Essays in Public Economics and Political Economy

Sarah Brockhoff

Freiburg im Breisgau, 2012
Essays in Public Economics and Political Economy

Sarah Brockhoff

Freiburg, im August 2012
Erstgutachter: Prof. Dr. Wolfgang Eggert
Zweitgutachter: Prof. Dr. Dieter K. Tscheulin
Dekan der Fakultät: Prof. Dr. Dieter K. Tscheulin
Datum des Promotionsbeschlusses: 10. Januar 2013
Preliminary Statement

According to Art. 7, para. 3 of the Doctoral Degree Regulations of the Faculty of Economics and Behavioral Science (as of October 2004) and the Modified Regulations (as of November 2006), University of Freiburg, this thesis is handed in as a cumulative dissertation. It consists of four stand-alone papers (Chapters 2–5) and an introduction to the common theoretical basis (Chapter 1, Sections 1.1, 1.2 and 1.5). In addition, each paper’s specific background information, the contribution to the literature, the main results and some ideas for future research avenues will be introduced (Chapter 1, Sections 1.3, 1.4, 1.6 and 1.7).

The papers belong to the literature in public economics and political economy. They are the results from (almost) four years of work as a doctoral student at Bielefeld University, the Université Paris 1, Panthéon–Sorbonne and the University of Freiburg, under the supervision of Professor Dr. Wolfgang Eggert (Institute for Public Finance II, University of Freiburg).
Acknowledgments

First of all, I would like to thank my scientific advisors Professor Dr. Wolfgang Eggert and Professor Dr. Tim Krieger for promoting my research, giving me a substantial degree of freedom and supporting me in many ways. I am also indebted to Emmanuelle Taugourdeau and Stéphane Rossignol, Sonja Brangewitz and Daniel Meierrieks for the intensive work on our joint projects, which I have always enjoyed. I have much benefited from the discussions with Professor Dr. Claus-Jochen Haake and Professor Dr. Jun-Ichi Itaya.

Then, I would like to thank the Bielefeld Graduate School of Economics and Management (BiGSEM), in particular Professor Dr. Herbert Dawid, Professor Dr. Volker Böhm and Dr. Ulrike Haake, for the possibility to take part in the doctoral study program in Bielefeld and for being member of the international research group “Economic Behavior and Interaction Models” (EBIM) during my time in Paris. This stay was financially supported by the German Academic Exchange Service, which is gratefully acknowledged, as well.

I thank my BiGSEM fellow students, especially Wencke Böhm, Dennis Heitmann and Jochen Manegold as well as my colleagues Steffen Minter, Handirk von Ungern-Sternberg and Günther König for the life inside but also outside university.

Finally, I want to thank my whole family for their support.
Contents

Summary ix

1. General Introduction 1
   1.1. Motivation and Outline ........................................... 1
   1.2. Repeated Interaction, Multiple Equilibria and Further Dynamics Explaining Conflict and Cooperation .................. 4
   1.3. The Three Worlds of Welfare Capitalism Revisited .................. 13
      1.3.1. Background .................................................. 13
      1.3.2. Contribution .................................................. 15
      1.3.3. Elaboration on the topic ................................... 16
      1.3.4. Conclusion .................................................. 18
   1.4. Stability of Coalitional Equilibria within Repeated Tax Competition .................................................. 19
      1.4.1. Background .................................................. 19
      1.4.2. Contribution .................................................. 20
      1.4.3. Elaboration on the topic ................................... 21
      1.4.4. Conclusion .................................................. 24
   1.5. The Strategy of Terror—Elaboration on the Topic .................. 25
      1.6.1. Background .................................................. 27
      1.6.2. Contribution .................................................. 28
      1.6.3. Conclusion .................................................. 30
   1.7. Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism .................. 31
      1.7.1. Background .................................................. 31
      1.7.2. Contribution .................................................. 32
      1.7.3. Conclusion .................................................. 33
   Bibliography .............................................................. 34

