform for the periods 2002-2005 and 2006-2011. Thus,

$$Settlements_{it} = \frac{Area\ of settlements\ to\ land\ reform_{it}}{area_i}$$

Geographical controls

The literature on deforestation usually discusses the role of geographical variables in explaining municipality variability (e.g. ASSUNÇÃO; GANDOUR; ROCHA (2015); ARIMA et al. (2011)). In order to control for these factors, the logarithm of mean values to rainfall and temperature along the relevant periods (2002-2005 and 2006-2011) were considered, as well as time-fixed variables as altitude and the municipality coordinates.

As for rain and temperature, annual estimates were used for each municipality, according to the PRODES year (from august of t-1 to july of t). In the following, the mean of natural logarithms of rain and temperature for 2002-2005 and 2006-2011.

Descriptive Statistics

Table 3.1 shows descriptive statistics of the variables used in the empirical model.

Tabela 3.1: Descriptive Statistics

VARIABLES	(1) mean	(2) sd	(3) min	(4) max	(5) N
Panel A: 2002-2005					
Ln(Deforestation)	-4.342	1.769	-10.39	-1.363	626
Composed Gini	74.47	4.633	50.53	88.29	611
Credit	6.732	1.885	-0.596	11.06	602
Settlements	0.987	3.174	0	45.41	611
Cattle prices	2.140	1.954	-6.282	4.996	620
Altitude	155.9	135.0	1	912.1	626
Composed idle land	5.977	3.702	0.410	17.35	611
Ln(temperature)	3.260	0.0487	2.900	3.352	626
Ln(rainfall)	7.508	0.227	6.964	8.092	626
Panel B: 2006-2011					
Ln(Deforestation)	-5.011	1.617	-10.89	-2.050	626
Composed Gini	75.15	3.173	60.69	83.03	626
Credit	7.082	1.838	-2.302	10.49	617
settlements	0.613	2.251	0	36.12	612
Cattle Prices	2.466	1.999	-6.161	5.393	623
Altitude	150.9	132.0	1	912.1	626
Composed idle land	3.476	2.308	0.0828	11.76	612
Ln(temperature)	3.265	0.0473	2.934	3.359	626
Ln(rainfall)	7.594	0.247	7.078	8.227	626

Note: sample include municipalities in the Braziilian Amazon with deforestation different from zero during the period 2002-2011.

As indicated above, comparing Panel A and Panel B shows that there was a significant decline in deforestation rates as a share of total municipality area from the first period to the second. Besides deforestation, only settled areas for land reform have declined from 2002-2005 to 2006-2011. On the other hand, heterogeneity across municipalities has increased with the exception of rainfall and, again, of settlements. As regards land inequality, as measured by the Composed Gini index, it shows stability between the two periods. This reflects a structural feature of the Brazilian

economy that has not been fully addressed.

3.5 Empirical Model

Deforestation rates show a high variability across Legal Amazon. Indeed, even when one considers the intensity of deforestation, normalizing by the area of each municipality, there is still substantial variation, as can be seen on Figure 3.2.

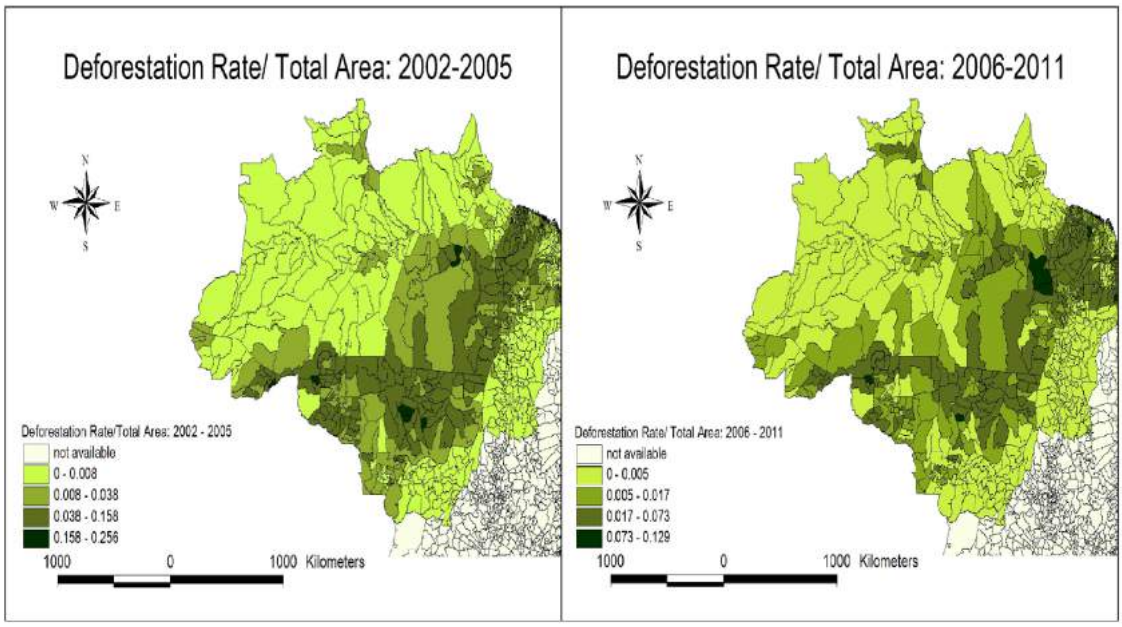

Figura 3.2: Deforestation Rate: 2002-2005 and 2006-2011
Source: INPE and IBGE

As a first examination by comparing the maps of deforestation and composed gini (see Figure 3.3), as defined in the section above, it seems that there is a geographical coincidence. Nevertheless, although suggestive, this observation is not conclusive and needs an empirical analysis.

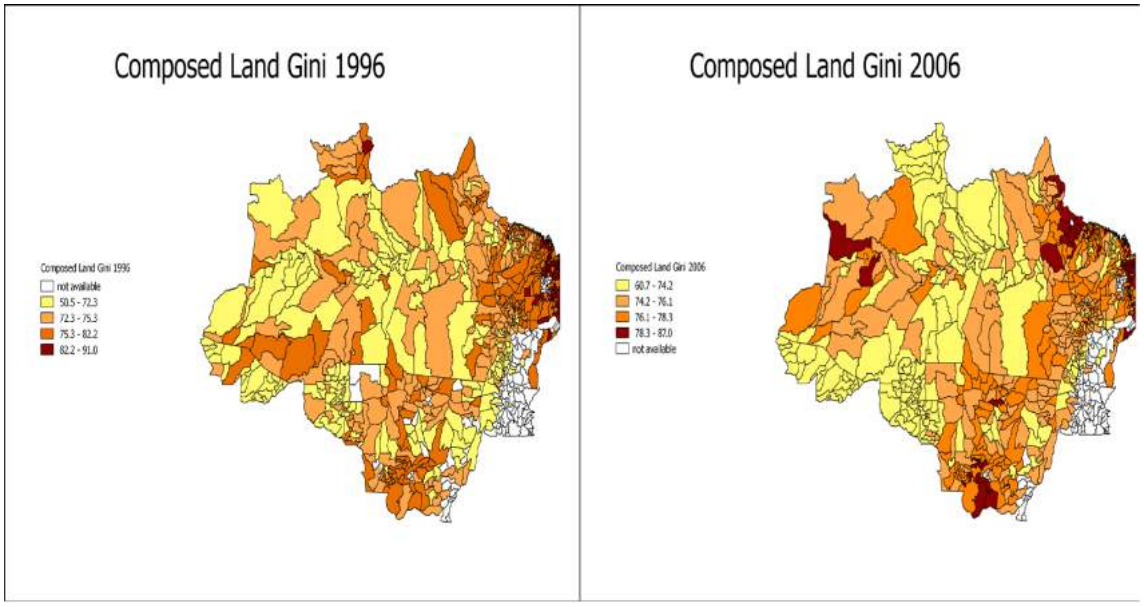

Figura 3.3: Composed Land Gini: 1996 and 2006
Source: own elaboration, based on data drom IBGE

3.5.1 Identification Strategy

In accordance with the predictions of the theoretical framework presented above, there must be a positive association between the magnitude of land inequality and the deforestation rate. Nevertheless, two problems may arise when simply testing this correspondence using an OLS estimation. First, it is possible to have a problem of reverse causality in the model. As deforestation is a form of land use change, increasing the supply of land for cattle ranching or agricultural use, it would be no more than coincidence that the concentration of landholdings would not be affected. Second, the relation proposed might possibly be driven by omitted variable bias.

In order to deal with these potential biases in the estimator, the measure

of land concentration is lagged and based on other municipalities, according to the pattern of migration to the municipalities of interest. Thus, the identification strategy adopted relies on the assumption that the way land concentration has been accounted for is not related to the error term.

Therefore, benchmark specification is defined by:

$$Def_{it} = \beta_1 * Composed\ Gini_{it-h} + \beta_2 * X_{it} + State_i + \varepsilon_{it} \qquad (12)$$

Where Def_{it} and $Composed\ Gini_{it-h}$ are exactly as defined in the section above. X_{it} is a vector of control variables containing municipality-level information according to the discussion and $State_i$ is a dummy for the state which the municipality belongs to. Finally ε_{it} is the error term.

In spite of the fact that the measure of land inequality can deal with reverse causality problems, there is still room for omitted variable bias. For example, agricultural and land prices may influence both the pattern of land concentration, even considering distinct localities, and the process of deforestation.

Then, in order to overcome this possible bias, an instrumental variable approach is proposed. This instrument is the ratio of idle productive land to total municipality area. As the *Composed gini* variable, this ratio is composed according to the municipalities of origin of migrants to locality *i*. The argument for using this variable lies in ASSUNÇÃO (2008) findings that unproductive farms are larger than agricultural farms on average. Thus, a positive relation between land concentration and the amount of idle productive land should be found.

Regarding concerns with validity of the instrument, the variable is measured ten years before the land concentration measure utilized. Thus, the instrument of *Composed gini* at 1995 is *Composed idle land* at 1985.[17] In addition, as argued by WALKER; HOMMA (1996), in established frontiers, land scarcity arises, in part

[17]The same applies for 2005, where the measure of idle land is from 1995.

due to land kept idle by large landowners, leading to a process of land concentration.[18] The difficulties imposed for small producers lead them to bankruptcy and outmigration to new frontiers (Wood, 1983 cited by WALKER; HOMMA (1996)).

3.6 Results

Table 3.2 presents results with OLS estimations for three different measures of land inequality: (i) *Composed Gini*; (ii) the alternative measure –*GiniMigrants* ; (iii) the gini index of land holdings of the municipality i – *Gini*.

Tabela 3.2: OLS: Different measures of inequality

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS 2002-2005	OLS 2002-2005	OLS 2002-2005	OLS 2006-2011	OLS 2006-2011	OLS 2006-2011
Composed Gini	0.047***			0.016		
	(0.015)			(0.020)		
Gini Migrants		0.066***			0.014***	
		(0.009)			(0.005)	
Gini			0.011**			-0.012**
			(0.005)			(0.005)
Observations	611	611	611	626	626	626
R-squared	0.015	0.086	0.008	0.001	0.011	0.008

Note: Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

From Table 3.2, it is possible to observe, as a first analysis, that there is a positive relationship between land concentration and deforestation, especially for the period 2002-2005. The variable *Gini Migrants* is that which has more economic and statistical significance in both periods. Nonetheless, this might be affected by the availability of a network of roads which facilitate migration from a given municipality j to a municipality i at the frontier, as discussed above. Therefore,

[18] See WALKER; HOMMA (1996) for a complete description of this process.

it is believed that this variable is more suitable to endogeneity problems than the *Composed Gini* variable. Finally, the *Gini* of the municipality itself is significant, albeit small and with its sign moving from positive to negative across time periods. Overall, coefficient estimators have a significant drop from the period 2002-2005 to the period 2006-2011. A possible explanation for this pattern may lie in the more stringent policies related to deforestation adopted, from 2004 and, in a second stage, 2008.

Considering the caveats on the use of *Gini Migrants*, Table 3.3 presents OLS estimation for the period 2002-2005, using the variables - *Composed Gini* and *Gini*- and controlling for a handful of covariates related to policy, prices and geography. Table 3.4 presents the same estimations for the period 2006-2011.

Tabela 3.3: OLS Estimation: 2002-2005

	(1)	(2)	(3)	(4)
VARIABLES	OLS 2002-2005	OLS 2002-2005	OLS 2002-2005	OLS 2002-2005
Composed Gini	0.027*	0.041*		
	(0.015)	(0.021)		
Credit	0.114*	0.151***	0.108*	0.146**
	(0.058)	(0.058)	(0.059)	(0.058)
Cattle Prices	0.201***	0.240***	0.207***	0.241***
	(0.056)	(0.066)	(0.056)	(0.066)
Settlements	0.014	-0.012	0.013	-0.013
	(0.013)	(0.015)	(0.012)	(0.015)
Gini			0.001	0.002
			(0.005)	(0.005)
Observations	587	587	587	587
R-squared	0.101	0.308	0.097	0.303
Geographic Controls	NO	YES	NO	YES
State dummy	NO	YES	NO	YES

Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Tabela 3.4: OLS Estimation: 2006-2011

VARIABLES	(1) OLS 2006-2011	(2) OLS 2006-2011	(3) OLS 2006-2011	(4) OLS 2006-2011
Composed Gini	0.018	0.005		
	(0.021)	(0.028)		
Credit	-0.053	0.123**	-0.027	0.121**
	(0.061)	(0.060)	(0.057)	(0.060)
Cattle Prices	0.275***	0.260***	0.257***	0.257***
	(0.053)	(0.052)	(0.052)	(0.051)
Settlements	-0.020	-0.037	-0.016	-0.037
	(0.029)	(0.027)	(0.028)	(0.027)
Gini			-0.012**	-0.002
			(0.005)	(0.005)
Observations	602	602	602	602
R-squared	0.091	0.333	0.098	0.334
Geographic Controls	NO	YES	NO	YES
State dummy	NO	YES	NO	YES

Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Again, estimates for the *Composed Gini* show a positive, albeit declining, relationship between land concentration and deforestation when one takes into account covariates including cattle prices, credit, geographic localization and state dummies.[19] During the period 2002-2005, the estimator is positive and statistically significant. In the period 2006-2011, significance disappears. Regarding the coefficients of Gini, they, again, are unstable and without significance.

As expected, cattle prices and rural credit have positive and relatively stable positive coefficients. These results are in line with a large number of authors' findings and signal that there are strong economic incentives for deforestation in the

[19]Some geographical variables, such as altitude and coordinates, are time-invariant. This helps to deal with unobserved effects that could lead to omitted variable bias.

Brazilian Amazon region (ALSTON; LIBECAP; MUELLER, 1999; MARGULIS, 2004; ROEBELING; HENDRIX, 2010; HARGRAVE; KIS-KATOS, 2013; ASSUNÇÃO; GANDOUR; ROCHA, 2015). In fact, as observed in Section II, deforestation confers to the occupant greater capitalization (because deforested land is more valued) and provides benefits through the sale of wood and the development of cattle activities.[20]

Another policy variable, rural settlements to land reform, fails to present statistical significant coefficients. This result suggests that settlements in the Amazon do not present additional pressure on deforestation. In fact, Soave Junior et al. (2014) show that deforestation trends in the Legal Amazon and within settlements are very similar.

As argued before, the OLS estimator can still suffer from omitted variable bias. Therefore, Table 3.5 presents the IV estimation, using the instrument described above.

[20]For a description of this process, see CASTRO (2008).

Tabela 3.5: IV Estimation

VARIABLES	(1) 2002-2005	(2) 2006-2011
	Panel A: First Stage	
Composed Idle Land	0.186***	0.220***
	(0.057)	(0.078)
Credit	-0.167	-0.099
	(0.104)	(0.119)
Cattle Prices	0.029	-0.300***
	(0.121)	(0.105)
Settlements	-0.051	0.066*
	(0.034)	(0.036)
	Panel B: Second Stage	
Composed Gini	0.618***	0.633**
	(0.229)	(0.269)
Credit	0.223**	0.179
	(0.087)	(0.116)
Cattle Prices	0.216**	0.437***
	(0.092)	(0.108)
Settlements	0.023	-0.066*
	(0.029)	(0.035)
Observations	587	602
Geographic Controls	YES	YES
State dummy	YES	YES
Kleibergen-Paap rk Wald F Statistic	10.758	7.960

Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Results under IV estimation show a positive and robust coefficient for land inequality. However, according to BAUM et al. (2007), in order to test for weak

identification, one should apply the 'rule of thumb' that the F statistic should be at least 10 for weak identification not to be considered a problem. Once this is applied, only the results for the period 2002-2005 seem to be robust.

3.6.1 Robustness checks

3.6.1.1 Exclusion Restriction and Additional Controls

Though results on Table 3.4 show that the instrumental variable is related to inequality, it is not clear that the exclusion restriction holds. That is to say, conditional on the controls included in Table 3.4, the amount of idle productive land (10 years before the period under analysis) in the municipalities from where migrants came from should have no effect on deforestation in Amazonian municipalities, other than its effect through land inequality. The major concern with this exclusion restriction is that the instrumental variable could be correlated with certain push factors to migration that are contemporaneous to the pattern of land concentration and, therefore, may have a direct effect on deforestation.

Therefore, in order to check for the validity of the instrument, a number of variables have been taken into consideration in the municipalities of origin that could plausibly be correlated with both the instrumental variable and deforestation. The variables included are seen as possibly affecting the decision to migrate to the frontier. The share of employment in the primary sector, unemployment rate, educational attainment and demographic density are considered in the main regression. In addition, as described by SOUSA (2014), some externalities are important when it comes to pushing migrants from their original locality: violence, measured as homicide rate, and sanitation coverage represent this kind of externality that might also affect the decision to migrate. These variables are constructed the same way as the $ComposedGini$ variable, as described before: they are calculated as unweighted

averages of the municipalities of origin of migrants.

Table 3.6 presents the IV estimation, using the additional controls described above.

Tabela 3.6: Robustness Checks: IV with additional controls

VARIABLES	(1) 2002-2005	(2) 2002-2005	(3) 2006-2011	(4) 2006-2011
	Panel A: First Stage			
Composed Idle Land	0.196***	0.231***	0.165**	0.146**
	(0.056)	(0.056)	(0.075)	(0.073)
Composed Pop Density	-0.009	0.052	-0.264	-0.266
	(0.133)	(0.138)	(0.247)	(0.193)
Composed Share of Employment in Agric.	0.050*	0.033	0.089*	0.100**
	(0.028)	(0.026)	(0.051)	(0.045)
Composed Expected Years of Education	-0.107	0.066	2.197**	1.620*
	(0.245)	(0.203)	(0.901)	(0.909)
Composed Unemployment Rate	-0.207**	-0.244***	-0.771***	-0.800***
	(0.099)	(0.093)	(0.277)	(0.305)
Composed Homicide Rate		-0.048		0.102***
		(0.049)		(0.036)
Composed Sanitation Rate		-0.026		0.001
		(0.029)		(0.049)
	Panel B: Second Stage			
Composed Gini	0.576***	0.536***	0.975*	0.714*
	(0.210)	(0.172)	(0.464)	(0.410)
Composed Pop Density	0.079	-0.179	0.180	0.175
	(0.200)	(0.195)	(0.234)	(0.233)
Composed Share of Employment in Agric.	-0.009	0.052	-0.264	-0.266
	(0.133)	(0.138)	(0.247)	(0.193)
Composed Expected Years of Education	0.497*	-0.197	-1.636***	-1.896***
	(0.282)	(0.318)	(0.336)	(0.413)
Composed Unemployment Rate	-0.043	0.133	0.438**	0.598***
	(0.133)	(0.140)	(0.188)	(0.214)
Composed Homicide Rate		0.198***		-.003
		(0.059)		(0.041)
Composed Sanitation Rate		0.129***		0.065
		(0.033)		(0.043)
Observations	587	587	602	602
Controls	YES	YES	YES	YES
Geographic Controls	YES	YES	YES	YES
State dummy	YES	YES	YES	YES
Kleibergen-Paap rk Wald F Statistic	12.337	16.838	4.852	3.935

Notes: Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Overall, comparing results from tables 3.5 and 3.6, it can be seen that results change remarkably little with the inclusion of additional controls. Thus, results from Table 3.6, with additional controls seem to reinforce the validity of the instrument, especially for the period 2002-2005.

3.6.1.2 Different Time Spans

Results shown above might be driven by the time spans chosen for deforestation rates. In this section, an alternative period classification was chosen in order to test whether results are robust to these alternative specifications.

As ASSUNÇÃO; GANDOUR; ROCHA (2015) point out, there were two major shifts in command and control policies for deforestation in the Legal Amazon: in 2004, there was the launch of new plan for combating deforestation – the PPCDAm. The second turning point was the passing of a Presidential Decree that selected a list of priority municipalities where to combat deforestation in 2008.

Given that, in this section, the sample was split into three different periods: 2002-2004, when deforestation reached its maximum; 2005-2008 – marked by a shift in the trend – and 2009-2011, with much smaller levels of deforestation, driven by a second shift in the deforestation trend.

Tabela 3.7: Robustness Checks: Different Time Spans

	(1)	(2)	(3)
VARIABLES	2002-2004	2005-2008	2009-2011
Composed $Gini_{1995}$	0.050**		
	(0.023)		
Credit $Area_{2004}$	0.124**		
	(0.060)		
Cattle $Prices_{2004}$	0.239***		
	(0.073)		
Composed $Gini_{2005}$		0.009	-0.033
		(0.031)	(0.024)
Credit $Area_{2008}$		0.094	
		(0.060)	
Cattle $Prices_{2008}$		0.376***	
		(0.058)	
Credit $Area_{2009}$			0.083
			(0.055)
Cattle $Prices_{2009}$			0.187***
			(0.050)
Observations	570	599	592
R-Squared	0.293	0.370	0.281
Geographic Controls	YES	YES	YES
State dummy	YES	YES	YES

Notes: Analysis is based on a cross-section of municipalities located in the Legal Amazon states of Acre, Amapá, Amazonas, Mato Grosso, Maranhão, Pará, Rondônia, Roraima and Tocantins which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Robust standard errors are clustered at the municipality level. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Indeed, as can be seen from Table 3.7 results are valid only in the period 2002-2004. For the periods 2005-2008 and 2009-2011, the estimator for the effects of land inequality is not different to zero.[21]

[21]Even when one considers alternative variables for land concentration, results lose economic and statistical significance. Results are not reported and may be sent by request.

3.6.1.3 Panel Structure

Another way to deal with unobserved effects is to consider a panel structure based on the two periods considered: using a fixed effects model allows to identify the effects of land concentration on deforestation independent of time-invariant omitted variables. In addition, to fixed effects, Table 3.8 presents results based on a panel with the instrumental variable considered above.

Tabela 3.8: Robustness Checks: Panel with IV

VARIABLES	(1)	(2)
	Panel A: First Stage	
Composed Idle Land	0.291***	0.201***
	(0.104)	(0.086)
Composed Pop Density		-0.084
		(0.225)
Composed Share of Employment in Agric.		0.151***
		(0.048)
Composed Expected Years of Education		-1.508***
		(0.407)
Composed Unemployment Rate		-0.015
		(0.170)
Composed Homicide Rate		0.082
		(0.054)
Composed Sanitation Rate		0.306***
		(0.047)
	Panel B: Second Stage	
Composed Gini	0.074	0.163
	(0.086)	(0.133)
Composed Pop Density		0.011
		(0.060)
Composed Share of Employment in Agric.		-0.026
		(0.025)
Composed Expected Years of Education		0.575**
		(0.225)
Composed Unemployment Rate		-0.046
		(0.051)
Composed Homicide Rate		-0.007
		(0.016)
Composed Sanitation Rate		-0.076*
		(0.043)
Observations	1136	1136
Municipalities	568	568
Controls	YES	YES
Geographic Controls	YES	YES
Municipality Fixed Effects	YES	YES
Time Fixed Effects	YES	YES
Kleibergen-Paap rk Wald F Statistic	7.856	2.701

Note: Analysis is based on a panel of municipalities located in the Legal Amazon states, which exhibited variation in forest cover during the sample periods. Dependent variable is the log of the annual deforestation increment as a share of total municipality area. Composed variables consider the municipalities of origin of migrants, as described in the text for the Composed Gini. Additional controls are cattle prices and rural credit, both measured at the municipalities of analysis. Robust standard errors are clustered at the municipality level. Significance: ***

Results still point to a positive relationship between land inequality and deforestation, though not statistically significant when considering a fixed effects with IV model. Though different from other results in this paper, it is perhaps unsurprising. Within the period of analysis, the Amazon experienced a large shift in command and control policies that led to a substantial increase in the cost of deforestation, thus leading to a discontinuity in deforestation figures. Therefore, as land inequality has an inertial structural pattern, without any sharp changes, when one uses a panel approach, the relationship under investigation is masked by other important factors that are changing fast, such as conservation policies. In such a context, the policy discontinuity increases the cost of deforestation and is not fully captured by the controls, even when controlling for time fixed effects, as heterogeneity in the timing of the introduction of conservation policies is substantial across municipalities.

Thus, the fixed effects model, though helpful in dealing with time-invariant unobservable variables, has a noisy within variation since deforestation has decreased in the second period due to the shift in its cost, which is an unobservable variable that is varying in time. Overall, these results may be interpreted by the theoretical model provided in Section 3. As government policies have become stricter in relation to deforestation, they can be interpreted as an increase in the cost of deforestation. This increase in the cost, as argued by proposition 1, leads to a reduction in the activity of clearing land. Thus, the effect of land inequality becomes *ceteris paribus* less important.

3.7 Conclusion

This work investigated the impacts of land inequality on deforestation. In order to gain some intuition, a simple model of occupational choice was developed. It concludes that land inequality, by reducing access to land, is positively related to deforestation. In the following, this proposition was tested empirically.

The main identification strategy was to use an instrumental variable in order to deal with potential endogeneity problems. Empirical results confirm the theoretical hypothesis and show a positive relationship between land concentration and deforestation. Results are stronger for the first period considered, 2002-2005. One conjecture for this is the increase in the cost of deforestation that occurred with the introduction of important command and control policies. This cost shift might have reduced the push factor for migration induced by the unequal pattern of land distribution in Brazil. Nevertheless, albeit less significant, results for the period 2006-2011 still point to a positive relationship between land inequality and deforestation.

The results of the present paper may provide interesting references for governmental policies regarding the relationship between land distribution and deforestation. Therefore, there is a substantial role for welfare improvements which ought to lead to a situation with less deforestation and improved land use.

4 THE THREAT OF COMMUNISM DURING COLD WAR: A CONSTRAINT TO INCOME INEQUALITY?

4.1 Introduction

Inequality is one of the most important and controversial topics of our times. It has converted into a central issue not only among socialists and anti-globalizers, but also the general public, the media, politicians from diverse affiliations and academics. Many authors have diverted from Lucas' mainstream approach to inequality (LUCAS et al., 2002). According to STIGLITZ (2014) (p.6) "of the tendencies that have marked modern macroeconomics, the most seductive and poisonous is the failure to pay due attention to inequality".

Rising inequality explains the renewed interest in the subject.[1] PIKETTY (2014) shows that inequality has increased across the developed world since the 1980s. Several possible explanations arise in this context. TIMMER et al. (2014) explain the recent surge in inequality as a result of technological innovation and globalization. PIKETTY; SAEZ; STANTCHEVA (2014) argue that technology cannot explain differences in inequality across continental Europe and Anglo-Saxon countries. The authors explore the role of institutions such as tax policy in conditioning inequality. ATKINSON; PIKETTY; SAEZ (2011) stress the role of the World Wars of the twentieth century in destroying massive stocks of capital. In order to finance the wars and to repay the national debts, post-war governments reached a consensus to increase tax rates, which played a role in distributing income.

The literature highlights the role of the world wars in reducing inequality, but

[1] This renewed interest is translated into several books recently published on the theme. See, e.g, PIKETTY (2014), ATKINSON (2015), SCHEVE; STASAVAGE (2016) and MILANOVIC (2016).

it does not explain why it remained in low levels in the three decades that followed 1945. We argue that this literature misses a relevant event that marked the post-war period: the global rise of communism.

The Cold War created a context favorable for the appearance of common-interest states, which, according to BESLEY; PERSSON (2013), are consensus among different groups in a society that enables the state to increase fiscal capacity in order to protect its existence. The ruling elites must have accepted to lose power to reach this consensus. As PRZEWORSKI (2009) and CONLEY; TEMIMI (2001) show in the context of franchise extension, this only happens when politically excluded groups impose a credible threat. In their study on the relation between revolutions and franchising in Europe between 1820 and 1938, AIDT; JENSEN (2014) observe that elites were more likely to expand franchising the closer the threat, either domestically or abroad. New common-interest states make society more equal both in terms of power and wealth. It represents a change in *de facto* institutions addressed by ACEMOGLU; ROBINSON (2006). This paper extends this argument to the context of democratic countries under the credible external threat of communism during the Cold War.