2. The Three Worlds of Welfare Capitalism Revisited 40
   2.1. Introduction .......................................................... 40
   2.2. The Model ............................................................ 44
      2.2.1. Distributions of income and risk ................................ 44
      2.2.2. Empirical evidence ........................................... 45
      2.2.3. The three systems ............................................ 46
   2.3. Majority Voting .......................................................... 48
      2.3.1. Choice of tax rate ............................................ 48
      2.3.2. Individual preferences on the system ......................... 49
      2.3.3. Choice of the system under majority voting ................ 54
2.4. Utilitarian Criterion ................................................. 58
  2.4.1. Choice of tax rate ............................................. 58
  2.4.2. Choice of the system ......................................... 59
  2.4.3. Do the positive results meet the normative recommendations? .... 60
2.5. Conclusion ......................................................... 61
Bibliography ............................................................ 63
Appendix .................................................................. 65
  2.A. Proof of Proposition 2.2 .......................................... 65
  2.B. Proof of Proposition 2.3 .......................................... 65
  2.C. Proof of Proposition 2.4 .......................................... 66
  2.D. Proof of Proposition 2.6 .......................................... 67

3. Stability of Coalitional Equilibria within Repeated Tax Competition 69
  3.1. Introduction .......................................................... 69
  3.2. The Tax Competition Model ..................................... 72
  3.3. Cooperative Behavior .............................................. 74
  3.4. Dynamic Stability of Cooperation ............................... 78
    3.4.1. The setting ..................................................... 78
    3.4.2. Cooperation and punishment tax revenues .................. 81
    3.4.3. Deviation tax rates and tax revenues ....................... 82
    3.4.4. The discount factor ........................................... 85
    3.4.5. Welfare maximization ......................................... 90
  3.5. Numerical Example ................................................ 90
    3.5.1. Equilibrium tax rates and tax revenues for five regions .... 90
    3.5.2. A repeated game with five regions ......................... 92
  3.6. Conclusion .......................................................... 93
Bibliography ............................................................ 95
Appendix .................................................................. 98
  3.A. Optimal tax rates with coalition structures ..................... 98
  3.B. Optimal tax rate and revenue under deviating behavior ......... 99
  3.C. Computation of the minimum discount factor ................. 101
  3.D. Maximizing welfare ............................................... 102
    3.D.2. Repeated interaction ......................................... 104
    3.D.3. A numerical example for five regions ...................... 105

  4.1. Introduction .......................................................... 107
  4.2. Left-Wing and Nationalist-Separatist Terrorism in Western Europe .... 110
  4.3. The Social Origins of Left-Wing and Nationalist-Separatist Terrorism: Literature Review and Hypotheses ............... 113
    4.3.1. Socio-economic conditions .................................... 113
    4.3.2. Domestic political factors .................................... 115
    4.3.3. Politico-historic factors ...................................... 117
    4.3.4. Demographic conditions ...................................... 118
  4.4. Empirical Methodology and Results ............................. 119
5. Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism

5.1. Introduction .......................................................... 144
5.2. The Terrorism-Education Nexus: Literature Review and Hypotheses ............... 146
  5.2.1. Great expectations: Why education should reduce terrorism ................. 146
  5.2.2. Education during good and hard times: An alternative view.................. 148
5.3. Data and Methodology .............................................. 151
  5.3.1. Dependent variable: Domestic terrorism ........................................... 151
  5.3.2. Education variables .................................................. 152
  5.3.3. Controls .................................................................... 153
  5.3.4. Empirical methodology .................................................. 155
5.4. Empirical Results ....................................................... 155
  5.4.1. Full sample findings ..................................................... 155
  5.4.2. Cluster analysis ......................................................... 156
  5.4.3. Results for a subsample of less developed countries ......................... 157
  5.4.4. Results for a subsample of developed countries ............................... 157
5.5. Robustness and Extensions ............................................ 158
  5.5.1. Reverse causality and endogeneity ................................................. 159
  5.5.2. Alternative dependent variables ................................................. 159
  5.5.3. Alternative estimation techniques ................................................. 160
  5.5.4. Long-run effects of education on terrorism ..................................... 160
  5.5.5. Education expansion and terrorism .............................................. 161
  5.5.6. Transmission channels ...................................................... 161
5.6. Conclusion .............................................................. 161
Bibliography ................................................................. 164
5.7. Tables, Appendices and Supplements ....................................... 168
Summary

This thesis consists of four stand-alone essays.