In order to test this hypothesis empirically, we constructed a variable that synthesizes the effects of communist threats around the world. This variable captures significant violent events related to the spread of communism. The list includes communism-related revolutions and invasions. The Cuban Revolution in 1959 and the Red Army invasion of Prague in 1968 are famous examples. We compiled the list from FRANKEL (1992) and SCHWARTZ (1997), two handbooks on the Cold War. The variable is defined as the sum of years with communist revolutions or USSR invasions weighted by the inverse of the distance between the capital of the country where the revolution/invasion happened and the capitals of each OECD country.[2] We regress this variable on a panel of OECD countries to test whether

[2]CAMPANTE et al. (2014) analyze how isolated (from the population) capital cities are asso-

the threat of communist revolutions represented a force that lead to the creation of common-interest states.

This article has similarities to the work by AIDT; JENSEN (2014), but we focus on the distribution of income in the postwar rather than the distribution of political power in the nineteenth century. Our results extend the work by MADSEN; WANG; STEINER (2017), which uses communism as an instrument on the relation between equality and state capacity. MADSEN; WANG; STEINER (2017) list a number of channels through which communism distributed income but do not test them. In contrast, we focus on the mechanism of the causal relation between communist threats and inequality.

The article is organized in six sections, including this introduction. Section II presents a conceptual discussion on the evolution of inequality and how external threats can be an important feature in shaping its dynamics. Section III reviews the historical literature and presents case studies that help develop our argument. Section IV describes the data and presents descriptive statistics. Section V presents the empirical strategy. Section VI presents the main results of the paper. Robustness tests are also conducted in this section. Finally, Section VII concludes the article.

4.2 Conceptual discussion

Inequality has been increasing in developed countries since the 1980s. This trend has attracted a great deal of interest among academics as well as the greater public. Economists have debated the causes of income concentration and identified a number of drivers of this process. In their seminal article, KATZ et al. (1999) stress the role of technology and labor market globalization in the rise of income concentration in rich countries. Globalization narrowed down the technological gap

ciated to less accountability.

between developed and developing economies. It also reduced trade barriers, which enabled relatively poor new industrial economies to access large consumer markets abroad. This process shifted low-skilled labor industries to less developed countries. As a consequence, the share of capital and high-skilled labor increased and the demand for low-skilled labor fell in developed economies (TIMMER et al., 2014).

Some authors highlight a role of institutions in this process. PIKETTY; SAEZ; STANTCHEVA (2014) assert that tax policy reforms raised inequality. The authors develop a model that lead to three different elasticities between tax rates and wages. The first one is the traditional effort elasticity, according to which higher marginal tax reduces the incentives for hardworking. The second elasticity is related to avoidance efforts. When marginal taxes are high, individuals have a greater incentive to search for other forms of income sources, such as dividends and stock options. Finally, higher taxes make top earner less likely to bargain for additional income.

ALVAREDO et al. (2013) find a strong and positive association between earned and capital income. They infer that networking makes rich-born individuals more likely to get better paid jobs.[3] Moreover, top executives are more able to accumulate wealth. ROINE; VLACHOS; WALDENSTRÖM (2009) conclude that financial development and GDP growth significantly increased top incomes vis-à-vis other income levels.[4] Similarly, financial liberalization has an important role on inequality, especially when one accounts for the initial level of financial development (HAAN; STURM, 2017; HAAN; PLENINGER; STURM, 2017).

Most of the literature focuses on the recent period, starting in the 1980s. This is natural given the speed at which inequality has been rising. Few authors address

[3]There is a growing literature on social networks and inequality. See, e.g., DIMAGGIO; GARIP (2011).

[4]PHILIPPON; RESHEF (2012) show that financial deregulation is associated to higher wages for financial employees in the U.S.

the following fact: in spite of western societies having become more unequal in the last three decades, inequality remained at low levels during the golden age period. PIKETTY (2014) documents that top income shares fell during the inter-war period and remained at record low levels in the post-war. The understudied question of why inequality remained low during the 30 years that followed the Second World War is as valid as the hot question of why it has been increasing lately.

Only a few authors have specifically studied the causes of low inequality in the post-war. PIKETTY; SAEZ; STANTCHEVA (2014) presents the destruction of capital during the two world wars and the rise in tax marginal rates in the post-war as the main explanations for the fall in top income shares. Similar point appears in ATKINSON; PIKETTY; SAEZ (2011), who also stresses the role the equalization of earned income. GOLDIN; MARGO (1992) refer to this process as 'the Great Compression'.

Omitted variable bias, however, may compromise these results. This may be the case of marginal tax effects. It is possible that a common variable has reduced the political power of the elites, leading to an increase in marginal taxes and to a fall in top income shares.[5]

This article addresses this omitted variable problem by assessing whether the Cold War determined the fall in inequality. The most important military rivalry of the XXth century, the Cold War conditioned the world order from 1945 to 1989. MAIER (2010) asserts that the potential worldwide spread of communism played a decisive role in the configuration of forces among western countries.

Our hypothesis is the following: the more national elites were under the threat of communist revolutions, more the state introduced policies that reduced

[5]PIKETTY; SAEZ; STANTCHEVA (2014) are aware of this methodological problem. In order to address this issue, they propose a micro-approach by assessing how CEO's behaved when taxes rose in a panel of countries.

top income shares. This hypothesis derives from relevant social science and historical literature. MADSEN; WANG; STEINER (2017) discuss the role of communist threats to inequality during the broader period between the 1870s and 2013.

MADSEN; WANG; STEINER (2017) use communism as an instrumental variable when assessing the impact of inequality on state and fiscal capacity. By doing so, they do not analyze the channels through which communism distributed income. The authors list some possible mechanisms, such as the growing influence of communist parties in parliaments of OECD countries and the rise of unions. Our article tests these possible channels. We support some of the claims in MADSEN; WANG; STEINER (2017) and refute other. For instance, our results show that the union's bargaining power did play a decisive role but communist parties were not so influential.

Without appraising the Cold War specifically, social scientists have affirmed that military conflicts and the risk of revolutions are likely to provide the state with the tools it needs to promote income distribution.[6] PERSSON; BESLEY (2009) and BESLEY; PERSSON (2010) show that states raised taxes, predominantly income and wealth taxes, in periods of armed conflicts. SCHEVE; STASAVAGE (2012) reach similar conclusion when studying inheritance taxes. AGHION; PERSSON; ROUZET (2012) find that governments invest more in primary education in times of wars.

PRZEWORSKI (2009) and CONLEY; TEMIMI (2001) show that ruling elites only agree to expand franchising when politically excluded groups impose a credible threat. Along the same lines, AIDT; JENSEN (2014) find a positive relation between revolutions and franchising in Europe between 1820 and 1938. The authors observe that the elites in each individual country responded to civil unrest not only within their borders, but also in neighboring countries. Elites were more

[6]SCHEIDEL (2017) argues that violence is one of the key forces that is drives inequality down.

likely to expand franchising the closer the threat, either domestically or abroad. AIDT; LEON (2016) show that a related dynamic occurred in Africa from 1990 to 2007: incumbents respond to an increase in the threat of a conflict by providing democratic concessions.

This social science literature provides a useful insight for the study of Cold War and inequality. At first the threat of revolutions pressured the elites to distribute power; once franchise became universal, they had to distribute income. The earlier stage happened in Europe before the Second World War. By the time the Cold War begun, the European elites had nothing but their own income to share.

4.3 Related Historical literature

While social scientists relate wars to income distribution but miss the Cold War, the historians that study the Cold War miss the role of income distribution in preventing the spread of communism. The historical literature focuses on international politics, which is natural given the nature of that conflict. The few pieces that draw parallels between the Cold War and inequality do so incompletely or indirectly.

KIRSHNER (1998) asserts that western policymakers distributed wealth during the post-war because inequality prevented the application of an "optimum foreign policy". The author argues that unequal economies grow less, compromising the capacity of states to spend in defense and diplomacy. Besides downplaying the impact of inequality on domestic stability, the author does not test his argument empirically.

A number of studies have related the Cold War to issues indirectly linked to inequality in the United States. Yet this literature is inconclusive. DUDZIAK (2011) argues that the threat of communism forced the US government to re-evaluate its approach to civil rights. The laws that discriminated African-Americans fostered

anti-Americanism around the world, particularly among left-wingers, and compromised the country's role as the leader of the "free world". On the other hand, SCHRECKER (1998) states that the union laws launched under Mccarthyism weakened labor movements, making unions more docile and less likely to pressure for higher wages. BROWN (1997) has a similar point. According to the author, the emergence of Mccarthyism explains why the private sector plays a greater role in healthcare, education and social programs in the USA than in Europe.

Historians that study post-war Europe openly rejects any relation between the Cold War and low inequality. WEGS (1991) claim that social classes stopped playing a significant role in Western Europe's politics after the end of the Second World War. In a related analysis, WHYTE (1981) and BILLIET (1996) argue that religion was more important than classes in European post-war elections. CONWAY (2004) argues that inequality was virtually irrelevant and the Cold War was nothing more than a "straightjacket".

Perhaps historians have found that issues involving classes were unimportant in post-war Europe because European governments kept the gap between classes narrow to prevent the threats of communism from disturbing the domestic *status quo*. OBINGER; SCHMITT (2011) present a discussion on regime competition and the expansion of social welfare states that is consistent to the arguments present in this paper.[7] By testing the role of the Cold War in the fall in inequality, this article provides an original contribution to that historical literature. The article also contributes to social science literature that studies wars and state capacity and to the recent empirical literature on the dynamics of inequality.

[7]BISIN; VERDIER (2017) and STURM; DE HAAN (2015) discuss the role of cultural integration and ethnic fractionalization on the provision of welfare and redistribution.

4.3.1 Case studies

The historical literature does not relate Cold War to income distribution directly at a global perspective, but country-specific studies identify mechanisms through which the threat of communism improved the working class‘s wealth, income, and standard of living from the 1950s to the 1970s. The remaining of this section revise this literature for the cases of countries that were geographically close to the eastern block: West Germany, Sweden, South Korea, and Japan.

During the immediate postwar, the United States pushed for a US-style collaborative labor relations in occupied Germany. The goal was to develop unions free from socialist influence that would represent workers rather than promote class struggle. The initial model was markedly disadvantageous for the workers, who were underrepresented in the process of wage bargaining. Nominal wages failed to keep up with inflation in the second half of the 1940s (EISENBERG, 1983). Inspired by the communist propaganda from Eastern Germany, “wildcat” strikes (independent from the trade unions) erupted across the country in the early 1950s (SILVER; ARRIGHI; DUBOFSKY, 1995). The Cold War conditioned a response from West Germany’s government after occupation. OBINGER; LEE (2013) argue that the government emulated policies that had been launched in East Germany such as subsidies to basic good, to which it added other welfare state instruments such as unemployment benefits. Industrial relations remained unfavorable to workers, but productivity growth created space for rising real wages, although below the former. The welfare state was a way the government found to compensate for such wage moderation in a context of competition with the eastern bloc (OBINGER; LEE, 2013).

A second round of socialist-inspired “wildcat” strikes broke up in the late 1960s (SILVER; ARRIGHI; DUBOFSKY, 1995). Productivity growth in the 1950s and 1960s narrowed down the catching-up potential, reducing the scope for further

rise in real wages without squeezing profits. The government responded by expanding the welfare state and changing laws on industrial relations to improve the power of shop-floor workers in negotiations over wages and benefits. According to HEDIN (2016), this new set of regulations set by the West German government followed the example of laws that had first been in Eastern European countries such as Yugoslavia and Poland.

HEDIN (2015) describes a similar process in Sweden, where communist political and labor leaders promoted wild cat strikes in the late 1960s. The government responded by passing laws that strengthened the power of unions to negotiate wages. The policies were well-received by both the left and the right-wing parties. The change fostered the development of the Swedish system that effectively promoted equality, which became known as "democratic socialism".

During occupation after the Second War, the United States reduced the power of workers in wage negotiations in South Korea and Japan. The socialist-inspired Korean unions collaborated with the authorities while the United States sought for a joined solution with the USSR over the future of postwar East Asia. As the early events of the Cold War made that partnership impossible, the unions became increasingly more hostile towards the employers as well as the US occupation (JUNG, 1989). OBINGER; LEE (2013) point out that the Americans responded to this adverse context by promoting a wide and successful land reform, with the aim of isolating radical left-winger. This measure worked as a response to a similar reform in North Korea, which was highly advertised by unionists and socialists on the southern side of the border.

US occupation was more intrusive in Japan, where communists were excluded from unions and the state in a wide reform launched in 1950. From then on labor movements were decentralized, with wage bargaining happening at the firm level (SUZUKI, 2015). Although unions became docile and weak, socialist politicians won

seats in Congress in the 1950s, threatening the alignment with the west in the context of the Cold War. GILSON; ROE (1999) argue that an collusion uniting officials, large entrepreneurs and unions promoted new labor regulations that promoted life-time employment. The goal was political: to prevent left-wingers from promoting strikes and inspiring radical unionists that could disturb industrial relations. The change empowered workers at the firm level, enabling unions to pressure for higher wages, consistently to productivity growth. The measures were formalized in the 1950s, and by the 1960s courts prevented employers from firing workers without strong reasons.[8] This life-long employment pattern remained in place in spite of the recession that followed the oil shocks of the 1970s.

These cases do not prove that the Cold War distributed income in OECD countries. Yet they do show that the competition between the western and eastern blocks was not restricted to guns OBINGER; SCHMITT (2011). Rivalry also included policies designed to isolate radical left-wingers domestically and promote social harmony, an important condition to avoid revolutions and maintain stability. Such policies worked as instruments of income distribution from the very rich (land and factories owners) to the poorer (peasants and workers), a feature of the Cold War that reflects in some of this article‘s main results, as will be explained below

4.4 Data description and descriptive statistics

This article tests the following hypothesis: national elites of developed countries redistributed income in the post-war to avoid communist revolution in the context of the Cold War. As an empirical strategy, we run a panel of 17 OECD countries, from 1950 to 1990. This section describes the variables and sources used in this exercise.

[8] Japan has only signed the ILO Convention that concerns the freedom of association and the right to organise in 1965, 15 years after its entry into force.

The dependent variable is a measure of income inequality based on top income shares. We use data on top income shares (0.1%, 1%, 5% and 10%) from the World Wealth and Income Database.[9] We chose to regress top income shares rather than Gini Index for two main reasons. Firstly, we test the claim that the threat of communism reduced the elite's share of national income . Secondly, top incomes is available for longer periods with reasonably confidence, especially in developed countries.

The main independent variable captures the distance between the capital of each OECD country and the location of 41 relevant events that indicate the spread of communism, such as coups, revolutions, military contention and invasions. Table 4.1 lists these events, providing their respective year, locations and a brief description. We have compiled the list from FRANKEL (1992) and SCHWARTZ (1997), two handbooks on the Cold War.

[9]http://wid.world/

Tabela 4.1: Communist-led Violent Events of the Cold War

Year	Country	Description
1945	Poland	USSR captures Warsaw
1945	Austria	USSR captures Vienna
1946	North Korea	Kim Il Sung takes office in North Korea
1946	China	Forces led by Mao win civil war
1946	Greece	War between royalists and communists
1947	Bulgaria	Bulgaria aligns with USSR
1948	Czechoslovakia	Communist coup is Czechoslovakia
1948	East Germany	USSR announces the Berlin Blockade
1948	East Germany	USSR blockades West Berlin
1948	East Germany	Soviet troops fire into demonstrators in East Berlin
1948	China	Communist forces reach Beijing
1949	China	Mao takes office
1950	South Korea	North Korea invades South Korea
1950	China	China invades Tibet
1950	North and South Korea	China enters Korean War
1953	East Germany	USSR supresses anti-Communist rioting in East Berlin
1954	Vietnam	Communist forces defeat French Army in Vietnam
1954	Vietnam	Communist forces take Hanoi
1955	North and South Korea	Military clashes start between North and South Vietnam
1956	Poland	Communist forces repress riots in Poznan
1956	Hungary	USSR invades Hungary
1958	Taiwan	China bombards the contested islands of Quemoy and Matsu
1959	Cuba	Forces led by Castro take over Havana
1960	East Germany	East Germany impedes access to East Berlin
1961	East Germany	East German builds the Berlin wall
1962	Laos	Parts of Laos fall to communist Pathet Lao
1962	Cuba	USSR provides arms to Cuba
1968	Vietnam	The Viet Cong launches the Ted Offensive
1968	Czechoslovakia	USSR invades Czechoslovakia
1969	North Korea	Fire between US and North Korean troops
1969	Libya	Qaddafi establishes the socialist Arab Republic of Libya
1970	Cambodia	Communists forces reach Phnom Penh
1975	Cambodia	Khmer Rouge takes over in Cambodia
1975	Vietnam	The Viet Cong takes Hanoi
1975	Laos	Vietnamese-backed Pathet Lao takes over in Laos
1978	Afghanistan	Afghan Communist Party takes Kabul
1979	Nicaragua	Sandinistas take Managua
1979	El Salvador	Left-wing uprising in El Salvador
1979	Afghanistan	USSR invades Afghanistan
1981	Poland	Government imposes martial law following strikes
1989	China	Government supresses demonstration in Tiananmen Square

Sources: FRANKEL (1992) and SCHWARTZ (1997)

The events may be divided into three phases. The first phase starts in 1945, when the Red Army takes Warsaw, and finished with the USSR suppressing a revolt in East Berlin in 1953. The communist block is consolidated during this rather turbulent period, when on average two events happened per year. The second phase of the Cold War was restricted to Eurasia, with about half of the events happening in each one of these two continents. The third phase is marked by the global expansion of communism. It starts with the uprising of communists against the French in Vietnam and finishes with the war in El Salvador, respectively in 1954 and 1979. Most of the events happened in Asia, but Latin America became a relevant region. Yet the invasion of Czechoslovakia in 1968 had relevant implications for the Cold War in Europe, which continued to stage the conflict. The last ten nine years of the Cold War (1980-1989) constitute the final phase. It characterizes the decadence the European communist block and the continuation of the authoritarian regime in China. The fall of the USSR and its satellite states explains the reduced number of events; in this period most of the events related to the Cold War implied the defeat rather than the expansion of communism.

The variable of interest is defined as the sum of communist revolutions or USSR invasions weighted by the distance (in kilometers) between the capital of the country where the revolution/invasion happened and the capitals of each OECD country. That is:

$$Cold\,War\,Event_{it} = 1000 * \sum_{it} \frac{CR_{jt}}{distance_{ij}} \qquad (1)$$

Where CR_{jt} is a dummy for the occurrence of the event communist revolution/ invasion at country j in period t and $distance_{ij}$ is the geographical distance - in kilometers - between the capitals of countries i and j. Thus, $Cold\,War\,Event_{it}$ captures two assumptions we test in this exercise: (i) the spread of communism during post-war represented an external threat to Western elites; (ii) this threat was unevenly distributed across the world. MADSEN et al. (2016) use cultural distance to communism proxied by linguistic similarities between countries. However, Karl Marx

wrote in German and lived in Britain, and yet revolutions happened in countries that spoke Russian, Mandarin and Spanish. We believe the distance between countries is a more appropriate and simple measure of the communist external threat. Yet, we test for cultural proximity as a robustness check.

In addition to the communist threat variable, we also test whether domestic groups of interest have pushed for communism. This is captured by two variables: (i) the share of communist parties in Parliament; and (ii) the presence of left-wing parties in the executive. The former, *communist vote share*, is a measure of the electoral importance of communist parties in legislative elections. It is calculated as the share of seats obtained by communist parties through each electoral cycle between 1945 and 1990. The data was collected from each country‘s congress websites. Following SCHEVE; STASAVAGE (2009), we use a dummy variable *Left Executive* that equals one if the country had a president or prime minister from a left-wing party.

Strong trade unions may also have pressured for income distribution. This argument appears in ATKINSON (2015), although the author has not provided robust evidence on it. We test for the role of labour institutions by using a measure of density of trade unions from 1945 to 1990. The data is from GOLDEN; LANGE; MICHAEL (2014).

Besides the variables described above, we use covariates in order to control for other factors that may have affected top income shares. The empirical literature on state capacity emphasizes the role of wars in building state capacity. We use the variable - *War Risk* - as defined by AGHION; PERSSON; ROUZET (2012)(p.16): “war risk is a binary indicator set equal to one if the country was engaged in an interstate war in the previous 10 years, according to the variable ‘interstate war’ in the Correlates of War (COW) database”. From BARRO; LEE (2013), we use the percentage of population that has completed high-school as a measure of human

capital stock.[10]

The model also controls for the role of democracy in determining inequality, an influential point in the literature (ACEMOGLU et al., 2015). We define this variable according to the Polity IV score from MARSHALL; JAGGERS; GURR (2011). ATKINSON; PIKETTY; SAEZ (2011) draw attention to the effects of global forces, especially globalization, in income distribution. We control for this by including the variable *Trade Openness*, defined as the ratio between trade flow and GDP (ROINE; VLACHOS; WALDENSTRÖM, 2009).

We do not include income or income per capita as independent variables to avoid endogeneity. These are arguably correlated to state capacity (PERSSON; BESLEY, 2009). In addition, we do not include top marginal tax rates, which is a common variable in the literature. ACEMOGLU et al. (2015) argue that top marginal tax rates may lead to bad control problems. The Cold War may have influenced the increase in taxes, especially those linked to the top incomes. [11]

Table 4.2 presents descriptive statistics for the variables used in the main sample.

[10] According to BARRO; LEE (2013), the years of schooling in advanced countries from 1950 to 1990 went from 6.22 to 9.56 years. Furthermore, the share of population aged 15 and over with the secondary complete accrued from 12.7 to 25.9 in the same group of countries. Thus, we believe this is a more appropriate variable to measure human capital and its effects on the middle class than the share of the population that has completed the tertiary.

[11] However, on the Supplementary Material, Table B.4 provides estimates controlling for the inclusion of top marginal tax rates. The coefficient on lagged *Cold War Event* remains statistically robust to this inclusion.

Tabela 4.2: Summary Statistics

VARIABLES	(1) mean	(2) sd	(3) min	(4) max	(5) N
Share Top 1%	7.966	1.980	3.828	12.45	139
Share Top 0.1%	2.206	0.930	0.730	4.650	102
Share Top 10%	30.88	3.488	19.91	38.78	129
Gross Gini	42.09	4.059	35.21	51.21	71
Cold War Event	0.355	1.105	0	7.814	139
(Ln) Union Density	3.627	0.407	2.160	4.398	121
Communist Party Share of Seats	3.495	7.185	0	32.80	139
Left Executive	0.501	0.418	0	1	126
Polity IV Index	9.854	0.659	5	10	138
Percentage of Secondary Complete	19.70	12.68	1.134	52.83	139
Trade Openness	33.64	17.15	3.380	90.17	139
(Dummy) War Risk	0.296	0.442	0	1	139
Relative Power	0.404	0.290	0.036	1.645	153
Cultural Distance	0.040	0.057	0	0.395	147

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 17 OECD countries: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom

4.5 Empirical Strategy

This section details the empirical strategy of the article and interprets the results. We run a fixed-effect model on a panel of 17 OECD countries covering the period from 1950 to 1990. The data is in a five years average basis. The benchmark specification is defined by equation (2):

$$Inequality_{it} = \beta_1 * Cold\,War\,Event_{it-1} + \beta_2 * X_{it} + \lambda_t + \mu_i + \varepsilon_{it} \qquad (2)$$

Where $Inequality_{it}$ refers to the different measures of inequality utilized in this paper. Benchmark variable for $Inequality$ is the top percentile income share for each country i at time t. The first term in the right-hand side, $ColdWar\,Event_{it-1}$, is the measure defined above that captures the effects of communist events as an

external disciplining device to inequality in western countries. The variable is defined at the beginning of the period and thus is indexed as *t-1*. X_{it} is a vector of control variables containing additional political and economic forces that may explain top income inequality. λ_t is period-fixed effects, μ_i is the country fixed-effect, and ε_{it} is the model error term.

The model relies on the identification strategy that β_1 captures the effects of the spread of communism on income inequality, controlling for other possible channels from political economy and allowing for country and period fixed effects. As the countries in the sample were not directly affected by communist invasions or revolutions, there is limited room for endogeneity problems. The United States is a possible exception. It was the only western country that played a key role and directly influenced the course of the Cold War. The leaders of the eastern bloc responded to US military and diplomatic decisions. That interaction defined the spread of communism around the world and leaves room for endogeneity: the US government could have shaped to some extent the global war against communism to deal with social issues related to inequality at home.[12] For this reason, the United States has been excluded from the sample. Results do not change significantly when it is included.

4.6 Results

Table 4.3 presents results with country and period fixed effects and includes economic controls in order to account for human capital and openness effects. As discussed before, human capital is proxied by the percentage of the population that has completed the secondary level and trade openness relates to economic openness. Table 4.3 is divided in two panels. Panel A displays results where the dependent

[12]BERGER et al. (2013) discuss how CIA interventions during the Cold War period had trade benefits to the USA.

variable is the share of the top percentile in the income distribution. Panel B displays results with the natural logarithm transformation of the share of top 1%. Results from columns (1) to (4) consider country and period fixed effects. However, if the trend is heterogeneous, country and period effects do not fully capture this heterogeneity. Therefore, Column (5) extends the analysis in order to consider country-specific trends.

Tabela 4.3: Effects of Cold War on Inequality: Economic Controls

	(1)	(2)	(3)	(4)	(5)
	Panel A: Dep. Variable: Top 1%				
Cold War Event$_{t-1}$	-0.108**	-0.087**	-0.092**	-0.080**	-0.068**
	(0.044)	(0.037)	(0.034)	(0.034)	(0.030)
Percentage of Secondary Complete		-0.058*		-0.041**	-0.032
		(0.029)		(0.019)	(0.021)
Trade Openness			-0.060*	-0.046*	-0.034
			(0.032)	(0.025)	(0.037)
R-squared	0.667	0.711	0.716	0.736	0.856
Observations	117	117	117	117	117
Number of id_country	17	17	17	17	17
Country FE	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y
Country-Specific Trend	N	N	N	N	Y
	Panel B: Dep. Variable: Ln(Top 1%)				
Cold War Event$_{t-1}$,	-0.021***	-0.018***	-0.019***	-0.017***	-0.007*
	(0.007)	(0.006)	(0.006)	(0.005)	(0.004)
Percentage of Secondary Complete		-0.008**		-0.007**	-0.004
		(0.004)		(0.003)	(0.003)
Trade Openness			-0.007	-0.004	-0.002
			(0.004)	(0.003)	(0.005)
R-squared	0.645	0.689	0.673	0.698	0.850
Observations	117	117	117	117	117
Number of id_country	17	17	17	17	17
Country FE	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y
Country-Specific Trend	N	N	N	N	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 17 OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Regressions at Column (5) include country-specific trends. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Results from Table 4.3 point to a negative relationship between the occur-

rence of communist events and the share of top percentile between 1950 and 1990. In Panel A, the introduction of the control variables does not reduce explanatory power of the variable related to previous cold war communist events. Even when one accounts for different trends for each country, the coefficient on *Cold War Event* is still significant. Considering the coefficients of columns (4), one would expect that the 1953 suppression of anti-Communist rioting at Berlin links to a reduction of 0.09 and 0.23 percentage points in the share of top income percentile in France and Denmark, respectively. Results from Panel B basically corroborate the findings in Panel A.[13] The measure of trade openness is no longer robust, though it keeps the same signal. Besides the external communist threat, the increase in the stock of human capital is consistently linked to a reduction in inequality. More trade is also associated to less inequality, albeit in a less consistent way.

Table 4.4 introduces covariates related to political economy. As discussed in the previous section, we introduce additional variables that capture political economy effects, such as the bargaining power of workers, the electorate's preference towards communist parties, external conflicts and domestic political institutions. Again, the Table is divided into two panels. Panel A displays results with a linear specification and Panel B displays results for the log-linear specification. In addition, every specification includes economic controls, time and country fixed effects. Finally, column (6) considers country-specific time trends.

[13]Results are robust to the use of lagged controls, as shown on Supplementary Material.