The first two papers belong to the literature in public economics and provide theoretical foundations for the following research questions:

[I] Accounting for a more precise way to model a Bismarckian type of social insurance system, which out of three archetypes of systems is chosen when the tax rate and the redistributive character are determined with majority voting and/or a utilitarian social planner? (Chapter 2)

[II] Is it possible to implicitly sustain cooperation between sovereign regions within coalition structures in a repeated interaction model of tax competition? (Chapter 3)

The last two papers have an economic perspective on specific political conflicts and give empirical evidence for the following questions:

[III] Accounting for the heterogeneity of terrorist groups, what are the mutual and distinct social origins of politically motivated left-wing terrorism and ethnically motivated nationalist-separatist terrorism? (Chapter 4)

[IV] What is the exact role of education in domestic terrorism? Does education help to reduce, or does it increase terrorist incidents? (Chapter 5)

Chapter 2: The Three Worlds of Welfare Capitalism Revisited

Joint work with Stéphane Rossignol and Emmanuelle Taugourdeau.
Available as Documents de Travail du Centre d’Economie de la Sorbonne No. 2012.18, March 2012, Université Paris 1, Panthéon–Sorbonne.
Summary

**Abstract.** This paper introduces a new way to model the Bismarckian social insurance system, stressing its corporatist dimension. Comparing the Beveridgean, Bismarckian and Liberal systems according to the majority voting rule, we show that for a given distribution of risks inside society, the Liberal system wins if the inequality of income is low, and the Beveridgean system wins if the inequality of income is high. Using a utilitarian criterion, the Beveridgean system always dominates and the Bismarckian system is preferred to the Liberal one.

**Chapter 3: The Stability of Coalitional Equilibria in Repeated Tax Competition**

Joint work with Sonja Brangewitz.
This chapter is based on a slightly modified version of: Institute of Mathematical Economics Working Paper No. 461, February 2012, Bielefeld University.

**Abstract.** This paper analyzes the stability of capital tax harmonization agreements in a stylized model where countries have formed coalitions which set a common tax rate in order to avoid the inefficient non-cooperative Nash equilibrium. In particular, for a given coalition structure we study to what extent the stability of tax agreements is affected by the coalitions that were formed. In our set-up, countries are symmetric, but coalitions can be of arbitrary size. We analyze stability by means of a repeated game setting, employing simple trigger strategies and we allow a sub-coalition to deviate from the coalitional equilibrium. For a given form of punishment we are able to rank the stability of different coalition structures as long as the size of the largest coalition does not change. Our main results are: (1) singleton regions have the largest incentives to deviate, (2) the stability of cooperation depends on the degree of cooperative behavior ex-ante.

**Chapter 4: Looking Back on Anger: Explaining the Social Origins of Left-Wing and Nationalist-Separatist Terrorism in Western Europe, 1970–2007**

Joint work with Tim Krieger and Daniel Meierries.

**Abstract.** A unique dataset is used to separately analyze the social origins of left-wing and nationalist-separatist terrorism in 17 Western European countries between 1970 and 2007. We argue that the differences in the historic roots, ultimate goals as well as their negotiability, levels of domestic and international support, and politico-military strategies of these types of ideologically or ethnically motivated terrorism make it plausible that they respond differently to specific social conditions. We show that there are indeed factors that matter
either to left-wing (e.g., the Cold War, leftist party strength) or nationalist-separatist terrorism (e.g., ethnic polarization, non-violent protest). However, both types of terrorism are solidly associated with larger populations and higher unemployment rates. This suggests that both may be ameliorated through social progress, even though ethnic terrorism seems to respond more strongly to socio-economic and political incentives (e.g., economic progress, political participation). Finally, we show that a ‘pooling’ of terrorism data—which disregards motivational bonds, but is nevertheless common in empirical analyses—may mask the role of otherwise relevant terrorism correlates within distinct types of terrorism.

Chapter 5: Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism

Joint work with Tim Krieger and Daniel Meierrieks.