Tabela 4.4: Effects of Cold War on Inequality: Political Economy

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Dep. Variable: Top 1%					
Cold War Event$_{t-1}$	-0.055	-0.037**	-0.037**	-0.035**	-0.056**	-0.079**
	(0.031)	(0.016)	(0.016)	(0.015)	(0.021)	(0.034)
Union Density		-1.914***	-1.922***	-2.002***	-2.306***	-1.080
		(0.624)	(0.617)	(0.617)	(0.563)	(1.189)
Polity2 Index			-0.037	0.004	0.016	-0.052
			(0.065)	(0.095)	(0.099)	(0.100)
War Risk				0.312	0.208	0.039
				(0.487)	(0.476)	(0.737)
Communist Party Share of Seats					0.097**	0.069
					(0.033)	(0.040)
Observations	101	101	101	101	101	101
R-squared	0.776	0.818	0.818	0.822	0.832	0.876
Number of id_country	14	14	14	14	14	14
Economic Controls	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y
Country-Specific Trend	N	N	N	N	N	Y
	Panel B: Dep. Variable: Ln(Top 1%)					
Cold War Event$_{t-1}$	-0.013**	-0.010***	-0.010***	-0.010***	-0.013***	-0.009*
	(0.005)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)
Union Density		-0.347***	-0.347***	-0.351***	-0.390***	-0.076
		(0.078)	(0.077)	(0.084)	(0.078)	(0.165)
Polity2 Index			-0.001	0.001	0.003	-0.002
			(0.009)	(0.013)	(0.014)	(0.015)
War Risk				0.016	0.002	0.013
				(0.073)	(0.071)	(0.110)
Communist Party Share of Seats					0.012**	0.007
					(0.004)	(0.005)
Observations	101	101	101	101	101	101
R-squared	0.737	0.806	0.806	0.806	0.814	0.873
Number of id_country	14	14	14	14	14	14
Economic Controls	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y
Country-Specific Trend	N	N	N	N	N	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 14 OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Results from both panels at Table 4.4 present a negative and robust relationship between top income inequality and the external threat of communism. The bargaining power of workers, as measured by *Union density*, also presents a significant and robust negative relationship with top income inequality. Nevertheless, the coefficient on *Union Density* is not robust to the inclusion of country-specific time trends. The variable that captures the composition of Congress has a positive relationship with inequality. However, this result may be related to endogeneity problems, related to reverse causality: high levels of inequality may move parties more to the left (PONTUSSON; RUEDA, 2010). The coefficients on the quality of political institutions, as measured by Polity 2 Index, and the participation in wars are not significant.

It is arguable that the effects of the external threats need not be lagged, as presented in the previous tables. Thus, on Table 4.5, we present results based on estimations with lagged and present *Cold War Event*. Columns (1) to (3) do not consider political economy controls. From column (4) on, we add as political controls: Polity2, Union Density and War Risk. Columns (3) and (5) consider country-specific time trends.

Tabela 4.5: Contemporaneous and Lagged Independent Variables

VARIABLES	(1) Top 1%	(2) Top 1%	(3) Top 1%	(4) Top 1%	(5) Top 1%
Cold War Event$_t$	0.024	0.017	0.012	0.033	0.012
	(0.021)	(0.026)	(0.054)	(0.022)	(0.082)
Cold War Event$_{t-1}$		-0.058*	-0.064	-0.041**	-0.069
		(0.028)	(0.059)	(0.015)	(0.079)
Observations	101	101	101	101	101
R-squared	0.821	0.776	0.873	0.822	0.875
Number of id_country	14	14	14	14	14
Economic Controls	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y
Political Controls	N	N	N	Y	Y
Country-Specific Trend	N	N	Y	N	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 14 OECD countries. Dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Economic Controls are: percentage of secondary complete and trade openness. Political controls are: Polity2, Union Density and War Risk. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Overall, results from Table 4.5 do not show evidence on a relationship between cold war communist-related events and income inequality. Yet the lagged independent variableis still robust when country and period fixed effects are considered. The inclusion of country-specific time trends reduces the statistical significance, albeit the coefficient remains relatively stable.

Furthermore, the initial level of inequality is also likely to be important. Therefore, we estimate the following equation:

$$Inequality_{it} = \alpha * Inequality_{it-1} + \beta_1 * ColdWarEvent_{it-1} + \beta_2 * X_{it} + \lambda_t + \mu_i + \varepsilon_{it} \quad (2)$$

Where $Inequality_{it-1}$ refers to the initial level of inequality and the rest of the

variables remain the same as described before. Under such a framework, estimation with fixed effects is not consistent, because the regressors and the error term are correlated (NICKELL, 1981). Therefore, we estimate model (2) with dynamic panel methods to account for persistence of the dependent variable.

Table 4.6 presents results based on a dynamic panel estimation. Column (1) shows the results of the Pooled OLS estimator, whereas column (2) presents results with the fixed effects estimator. These estimates provide the upper and lower bound for the coefficient on lagged inequality. Both estimators point to an autoregressive component on inequality. As discussed before, OLS estimates are not consistent. Columns (3) and (4) provide estimates with dynamic panel GMM techniques. On Column (3), results are based on a Twostep Diff-GMM estimation with WINDMEIJER (2005) finite sample correction to standard errors. Results point to a negative relationship, albeit not robust, between Cold War Events and Top income inequality. However, as pointed by KRIEGER; MEIERRIEKS (2016), system-GMM estimator is more appropriate when there are institutional conditions that are persistent over time. This is so because lagged levels of highly persistent dependent variables are weak instruments in Diff-GMM (BLUNDELL; BOND, 1998).[14] Thus, Column (4) presents results based on Twostep Sys-GMM estimation. Again, results point to a negative but not statistically significant relationship between communist threats and inequality.

[14] In addition, ROODMAN (2006) argues that first differences magnify gaps in unbalanced panels, as is the case here.

Tabela 4.6: Dynamic Panel

VARIABLES	(1) Pooled OLS	(2) FE OLS	(3) Twostep Diff-GMM	(4) Twostep Sys-GMM
Cold War Event$_{t-1}$	0.025	-0.056*	-0.108	-0.108
	(0.039)	(0.029)	(0.142)	(0.370)
Top 1%$_{t-1}$	0.888***	0.479***	0.493***	0.763*
	(0.052)	(0.065)	(0.135)	(0.392)
Observations	113	113	113	113
R-squared	0.885	0.841		
Economic Controls	Y	Y	Y	Y
Country FE	N	Y	N	N
Period FE	Y	Y	Y	Y
Number of id_country		17	17	17
Hansen J-test			0.840	0.991
Diff-in-Hansen				0.910
Number of Instruments			25	33
AR2 p-value			0.419	0.812

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 17 OECD countries. Dependent variable is the top income percentile share. All regressions include period fixed effects. Robust standard errors are clustered at the country level in columns (1) and (2). On GMM estimations (columns (3)-(4)), WINDMEIJER (2005) finite sample correction for standard errors is employed. The row for the Hansen J-test reports the p-values for the null hypothesis of instrument validity. The values reported for the Diff-in-Hansen test are the p-values for the validity of the additional moment restriction necessary for system GMM. All regressions exclude the United States of America. Controls are: percentage of secondary complete and trade openness. Significance: *** p<0.01, ** p<0.05, * p<0.1.

4.6.1 Robustness checks: alternative variables

According to the literature on franchise extension (ACEMOGLU; ROBINSON, 2000; AIDT; JENSEN, 2014), it might be argued that the Cold War contributed for income distribution because it reduced the power of national elites. If that was so, the threat of communism must have affected the very top income more than the lower top income cohorts. In order to test for this hypothesis, we divide the top

income shares into three groups: top 10%, top 1% and top 0.1%. In addition, we test the effects on the Gini of Market Income, available from the SWIID database (SOLT, 2016).[15] Table 4.7 shows the results of this exercise. The sample of countries is restricted to those that have available data on the three measures of top income shares.

[15]The standardized world income inequality database incorporates data on inequality from several sources

Tabela 4.7: Alternative Measures of Inequality

VARIABLES	(1) Top 1%	(2) Top 0.1%	(3) Top 10%	(4) Gross Gini
	Panel A: Dependent variables in linear form			
Cold War Event$_{t-1}$	-0.018	-0.030***	-0.010	-0.309***
	(0.025)	(0.007)	(0.121)	(0.095)
Observations	84	84	84	55
R-squared	0.791	0.686	0.435	0.263
Number of id_country	13	13	13	12
Economic Controls	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Period FE	Y	Y	Y	Y
	Panel B: Dependent variables in log form			
Cold War Event$_{t-1}$	-0.008*	-0.022***	-0.001	-0.007**
	(0.004)	(0.005)	(0.004)	(0.002)
Observations	84	84	84	55
R-squared	0.746	0.701	0.402	0.284
Number of id_country	13	13	13	12
Economic Controls	Y	Y	Y	Y
Country FE	Y	Y	Y	Y
Period FE	Y	Y	Y	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 13 (12 in the last column) OECD countries. Dependent variable is Panel A are in its linear form, whereas Panel B presents dependent variables transformed by taking the natural logarithm. All regressions include economic controls, period and country fixed effects. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Economic Controls are: percentage of secondary complete and trade openness. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 4.7 shows the Cold War‘s effect holds independently from the way we measure inequality – GINI or top income percentiles. From Column (4), the coefficient on the Gini of gross income is negative and significant. Furthermore,

both panels show a declining effect of communist revolutions on top income shares. On Panel A, the comparison between top income shares shows that, although all coefficients are negative, only the coefficients of top 0.1% are significant. Similar results appear on Panel B that has variables log transformed. These results suggest that the threat of communism impacted the very rich, whose income derived mainly from capital gains. Together with the significant coefficient of *union density*, Table 4.7 suggests that the Cold War strengthened the power of workers in negotiating wages with employers.

Another possible caveat of the previous set of results is that the degree of the impact of Cold War events in specific countries might be related to historical or cultural links rather than to geodesic distance. In order to test this hypothesis, we re-scale our *Cold War Event* variable by replacing geodesic for linguistic distance. We define the variable *Cultural Distance* based on a distance matrix among European languages from GAMALLO; PICHEL; ALEGRIA (2017). The *Cultural Distance* variable is similar to the *Cold War Event* variable, except that geodesic distance is substituted by the distance between languages. Given the limitation to European languages, we restrict our sample to countries from Europe or that speak European languages (in that case, we add Canada, New Zealand and Australia). Besides the effects of cultural distance, it is possible to capture the threats related to the spread of communism by looking at the relative military power of Soviet Union. Thus, the variable *Relative Power* captures relative military expenditures of Soviet Union and United States divided by the geodesic distance between country i's capital and Moscow.[16]

Table 4.8 displays results considering the variables discussed above. Columns (1) and (3) provide results of *Relative Power*, respectively for the whole sample of countries, European countries and European countries plus Western offshoots.

[16] A previous version of this paper develops further this idea (ALBUQUERQUE SANT'ANNA, 2015)

Columns (4) and (5) provide results for *Cultural Distance* for Europe and Europe plus Western Offshoots, respectively. Results point to a significant effect of Soviet Union's relative military strength. However, the effects of Cold War weighted by cultural distance instead of geodesic distance do not appear to have had any effect on inequality.[17]

Tabela 4.8: Alternative Measures of Communist Threat

	(1)	(2)	(3)	(4)	(5)
Relative Power$_{t-1}$	-2.971**	-4.846**	-3.345**		
	(1.340)	(1.727)	(1.425)		
Cultural Distance$_{t-1}$				0.039	1.211
				(1.847)	(2.196)
Observations	101	77	93	77	93
R-squared	0.844	0.901	0.851	0.875	0.826
Number of id_country	14	11	13	11	13
Controls	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y
Sample	All	Europe	Europe + Western Offshoots	Europe	Europe + Western Offshoots

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample varies according to the specifications. Dependent variable is the share of top income percentile All regressions include economic and political controls, period and country fixed effects. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Controls are: percentage of secondary complete, trade openness, union density, Polity2 and War Risk. Significance: *** p<0.01, ** p<0.05, * p<0.1.

4.7 Conclusion

This paper discusses how the threat of communism acted as a disciplining device to inequality in OECD countries during the Cold War. In doing so, it contributes to the recent literature on top income inequality in explaining the causes of inequality beyond the marginal productivity framework. Our results suggest that

[17]For the same sample, results are robust for the *Cold War Events* variable. Results are not reported.

employers, employees and governments formed common-interest states. Unions became more powerful the closer their countries were to the spread of communism. On the other side of the bargaining table, employers agreed to reduce their gains from capital in favor of wages. The government complemented this common-interest state by spending with the poor. The economic and political elites formed this Cold-War coalition to redistribute income and reduce the likelihood of communist revolutions. The unions took advantage of this special conjuncture to push for higher wages, changing the return of labor vis-à-vis capital in favor of the former.

The Cold War redistributed income by making the society more politically equal. The rise of workers resemble the process ACEMOGLU; ROBINSON (2006) refer to as an *de facto* institutional change that reduce the power of the elites in benefit of the masses. The new inclusive institutions create more equal and vibrant societies. The authors describe this process but do not identify its ultimate cause. They rely on stochastic historical events that may trigger profound redistributive social changes. This article indicates that the communist events that happened during the Cold War worked as one of these triggers in the post-war.

4.8 Appendix

Chart A.1 displays the countries utilized in this article.

Table A.1 - Countries in the sample

Australia	Canada
Denmark	Finland
France	Germany
Ireland	Italy
Japan	Netherlands
New Zealand	Norway
Portugal	Spain
Sweden	Switzerland
United Kingdom	

Table 4.3 displays results with contemporary covariates. Table B.1 displays results with lagged controls. Results are still robust to the use of lagged covariates.

Table B.1: Effects on inequality - lagged controls

VARIABLES	(1) Top 1%	(2) Top 1%	(3) Top 1%	(4) Top 1%
Cold War Event$_{t-1}$	-0.062	-0.108***	-0.078**	-0.075**
	(0.037)	(0.034)	(0.031)	(0.027)
Percentage of Secondary *Complete*$_{t-1}$	-0.064*		-0.042	-0.045
	(0.033)		(0.028)	(0.037)
Trade *Openness*$_{t-1}$		-0.072**	-0.057**	0.022
		(0.026)	(0.024)	(0.039)
Observations	117	117	117	117
R-squared	0.711	0.728	0.745	0.859
Number of id_country	17	17	17	17
Country FE	Y	Y	Y	Y
Period FE	Y	Y	Y	Y
Country-Specific Trend				Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 17 OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Regressions at Column (5) include country-specific trends. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table B.2 provides results similar to Table 4.3, but use as additional controls the share of Government Expenditures on GDP and the share of Private Credit on GDP. Furthermore, instead of the Percentage of the population over 15 years old with the secondary complete, we use on specifications (3) and (6) the percentage of the same population with the tertiary complete.

Table B.2: Effects on inequality - additional controls

VARIABLES	(1) Top 1%	(2) Top 1%	(3) Top 1%	(4) Top 1%	(5) Top 1%	(6) Top 1%
Cold War Event$_{t-1}$	-0.074**	-0.084**	-0.081**	-0.065**	-0.061*	-0.069**
	(0.029)	(0.030)	(0.035)	(0.029)	(0.030)	(0.032)
Percentage of Secondary Complete	-0.038*	-0.027		-0.023	-0.025	
	(0.018)	(0.018)		(0.027)	(0.027)	
Trade Openness	-0.047	-0.042*	-0.050*	-0.032	-0.034	-0.022
	(0.027)	(0.024)	(0.028)	(0.038)	(0.039)	(0.042)
Private Credit	0.615	0.465	0.624	0.969	0.957	1.275
	(0.845)	(0.796)	(0.772)	(1.626)	(1.646)	(1.412)
Government Expenditures		-10.995*	-12.472**		2.837	3.582
		(5.636)	(4.999)		(6.591)	(7.724)
Percentage of Tertiary Complete			-0.034			-0.069
			(0.050)			(0.059)
Observations	117	117	117	117	117	117
R-squared	0.740	0.758	0.752	0.858	0.859	0.859
Number of id_country	17	17	17	17	17	17
Country FE	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y
Country-Specific Trend	N	N	N	Y	Y	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 17 OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Regressions at Column (5) include country-specific trends. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table B.3 considers political economy controls and other variables that measure inequality. On the political economy controls, we substitute the share of communist seats to a dummy of *Left Executive*, as discussed by SCHEVE; STASAVAGE (2009).

Table B.3: Effects on inequality - political economy

VARIABLES	(1) Top 1%	(2) Top 1%	(3) Top 0.1%	(4) Top 0.1%	(5) Top 10%	(6) Top 10%	(7) Gross Gini	(8) Gross Gini
Cold War Event$_{t-1}$	-0.045***	-0.075**	-0.036***	-0.042	0.068	-0.042	-0.058	-0.058
	(0.013)	(0.030)	(0.010)	(0.023)	(0.102)	(0.057)	(0.149)	(0.062)
Union Density	-1.616***	-0.897	0.413	-0.374	-6.133**	-5.096*	-6.596	1.258
	(0.518)	(1.135)	(0.295)	(0.809)	(2.724)	(2.781)	(3.881)	(3.632)
Polity2 Index	0.012	-0.068	0.007	-0.042	-0.477**	-0.438**	-1.345	0.567
	(0.101)	(0.105)	(0.034)	(0.035)	(0.173)	(0.162)	(1.040)	(0.462)
War Risk	-0.041	-0.036	-0.381	-0.600	0.894	2.175**	0.715	3.400***
	(0.469)	(0.661)	(0.230)	(0.382)	(0.909)	(0.779)	(2.392)	(0.626)
Left Executive	-0.276*	-0.131	-0.042	-0.060	-0.212	-0.144	-0.779	0.436
	(0.142)	(0.159)	(0.095)	(0.104)	(0.458)	(0.420)	(0.537)	(0.638)
Observations	89	89	64	64	82	82	56	56
R-squared	0.851	0.881	0.794	0.830	0.679	0.862	0.645	0.941
Number of id_country	12	12	9	9	12	12	12	12
Economic Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y	Y	Y
Country-Specific Trend	N	Y	N	Y	N	Y	N	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 12 OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Regressions at Column (5) include country-specific trends. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

Table B.4 presents results controlling for top marginal income tax rates. We use data top marginal tax rates from PIKETTY; SAEZ; STANTCHEVA (2014). Results point to a strong negative effect of tax rates on different measures of inequality. Interestingly, even with the introduction of this variable, the coefficient on *Cold War Events* remains statistically significant.

Table B.4: Effects on inequality - Top Marginal Income Tax Rate

VARIABLES	(1) Top 1%	(2) Top 1%	(3) Top 0.1%	(4) Top 0.1%	(5) Top 10%	(6) Top 10%	(7) Gross Gini	(8) Gross Gini
Cold War Event$_{t-1}$	-0.050*	-0.047*	0.007	-0.024*	-0.306*	-0.059*	-0.392***	-0.106*
	(0.026)	(0.022)	(0.013)	(0.011)	(0.163)	(0.031)	(0.078)	(0.052)
Percentage of Secondary Complete	-0.050*	-0.024	-0.014*	-0.012	-0.102	-0.030	-0.001	0.009
	(0.024)	(0.021)	(0.007)	(0.010)	(0.075)	(0.048)	(0.056)	(0.050)
Trade Openness	-0.037*	-0.042	-0.021**	-0.035**	0.007	0.002	0.035	0.052
	(0.019)	(0.041)	(0.008)	(0.015)	(0.065)	(0.162)	(0.044)	(0.100)
TopIncomeTaxRate	-2.898**	-3.612	-1.343**	-0.982	-7.145	-9.954	-8.988**	-6.977
	(1.113)	(2.313)	(0.610)	(0.969)	(6.556)	(5.821)	(3.793)	(5.227)
Observations	75	75	75	75	75	75	55	55
R-squared	0.835	0.901	0.766	0.850	0.468	0.795	0.350	0.888
Number of id_country	13	13	13	13	13	13	12	12
Economic Controls	Y	Y	Y	Y	Y	Y	Y	Y
Country FE	Y	Y	Y	Y	Y	Y	Y	Y
Period FE	Y	Y	Y	Y	Y	Y	Y	Y
Country Trend	N	Y	N	Y	N	Y	N	Y

Notes: The analysis is based on a country-by-period panel data set covering the period 1950-1990. Sample includes 13(12) OECD countries. Panel A has the share of income of the top percentile as dependent variable, whereas Panel B displays results where dependent variable is the natural logarithm of top income percentile share. All regressions include period and country fixed effects. Regressions at Column (5) include country-specific trends. Robust standard errors are clustered at the country level. All regressions exclude the United States of America. Significance: *** p<0.01, ** p<0.05, * p<0.1.

REFERÊNCIAS

ABADIE, A. et al. **When Should You Adjust Standard Errors for Clustering?** [S.l.]: National Bureau of Economic Research, 2017. Working Paper. (24003).

ABNEY, F. G.; HILL, L. B. Natural disasters as a political variable: the effect of a hurricane on an urban election. **American Political Science Review**, [S.l.], v.60, n.04, p.974–981, 1966.

ACEMOGLU, D. et al. Chapter 21 - Democracy, Redistribution, and Inequality. In: ATKINSON, A. B.; BOURGUIGNON, F. (Ed.). **Handbook of Income Distribution**. [S.l.]: Elsevier, 2015. p.1885 – 1966. (Handbook of Income Distribution, v.2).

ACEMOGLU, D.; ROBINSON, J. A. Why Did the West Extend the Franchise? Growth, Inequality and Democracy in Historical Perspective. **Quarterly Journal of Economics**, [S.l.], v.115, 2000.

ACEMOGLU, D.; ROBINSON, J. A. De facto political power and institutional persistence. **The American economic review**, [S.l.], v.96, n.2, p.325–330, 2006.

ACHEN, C. H.; BARTELS, L. M. Blind retrospection: why shark attacks are bad for democracy. **Center for the Study of Democratic Institutions, Vanderbilt University. Working Paper**, [S.l.], 2012.

AGHION, P.; PERSSON, T.; ROUZET, D. **Education and military rivalry**. [S.l.]: National Bureau of Economic Research, 2012.

AIDT, T. S. Political internalization of economic externalities and environmental policy. **Journal of Public Economics**, [S.l.], v.69, n.1, p.1–16, 1998.

AIDT, T. S.; JENSEN, P. S. Workers of the world, unite! Franchise extensions and the threat of revolution in Europe, 1820–1938. **European Economic Review**, [S.l.], v.72, p.52–75, 2014.

AIDT, T. S.; LEON, G. The democratic window of opportunity: evidence from riots in sub-saharan africa. **Journal of Conflict Resolution**, [S.l.], v.60, n.4, p.694–717, 2016.

ALBUQUERQUE SANT'ANNA, A. **A spectre has haunted the west**: did socialism discipline income inequality? [S.l.]: University Library of Munich, Germany, 2015.

ALMEIDA, A. L. O. de; CAMPARI, J. S. et al. **Sustainable settlement in the Brazilian Amazon.** [S.l.]: Oxford University Press, 1995.

ALSTON, L. J.; LIBECAP, G. D.; MUELLER, B. A model of rural conflict: violence and land reform policy in brazil. **Environment and Development Economics**, [S.l.], v.4, n.02, p.135–160, 1999.

ALVAREDO, F. et al. The top 1 percent in international and historical perspective. **Journal of Economic Perspectives**, [S.l.], v.27, n.3, p.3–20, 2013.

ANBARCI, N.; ESCALERAS, M.; REGISTER, C. A. Earthquake fatalities: the interaction of nature and political economy. **Journal of Public Economics**, [S.l.], v.89, n.9, p.1907–1933, 2005.

ANDREW, R. Building community resilience. **Proceedings of the Institution of Civil Engineers - Civil Engineering**, [S.l.], v.165, n.6, p.59–64, 2012.

ANGELSEN, A. Agricultural expansion and deforestation: modelling the impact of population, market forces and property rights. **Journal of development economics**, [S.l.], v.58, n.1, p.185–218, 1999.

ANGRIST, J. D.; PISCHKE, J.-S. **Mostly harmless econometrics**: an empiricist's companion. [S.l.]: Princeton university press, 2008.

ARIMA, E. Y. et al. Statistical confirmation of indirect land use change in the Brazilian Amazon. **Environmental Research Letters**, [S.l.], v.6, n.2, p.024010, 2011.

ASHWORTH, S. Electoral accountability: recent theoretical and empirical work. **Annual Review of Political Science**, [S.l.], v.15, p.183–201, 2012.

ASHWORTH, S.; MESQUITA, E. B. de; FRIEDENBERG, A. Learning About Voter Rationality. , [S.l.], 2016.

ASSUNÇÃO, J. et al. Deforestation Slowdown and Rural Credit Policies in the Brazilian Amazon. , [S.l.].

ASSUNÇÃO, J.; GANDOUR, C.; ROCHA, R. Deforestation slowdown in the Brazilian Amazon: prices or policies? **Environment and Development Economics**, [S.l.], v.20, n.06, p.697–722, 2015.

ASSUNÇÃO, J. J. Rural organization and land reform in Brazil: the role of nonagricultural benefits of landholding. **Economic Development and Cultural Change**, [S.l.], v.56, n.4, p.851–870, 2008.

ASSUNCAO, J. J.; GHATAK, M. Can unobserved heterogeneity in farmer ability explain the inverse relationship between farm size and productivity. **Economics Letters**, [S.l.], v.80, n.2, p.189–194, 2003.

ATKINSON, A. B. **Inequality**. [S.l.]: Harvard University Press, 2015.

ATKINSON, A. B.; PIKETTY, T.; SAEZ, E. Top Incomes in the Long Run of History. **Journal of Economic Literature**, [S.l.], v.49, n.1, p.3–71, 2011.

BAHIA SCHLEE, M. Ocupação de encostas urbanas: algumas considerações sobre resiliência e sustentabilidade. **Cadernos Metrópole**, [S.l.], v.15, n.29, 2013.

BARDHAN, P. State and development: the need for a reappraisal of the current literature. **Journal of Economic Literature**, [S.l.], v.54, n.3, p.862–892, 2016.

BARRO, R. J.; LEE, J. W. A new data set of educational attainment in the world, 1950–2010. **Journal of development economics**, [S.l.], v.104, p.184–198, 2013.

BAUM, C. F. et al. Enhanced routines for instrumental variables/GMM estimation and testing. **Stata Journal**, [S.l.], v.7, n.4, p.465–506, 2007.

BECKER, B. K. **Amazônia**. [S.l.]: Editora Ática, 1990. v.192.

BERGER, D. et al. Commercial imperialism? Political influence and trade during the Cold War. **The American Economic Review**, [S.l.], v.103, n.2, p.863–896, 2013.

BESLEY, T.; PERSSON, T. State capacity, conflict, and development. **Econometrica**, [S.l.], v.78, n.1, p.1–34, 2010.

BESLEY, T.; PERSSON, T. **Pillars of prosperity**: the political economics of development clusters. [S.l.]: Princeton University Press, 2011.

BESLEY, T.; PERSSON, T. **Taxation and Development, Handbook of Public Economics Vol. 5**. [S.l.]: Elsevier, Amsterdam. in Alan Auerbach, Raj Chetty, Martin Feldstein, and Emmanuel Saez (eds.), Elsevier, Amsterdam, 2013.

BILLIET, J. Les Electeurs du PSC et du CVP. **Un Parti dans l'histoire: 50 ans d'action du Parti Social Chrétien**, [S.l.], 1996.

BISIN, A.; VERDIER, T. Inequality, redistribution and cultural integration in the Welfare State. **European Journal of Political Economy**, [S.l.], 2017.

BLUNDELL, C. **'Artificial'Land and'Natural'Disaster**: hazard and vulnerability on created urban land. 2011. Tese (Doutorado em Ciência da Computação) — .

BLUNDELL, R.; BOND, S. Initial conditions and moment restrictions in dynamic panel data models. **Journal of econometrics**, [S.l.], v.87, n.1, p.115–143, 1998.

BODET, M. A.; THOMAS, M.; TESSIER, C. Come hell or high water: an investigation of the effects of a natural disaster on a local election. **Electoral Studies**, [S.l.], v.43, p.85–94, 2016.

BORDALO, P.; GENNAIOLI, N.; SHLEIFER, A. Salience Theory of Choice Under Risk. **Quarterly Journal of Economics**, [S.l.], v.127, n.3, p.1243–1285, 2012.

BOUSTAN, L. P.; KAHN, M. E.; RHODE, P. W. Moving to higher ground: migration response to natural disasters in the early twentieth century. **The American Economic Review**, [S.l.], v.102, n.3, p.238–244, 2012.

BRADSHAW, C. J. et al. Global evidence that deforestation amplifies flood risk and severity in the developing world. **Global Change Biology**, [S.l.], v.13, n.11, p.2379–2395, 2007.