Abstract. This contribution investigates the role of education in domestic terrorism for 133 countries between 1984 and 2007. The findings point at a nontrivial effect of education on terrorism. Lower education (primary education) tends to promote terrorism in a cluster of countries where the socio-economic, political and demographic conditions are unfavorable, while higher education (university education) reduces terrorism in a cluster of countries where conditions are more favorable. This suggests that country-specific circumstances mediate the effect of education on the (opportunity) costs and benefits of terrorism. For instance, the prevalence of poor structural conditions in combination with advances in education may explain past and present waves of terrorism and political instability in the Middle East. The results of this study imply that promoting education needs to be accompanied by sound structural change so that it can positively interact with (individual and social) development, thereby reducing terrorism.
1. General Introduction

1.1. Motivation and Outline

The common basis for the papers in this dissertation is the study of specific problems of cooperation and conflict in the fields of public economics and political economy. In this sense, we analyze distinct applications of the non-cooperative branch of game theory which are related to these two fundamental problem structures, regarding agents who act in their pure self-interest in various environments. Hereby, we employ both theoretical and applied econometric concepts.

The contributions in the first part of this dissertation are both theoretical models. They focus on the impact and the sustainability of cooperative agreements. We begin with a static, two-stage model studying a classical subject of analysis in public economics: social insurance. We provide a model that explains on what specific type of social insurance system a society with heterogenous agents coordinates. This model can be seen as a building block in the analysis of the “socio-political contract” in terms of the sustainability of its multidimensional redistributive elements because it deals with the notion of cooperation in form of different degrees of solidarity between agents. The paper offers positive and normative theoretical insights for the choice of different types of insurance systems and underlines the importance of the distribution of risk in society. The second paper refers again to a well established subject of analysis in public economics. It presents model of tax competition with repeated interaction where we introduce coalition structures in a general form. The focus of the analysis is on the sustainability of cooperation in these very coalition structures in the absence of an international authority enforcing such cooperative behavior among sovereign governments. This stylized model provides a partial ordering for the stability of different coalition structures.

The contributions in the second part change the methodology and employ econometric techniques. They study specific determinants in political conflicts, in particular, terrorism from an economic perspective. The focus of the third paper is on the question whether different types of terrorism are affected by likewise distinct or common factors. The fourth paper reassesses the impact of education on terrorist activity. To put it briefly, we ask whether different levels of education mark the beginning or the end of terrorism. As will be explained,
terrorism is a form of asymmetric and violent conflict that pursues defined, political goals. Basically, it can be interpreted as an interest-group activity to influence government decisions to achieve, e.g., political grants or territorial concessions (cf. Congleton, 2002, p. 48). In this respect terrorists try to challenge established property rights by seeking to induce changes in political power and control.

Besides introducing background information and the specific contribution, the purpose of this chapter is twofold: First, it serves to provide a basis of discussion of the theory which can be applied to a manifold of interesting problems related to the dichotomy of conflict and cooperation. Second, this chapter establishes a relation between the underlying theoretical construct and the research questions analyzed in the papers of this dissertation.

With regard to the underlying theoretical framework, we will emphasize a selection of dynamic arguments. They basically reflect the idea that economic activities and processes in society need to stabilize in the long-run to create sustainable social conventions. The thesis I defend is that many of these contracts are available as equilibria in the societal processes analyzed, ranging from less to more cooperative outcomes. But very much to the same extent that natural and cultural circumstances impose bounds on the feasibility of contracts ex-ante, developments and new conditions lead to a pressure of reform for once established conventions ex-post. This has obvious implications also in a political dimension because sustaining and reforming conventions requires an understanding of the economic mechanisms which have led to these in the first place.

This view also bears consequences relating to the enforcement of social conventions by authorities. Rational agents need to have incentives to follow these conventions on their own, which means that outcomes can only be stable if they are self-enforcing, that is, if they are equilibria. In this respect, self-enforcing agreements or, more generally, implicit contracts constitute a central theoretical element in explaining sustainable forms of cooperation between otherwise selfish and opportunistic type of economic agents.