BROWN, M. K. Bargaining for social rights: unions and the reemergence of welfare capitalism, 1945-1952. **Political Science Quarterly**, [S.l.], v.112, n.4, p.645–674, 1997.

BURKE, M.; HSIANG, S. M.; MIGUEL, E. Climate and conflict. **Annu. Rev. Econ.**, [S.l.], v.7, n.1, p.577–617, 2015.

CAMPANTE, F. R.; CHOR, D. "The people want the fall of the regime": schooling, political protest, and the economy. **Journal of Comparative Economics**, [S.l.], v.42, n.3, p.495–517, 2014.

CAMPANTE, F. R. et al. Isolated capital cities, accountability, and corruption: evidence from us states. **The American Economic Review**, [S.l.], v.104, n.8, p.2456–2481, 2014.

CARMO, R. L. do; ANAZAWA, T. M. Mortalidade por desastres no Brasil: o que mostram os dados. **Ciência & Saúde Coletiva**, [S.l.], v.19, n.9, p.3669–3681, 2014.

CASTRO, E. Dinâmica socioeconômica e desmatamento na Amazônia. **Novos cadernos NAEA**, [S.l.], v.8, n.2, 2008.

CEPED, U. Atlas brasileiro de desastres naturais 1991 a 2010: volume brasil. **Florianópolis, CEPED UFSC**, [S.l.], 2012.

CEPED/UFSC. **Relatorio dos danos materiais e prejuizos decorrentes de desastres naturais no Brasil**: 1995-2014. [S.l.: s.n.], 2016.

CHANCEL, L.; PIKETTY, T. Carbon and inequality: from kyoto to paris. **Trends in the global inequality of carbone emissions (1998-2013) & Prospects for an equitable adaptation fund. Paris: Paris School of Economics**, [S.l.], 2015.

CHEN, F.-W.; LIU, C.-W. Estimation of the spatial rainfall distribution using inverse distance weighting (IDW) in the middle of Taiwan. **Paddy and Water Environment**, [S.l.], v.10, n.3, p.209–222, 2012.

CHEN, J. Voter partisanship and the effect of distributive spending on political participation. **American Journal of Political Science**, [S.l.], v.57, n.1, p.200–217, 2013.

COLE, S.; HEALY, A.; WERKER, E. Do voters demand responsive governments? Evidence from Indian disaster relief. **Journal of Development Economics**, [S.l.], v.97, n.2, p.167–181, 2012.

CONLEY, J. P.; TEMIMI, A. Endogenous enfranchisement when groups' preferences conflict. **Journal of Political Economy**, [S.l.], v.109, n.1, p.79–102, 2001.

CONLEY, T. G. GMM estimation with cross sectional dependence. **Journal of econometrics**, [S.l.], v.92, n.1, p.1–45, 1999.

CONWAY, M. The Rise and Fall of Western Europe's Democratic Age, 1945–1973. **Contemporary European History**, [S.l.], v.13, n.01, p.67–88, 2004.

COOPERMAN, A. D. **(Un)Natural Disasters**:distributive politics in northeast brazil. 2017.

CURRIE, J. Inequality at Birth: some causes and consequences. **The American Economic Review**, [S.l.], v.101, n.3, p.1–22, 2011.

CURRIE, J.; NEIDELL, M. Air pollution and infant health: what can we learn from california's recent experience? **The Quarterly Journal of Economics**, [S.l.], v.120, n.3, p.1003–1030, 2005.

DAPPLES, F. et al. Paleolimnological evidence for increased landslide activity due to forest clearing and land-use since 3600 cal BP in the western Swiss Alps. **Journal of Paleolimnology**, [S.l.], v.27, n.2, p.239–248, 2002.

DEAN, W. Latifundia and land policy in nineteenth-century Brazil. **The Hispanic American Historical Review**, [S.l.], v.51, n.4, p.606–625, 1971.

DEAN, W. **With broadax and firebrand**: the destruction of the brazilian atlantic forest. [S.l.]: Univ of California Press, 1997.

DEBORTOLI, N. S. et al. An index of Brazil's vulnerability to expected increases in natural flash flooding and landslide disasters in the context of climate change. **Natural Hazards**, [S.l.], p.1–26, 2017.

DIETZ, S.; MARCHIORI, C.; TAVONI, A. Domestic politics and the formation of international environmental agreements. **Grantham Research Institute on Climate Change and the Environment Working Paper**, [S.l.], n.87, 2012.

DILLEY, M. **Natural disaster hotspots**: a global risk analysis. [S.l.]: World Bank Publications, 2005. v.5.

DIMAGGIO, P.; GARIP, F. How network externalities can exacerbate intergroup inequality. **American Journal of Sociology**, [S.l.], v.116, n.6, p.1887–1933, 2011.

DUDZIAK, M. L. **Cold War civil rights**: race and the image of american democracy. [S.l.]: Princeton University Press, 2011.

EASTERLY, W. Inequality does cause underdevelopment: insights from a new instrument. **Journal of Development Economics**, [S.l.], v.84, n.2, p.755–776, 2007.

EISENBERG, C. Working-Class Politics and the Cold War: american intervention in the german labor movement, 1945–49. **Diplomatic History**, [S.l.], v.7, n.4, p.283–306, 1983.

EM-DAT, C. The OFDA/CRED international disaster database. **Université catholique**, [S.l.], 2010.

ENGERMAN, S. L.; SOKOLOFF, K. L. **Factor endowments, inequality, and paths of development among new world economics**. [S.l.]: National Bureau of Economic Research, 2002.

ERIKSSON, L. M. Winds of Change: voter blame and storm gudrun in the 2006 swedish parliamentary election. **Electoral Studies**, [S.l.], v.41, p.129–142, 2016.

FAIR, C. C. et al. Natural Disasters and Political Engagement: evidence from the 2010–11 pakistani floods. , [S.l.], 2017.

FEARNSIDE, P. M. Desmatamento e desenvolvimento agrícola na Amazônia brasileira. **Amazônia: a fronteira agrícola**, [S.l.], v.20, 1992.

FEARNSIDE, P. M. Land-tenure issues as factors in environmental destruction in Brazilian Amazonia: the case of southern pará. **World Development**, [S.l.], v.29, n.8, p.1361–1372, 2001.

FETZER, T. Can workfare programs moderate violence? Evidence from India. , [S.l.], 2014.

FIELD, C. B. **Managing the risks of extreme events and disasters to advance climate change adaptation**: special report of the intergovernmental panel on climate change. [S.l.]: Cambridge University Press, 2012.

FIORINA, M. P. Retrospective voting in American national elections. , [S.l.], 1981.

FRANKEL, B. **The Cold War, 1945-1991**: leaders and other important figures in the united states and western europe. [S.l.]: Gale Cengage, 1992. v.1.

FRANKEL, J. A. **The natural resource curse**: a survey. [S.l.]: National Bureau of Economic Research, 2010.

FREDRIKSSON, P. G. et al. Environmentalism, democracy, and pollution control. **Journal of environmental economics and management**, [S.l.], v.49, n.2, p.343–365, 2005.

FREITAS, C. M. de et al. Natural disasters and health: an analysis of the situation in brazil. **Ciência & Saúde Coletiva**, [S.l.], v.19, n.9, p.3645, 2014.

FRIMAN, M.; STRANDBERG, G. Historical responsibility for climate change: science and the science–policy interface. **Wiley Interdisciplinary Reviews: Climate Change**, [S.l.], v.5, n.3, p.297–316, 2014.

FUCHS, A. **Voter Response to Natural Disaster Aid**: quasi-experimental evidence from drought relief payments in mexico. [S.l.]: The World Bank, 2014.

GALLEGO, J. A. Natural Disasters and Clientelism: the case of floods and landslides in colombia. In: APSA 2012 ANNUAL MEETING PAPER. **Anais...** [S.l.: s.n.], 2012.

GAMALLO, P.; PICHEL, J. R.; ALEGRIA, I. From language identification to language distance. **Physica A: Statistical Mechanics and its Applications**, [S.l.], v.484, p.152–162, 2017.

GENCER, E. A. Natural disasters, urban vulnerability, and risk management: a theoretical overview. In: **The Interplay between Urban Development, Vulnerability, and Risk Management**. [S.l.]: Springer, 2013. p.7–43.

GENTRY, A.; LOPEZ-PARODI, J. Deforestation and increased flooding of the upper Amazon. **Science**, [S.l.], v.210, n.4476, p.1354–1356, 1980.

GILSON, R. J.; ROE, M. J. Lifetime employment: labor peace and the evolution of japanese corporate governance. **Columbia Law Review**, [S.l.], p.508–540, 1999.

GOLDEN, M.; LANGE, P.; MICHAEL, W. **Union Centralization among Advanced Industrial Societies**: an empirical study. [S.l.]: Harvard Dataverse, 2014.

GOLDIN, C.; MARGO, R. A. The Great Compression: the wage structure in the united states at mid-century. **The Quarterly Journal of Economics**, [S.l.], v.107, n.1, p.1–34, 1992.

GOLLIER, C.; TIROLE, J. 10 Effective Institutions against Climate Change. **Global carbon pricing: The path to climate cooperation**, [S.l.], p.165, 2017.

GUIMARÃES, R. M. et al. Análise temporal da relação entre leptospirose e ocorrência de inundações por chuvas no município do Rio de Janeiro, Brasil, 2007-2012. **Ciência & Saúde Coletiva**, [S.l.], v.19, n.9, p.3683–3692, 2014.

GUZZETTI, F. et al. The rainfall intensity–duration control of shallow landslides and debris flows: an update. **Landslides**, [S.l.], v.5, n.1, p.3–17, 2008.

HAAN, J. de; PLENINGER, R.; STURM, J.-E. Does the impact of financial liberalization on income inequality depend on financial development? Some new evidence. **Applied Economics Letters**, [S.l.], p.1–4, 2017.

HAAN, J. de; STURM, J.-E. Finance and income inequality: a review and new evidence. **European Journal of Political Economy**, [S.l.], 2017.

HABLA, W.; WINKLER, R. Political influence on non-cooperative international climate policy. **Journal of Environmental Economics and Management**, [S.l.], v.66, n.2, p.219–234, 2013.

HALLEGATTE, S. et al. **Unbreakable**: building the resilience of the poor in the face of natural disasters. [S.l.]: World Bank Publications, 2016.

HARGRAVE, J.; KIS-KATOS, K. Economic causes of deforestation in the Brazilian Amazon: a panel data analysis for the 2000s. **Environmental and Resource Economics**, [S.l.], p.1–24, 2013.

HEALY, A.; MALHOTRA, N. Myopic voters and natural disaster policy. **American Political Science Review**, [S.l.], v.103, n.03, p.387–406, 2009.

HEALY, A.; MALHOTRA, N. Retrospective voting reconsidered. **Annual Review of Political Science**, [S.l.], v.16, p.285–306, 2013.

HEDIN, A. The origins and myths of the Swedish model of workplace democracy. **Contemporary European History**, [S.l.], v.24, n.1, p.59–82, 2015.

HEDIN, A. Cold war isomorphism: communist regimes and the west european model of worker participation. **European Journal of Cultural and Political Sociology**, [S.l.], v.3, n.2-3, p.201–242, 2016.

HONG, Y.; ADLER, R.; HUFFMAN, G. Use of satellite remote sensing data in the mapping of global landslide susceptibility. **Natural Hazards**, [S.l.], v.43, n.2, p.245–256, 2007.

HSIANG, S. M. Temperatures and cyclones strongly associated with economic production in the Caribbean and Central America. **Proceedings of the National Academy of sciences**, [S.l.], v.107, n.35, p.15367–15372, 2010.

HSIANG, S.; OLIVA, P.; WALKER, R. **The distribution of environmental damages**. [S.l.]: National Bureau of Economic Research, 2017.

IBGE. Aglomerados subnormais: informações territoriais. **Rio de Janeiro: IBGE**, [S.l.], 2010.

IBGE. **Base de informações do Censo Demográfico 2010**: resultados do universo por setor censitário. [S.l.]: IBGE Rio de Janeiro, 2011.

JUNG, Y.-T. THE RISE OF THE COLD WAR AND LABOR MOVEMENTS IN SOUTH KOREA, 1945-1948. **Asian Perspective**, [S.l.], v.13, n.1, p.151–171, 1989.

KAHN, M. E. The death toll from natural disasters: the role of income, geography, and institutions. **Review of economics and statistics**, [S.l.], v.87, n.2, p.271–284, 2005.

KAHN, M. E. Environmental disasters as risk regulation catalysts? The role of Bhopal, Chernobyl, Exxon Valdez, Love Canal, and Three Mile Island in shaping US environmental law. **Journal of Risk and Uncertainty**, [S.l.], v.35, n.1, p.17–43, 2007.

KAMP, U. et al. GIS-based landslide susceptibility mapping for the 2005 Kashmir earthquake region. **Geomorphology**, [S.l.], v.101, n.4, p.631–642, 2008.

KATZ, L. F. et al. Changes in the wage structure and earnings inequality. **Handbook of labor economics**, [S.l.], v.3, p.1463–1555, 1999.

KELLENBERG, D. K.; MOBARAK, A. M. Does rising income increase or decrease damage risk from natural disasters? **Journal of Urban Economics**, [S.l.], v.63, n.3, p.788–802, 2008.

KERSTENETZKY, C. L. **O Estado do Bem-Estar Social na Idade da Razão**. [S.l.]: Campus, 2012.

KIRSHNER, J. Political economy in security studies after the cold war. **Review of International Political Economy**, [S.l.], v.5, n.1, p.64–91, 1998.

KRIEGER, T.; MEIERRIEKS, D. Political capitalism: the interaction between income inequality, economic freedom and democracy. **European Journal of Political Economy**, [S.l.], v.45, p.115–132, 2016.

LEE, T. M. et al. Predictors of public climate change awareness and risk perception around the world. **Nature climate change**, [S.l.], v.5, n.11, p.1014–1020, 2015.

LEHMANN, J.; COUMOU, D.; FRIELER, K. Increased record-breaking precipitation events under global warming. **Climatic Change**, [S.l.], v.132, n.4, p.501–515, 2015.

LIAO, Z. et al. Assessment of shallow landslides from Hurricane Mitch in central America using a physically based model. **Environmental Earth Sciences**, [S.l.], v.66, n.6, p.1697–1705, 2012.

LUCAS, R. E. et al. The industrial revolution: past and future. **Lectures on economic growth**, [S.l.], p.109–188, 2002.

MADSEN, J. B. et al. **Inequality, Financial Development and Economic Growth in the OECD, 1870-2011**. [S.l.]: Monash University, Department of Economics, 2016.

MADSEN, J. B.; WANG, C.; STEINER, B. The creation of effective states in the OECD since 1870: the role of inequality. **European Journal of Political Economy**, [S.l.], 2017.

MAIER, C. S. The World Economy and the Cold War in the Middle of the 20th Century. **Leffler and Wested, eds**, [S.l.], p.64, 2010.

MALHOTRA, N.; KUO, A. G. Attributing blame: the public's response to hurricane katrina. **The Journal of Politics**, [S.l.], v.70, n.01, p.120–135, 2008.

MARCHAND, S. The colonial origins of deforestation: an institutional analysis. **Environment and Development Economics**, [S.l.], v.21, n.03, p.318–349, 2016.

MARGULIS, S. **Causes of deforestation of the Brazilian Amazon**. [S.l.]: World Bank Publications, 2004. v.22.

MARSHALL, M. G.; JAGGERS, K.; GURR, T. R. Dataset Users' Manual. Polity IV Project. **Center for Systemic Peace**, [S.l.], 2011.

MILANOVIC, B. **Global inequality**: a new approach for the age of globalization. [S.l.]: Harvard University Press, 2016.

MILLNER, A.; DIETZ, S.; HEAL, G. Scientific ambiguity and climate policy. **Environmental and Resource Economics**, [S.l.], p.1–26, 2013.

MILLNER, A.; OLLIVIER, H. Beliefs, politics, and environmental policy. **Review of Environmental Economics and Policy**, [S.l.], v.10, n.2, p.226–244, 2016.

MIRON-SHATZ, T.; STONE, A.; KAHNEMAN, D. Memories of yesterday‘s emotions: does the valence of experience affect the memory-experience gap? **Emotion**, [S.l.], v.9, n.6, p.885, 2009.

MONTEIRO, J.; ROCHA, R. Drug battles and school achievement: evidence from rio de janeiro's favelas. **Review of Economics and Statistics**, [S.l.], v.99, n.2, p.213–228, 2017.

NARITOMI, J.; SOARES, R. R.; ASSUNÇÃO, J. J. Institutional development and colonial heritage within Brazil. **The journal of economic history**, [S.l.], v.72, n.02, p.393–422, 2012.

NICKELL, S. Biases in dynamic models with fixed effects. **Econometrica: Journal of the Econometric Society**, [S.l.], p.1417–1426, 1981.

NOBRE, A. D. O futuro climático da Amazônia. **Relatório de avaliação científica. Disponível em:< http://www. socioambiental. org/sites/blog. socioambiental. org/files/futuro-climatico-daamazonia. pdf>. Acesso em**, [S.l.], v.31, 2014.

NOY, I. A Global Comprehensive Measure of the Impact of Natural Hazards and Disasters. **Global Policy**, [S.l.], 2015.

OBINGER, H.; LEE, S. The Cold War and the welfare state in divided Korea and Germany. **Journal of International and Comparative Social Policy**, [S.l.], v.29, n.3, p.258–275, 2013.

OBINGER, H.; SCHMITT, C. Guns and butter? Regime competition and the welfare state during the Cold War. **World Politics**, [S.l.], v.63, n.2, p.246–270, 2011.

OBREGON, G.; MARENGO, J. Caracterização do clima do século XX no Brasil: tendências de chuvas e temperaturas médias e extremas. **Brasília: MMA/CPTEC/INPE. Relatório no**, [S.l.], v.2, 2007.

OLIVEIRA, N. S. de et al. Correlation between rainfall and landslides in Nova Friburgo, Rio de Janeiro—Brazil: a case study. **Environmental Earth Sciences**, [S.l.], v.75, n.20, p.1358, 2016.

PACHECO, P. Agrarian reform in the Brazilian Amazon: its implications for land distribution and deforestation. **World Development**, [S.l.], v.37, n.8, p.1337–1347, 2009.

PAULAIS, T. **Urban Risk Assessments**: an approach for understanding disaster and climate risk in cities. [S.l.]: World Bank Publications, 2012.

PAUW, P. et al. **Different perspectives on differentiated responsibilities**: a state-of-the-art review of the notion of common but differentiated responsibilities in international negotiations. [S.l.: s.n.], 2014.

PAVAO, N. **The failures of electoral accountability for corruption**: brazil and beyond. 2015. Tese (Doutorado em Ciência da Computação) — University of Notre Dame.

PEREIRA, C. A. R. et al. Avaliação econômica dos casos de Dengue atribuídos ao desastre de 2011 em Nova Friburgo (RJ), Brasil. , [S.l.], 2014.

PERSSON, T.; BESLEY, T. The Origins of State Capacity: property rights, taxation, and politics. **American Economic Review, September**, [S.l.], v.99, n.4, p.1218–44, 2009.

PHILIPPON, T.; RESHEF, A. Wages and human capital in the US finance industry: 1909–2006. **The Quarterly Journal of Economics**, [S.l.], v.127, n.4, p.1551–1609, 2012.

PIKETTY, T. **Capital in the twenty-first century**. [S.l.]: Harvard University Press, 2014.

PIKETTY, T.; SAEZ, E.; STANTCHEVA, S. Optimal Taxation of Top Labor Incomes: a tale of three elasticities. **American Economic Journal: Economic Policy**, [S.l.], v.6, n.1, p.230–271, 2014.

PONTUSSON, J.; RUEDA, D. The politics of inequality: voter mobilization and left parties in advanced industrial states. **Comparative Political Studies**, [S.l.], v.43, n.6, p.675–705, 2010.

PRZEWORSKI, A. Conquered or granted? A history of suffrage extensions. **British Journal of Political Science**, [S.l.], v.39, n.02, p.291–321, 2009.

RICHARDS, P. D.; WALKER, R. T.; ARIMA, E. Y. Spatially complex land change: the indirect effect of brazil's agricultural sector on land use in amazonia. **Global Environmental Change**, [S.l.], v.29, p.1–9, 2014.

RODRIK, D. When Ideas Trump Interests: preferences, worldviews, and policy innovations. **Journal of Economic Perspectives**, [S.l.], v.28, n.1, p.189–208, 2014.

ROEBELING, P. C.; HENDRIX, E. M. Land speculation and interest rate subsidies as a cause of deforestation: the role of cattle ranching in costa rica. **Land Use Policy**, [S.l.], v.27, n.2, p.489–496, 2010.

ROINE, J.; VLACHOS, J.; WALDENSTRÖM, D. The long-run determinants of inequality: what can we learn from top income data? **Journal of Public Economics**, [S.l.], v.93, n.7, p.974–988, 2009.

ROODMAN, D. How to do xtabond2: an introduction to 'difference'and 'system. In: GMM IN STATA', CENTER FOR GLOBAL DEVELOPMENT WORKING PAPER NO. 103. **Anais...** [S.l.: s.n.], 2006.

SANDERSON, E.; WINDMEIJER, F. A weak instrument F-test in linear IV models with multiple endogenous variables. **Journal of Econometrics**, [S.l.], v.190, n.2, p.212–221, 2016.

SANT'ANNA, A.; YOUNG, C. et al. Property rights, deforestation and rural conflicts in Amazonia. **Economia Aplicada**, [S.l.], v.14, n.3, p.381–393, 2010.

SCHÄFFER, W. B. et al. **Áreas de Preservação Permanente e Unidades de Conservação x Áreas de Risco. O que uma Coisa Tem a Ver com a Outra? Relatório de Inspeção da Área Atingida pela Tragédia das Chuvas na Região Serrana do Rio de Janeiro. Série Biodiversidade, 41. Brasília**. 2013.

SCHEIDEL, W. **The great leveler**: violence and the history of inequality from the stone age to the twenty-first century. [S.l.]: Princeton University Press, 2017.

SCHEVE, K.; STASAVAGE, D. Institutions, partisanship, and inequality in the long run. **World Politics**, [S.l.], v.61, n.02, p.215–253, 2009.

SCHEVE, K.; STASAVAGE, D. Democracy, war, and wealth: lessons from two centuries of inheritance taxation. **American Political Science Review**, [S.l.], v.106, n.01, p.81–102, 2012.

SCHEVE, K.; STASAVAGE, D. **Taxing the rich**: a history of fiscal fairness in the united states and europe. [S.l.]: Princeton University Press, 2016.

SCHNEIDER, R. R. **Government and the Economy on the Amazon Frontier**. [S.l.]: World Bank Publications, 1995. v.11.

SCHRECKER, E. **Many are the crimes**: mccarthyism in america. [S.l.]: Princeton University Press Princeton, 1998. v.166.

SCHWARTZ, R. A. The Cold War Reference Guide. **Jefferson, NC: McFarland**, [S.l.], v.472, p.1964–1998, 1997.

SENEVIRATNE, S. I. et al. Changes in climate extremes and their impacts on the natural physical environment. **Managing the risks of extreme events and disasters to advance climate change adaptation**, [S.l.], p.109–230, 2012.

SILVER, B. J.; ARRIGHI, G.; DUBOFSKY, M. **Labor Unrest in the World-economy, 1870-1990**. [S.l.]: Fernand Braudel Center for the Study of Economies, Historical Systems, and Civilizations, 1995.

SIMMONS, C. S. Territorializing land conflict: space, place, and contentious politics in the brazilian amazon. **GeoJournal**, [S.l.], v.64, n.4, p.307–317, 2005.

SINCLAIR, B.; HALL, T. E.; ALVAREZ, R. M. Flooding the vote: hurricane katrina and voter participation in new orleans. **American politics research**, [S.l.], v.39, n.5, p.921–957, 2011.

SMYTH, C. G.; ROYLE, S. A. Urban landslide hazards: incidence and causative factors in niteroi, rio de janeiro state, brazil. **Applied Geography**, [S.l.], v.20, n.2, p.95–118, 2000.

SOLT, F. The standardized world income inequality database. **Social science quarterly**, [S.l.], v.97, n.5, p.1267–1281, 2016.

SOUSA, F. Lage de. Does crime affect migration flows? **Papers in Regional Science**, [S.l.], v.93, n.S1, p.S99–S111, 2014.

SPENCE, A. et al. Perceptions of climate change and willingness to save energy related to flood experience. **Nature climate change**, [S.l.], v.1, n.1, p.46–49, 2011.

STANLEY, T.; KIRSCHBAUM, D. B. A heuristic approach to global landslide susceptibility mapping. **Natural Hazards**, [S.l.], v.87, n.1, p.145–164, 2017.

STERNER, T.; PERSSON, U. M. An even sterner review: introducing relative prices into the discounting debate. **Review of Environmental Economics and Policy**, [S.l.], v.2, n.1, p.61–76, 2008.

STIGLITZ, J. E. **Reconstructing Macroeconomic Theory to Manage Economic Policy**. [S.l.]: National Bureau of Economic Research, 2014.

STURM, J.-E.; DE HAAN, J. Income inequality, capitalism, and ethno-linguistic fractionalization. **The American Economic Review**, [S.l.], v.105, n.5, p.593–597, 2015.

SUZUKI, A. The changing relationship between labor unions and civil society organizations in postwar Japan. **Development and Society**, [S.l.], v.44, n.2, p.219, 2015.

TAKASAKI, Y. et al. **Wealth accumulation and activity choice evolution among Amazonian forest peasant households**. [S.l.]: Wisconsin-Madison Agricultural and Applied Economics Department, 2000.

TIMMER, M. P. et al. Slicing up global value chains. **The Journal of Economic Perspectives**, [S.l.], v.28, n.2, p.99–118, 2014.

TIROLE, J. Some political economy of global warming. **Economics of Energy & Environmental Policy**, [S.l.], v.1, n.1, 2012.

TIROLE, J. **Economics for the Common Good**. [S.l.]: Princeton University Press, 2017.

TOLE, L. A quantitative investigation of the population-land inequality-land clearance nexus. **Population and Environment**, [S.l.], v.26, n.2, p.75–106, 2004.

TOMINAGA, L. K.; SANTORO, J.; AMARAL, R. do. **Desastres naturais**: conhecer para prevenir. [S.l.]: Instituto Geológico, 2009.

VAN WESTEN, C. J.; CASTELLANOS, E.; KURIAKOSE, S. L. Spatial data for landslide susceptibility, hazard, and vulnerability assessment: an overview. **Engineering geology**, [S.l.], v.102, n.3, p.112–131, 2008.

VASANTHA KUMAR, S.; BHAGAVANULU, D. V. Effect of deforestation on landslides in Nilgiris district—A case study. **Journal of the Indian Society of Remote Sensing**, [S.l.], v.36, n.1, p.105–108, 2008.

WALKER, R.; HOMMA, A. K. O. Land use and land cover dynamics in the Brazilian Amazon: an overview. **Ecological Economics**, [S.l.], v.18, n.1, p.67–80, 1996.

WEGS, J. R. **Europe since 1945**: a concise history. [S.l.]: Springer, 1991.

WHYTE, J. H. **Catholics in Western democracies**: a study in political behaviour. [S.l.]: Gill and Macmillan, 1981.

WINDMEIJER, F. A finite sample correction for the variance of linear efficient two-step GMM estimators. **Journal of econometrics**, [S.l.], v.126, n.1, p.25–51, 2005.

World Bank. Avaliação de perdas e danos: inundações e deslizamentos na região serrana do rio de janeiro-janeiro de 2011. **Relatório elaborado pelo Banco Mundial com apoio do Governo do Estado do Rio de Janeiro. Brasília**, [S.l.], 2012.

World Bank and United Nations . **Natural hazards, unnatural disasters**: the economics of effective prevention. [S.l.]: The World Bank, 2010.

YOUNG, C. E. F. **Economic adjustment policies and the environment**: a case study of brazil. [S.l.]: University of London, 1997.

YOUNG, C.; NEVES, A. Destroying the myth: deforestation, rural employment and human development in the brazilian atlantic forest. In: IV CONGRESO DE LA ASOCIACIÓN LATINOAMERICANA Y DEL CARIBE DE ECONOMISTAS AMBIENTALES Y DE RECURSOS NATURALES. **Anais...** [S.l.: s.n.], 2009.

ZIVIN, J. G.; NEIDELL, M. Environment, health, and human capital. **Journal of Economic Literature**, [S.l.], v.51, n.3, p.689–730, 2013.