As regards to the theoretical basis, a general framework to study the logic of self-enforcing agreements are repeated games. The unifying theme of the literature employing repeated interactions is the creation of incentives that do not exist if one were to examine interaction in isolation (cf. Mailath and Samuelson, 2006, p. 8). The relevance of this theory regarding the general theme of conflict and cooperation is put into perspective by Aumann (2005, p. 352):

“The theory of repeated games is able to account for phenomena such as altruism, cooperation, trust, loyalty, revenge, threats (self-destructive or otherwise)—phenomena that may at first seem irrational—in terms of the ‘selfish’ utility-maximizing paradigm of game theory and neoclassical economics. That it ‘ac-
counts’ for such phenomena does not mean that people deliberately choose to take revenge, or to act generously, out of consciously self-serving, rational motives. Rather, over the millennia, people have evolved norms of behavior that are by and large successful, indeed optimal.”

Games in which evolutionary dynamics—as indicated by Robert J. Aumann—have an implication are situations where agents interact repeatedly but in which they adjust their behavior over time in rejecting strategies that turn out to be unsuccessful in favor of strategies that do well in a specific environment (cf. Samuelson, 1997, p. 15). That is, depending on the underlying structure of the game, the more or less cooperative behavior turns out to be relatively favorable and hence adopted to establish outcomes which are again in the very self-interest of agents.

An essential point in situations of conflict is that agents can improve their status quo by essentially playing non-cooperatively, even aggressively, against an opponent. The environments of such games or contests may be very abstractly characterized by the condition that property rights over resources cannot be perfectly (or costlessly) enforced by a third party. Turning to conflict is then a way to achieve redistribution of power, control and wealth in the long run (cf. Garfinkel and Skaperdas, 2007). In a non-cooperative and selfishly acting environment, one may ask then for the economic forces that induce rational agents, facing a choice between cooperative (e.g. productive) and non-cooperative (e.g. aggressive and appropriative) strategies, to implicitly sustain property rights over resources on their own.

This dissertation is organized as follows: In this first Chapter, I will introduce theoretical foundations for the emergence of cooperation and the rationale for conflicts (Section 1.2), and elaborate on the specific phenomenon of terrorism (Section 1.5). The emphasis will be on the theories just described, which also relate to my motivation studying distinct applications. Hereafter, in Sections 1.3, 1.4, 1.6 and 1.7, I will establish the relation to the theoretical basis and give a more in-depth summary of each paper’s specific background, the model, the results and ideas for future research avenues. The complete papers follow in Chapters 2–5.
Many aspects of organizing social life are the result of social conventions, which govern the choice of specific equilibria in various societal interaction processes. The dimension of these coordination processes is found on different scales but their impact is always decisive: They affect institutional outcomes via political processes in a likewise manner as they affect the choice of specific behavior strategies on the individual level. Our interests refer not only to the observation of a particular outcome: We are interested in the conditions that drive individual incentives and finally lead to one particular outcome and/or behavior, in various applications. However, before we turn to the applications, we begin with characterizing equilibria to be more precise about what outcomes are feasible and stable.

The overall picture is that social conventions can be regarded as the end of an equilibrium selection process. In a static world, the availability of stable social conventions is first of all determined by the underlying problem structure. So the question whether “cooperative” or “non-cooperative” behavior is equilibrium play depends on the incentives which agents, acting in their pure self-interest, face. As we analyze different applications, and hence different economic mechanisms, we start bottom-up with three simple games to illustrate the very elementary incentives at work.\(^1\) We introduce more advanced theories hereafter.\(^2\)

**Example 1: A Game of Coordination.** A game of pure coordination is the “Driving Game”.\(^3\) It has two players who simultaneously choose strategies “Left” or “Right”. The payoffs are given in the following matrix.

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>(1^<em>, 1^</em>)</td>
<td>(-1, -1)</td>
</tr>
<tr>
<td>Right</td>
<td>(-1, -1)</td>
<td>(1^<em>, 1^</em>)</td>
</tr>
</tbody>
</table>

The Driving Game.

The static game has two Nash equilibria in pure strategies referring to the outcomes that both players choose either “Left” or “Right” (in addition, there is a Nash equilibrium in mixed strategies). That is, the best reply of player 1 is to choose the same strategy as player 2 and vice versa. Which specific equilibrium will be selected from the set of available

\(^1\)We study non-cooperative games where cooperation can only unfold if it is in the player’s best interest. This is in contrast to cooperative game theory, where one basic characteristic is the ability of players to write binding agreements.

\(^2\)The following examples refer to Binmore (2005, ch. 4.3).

\(^3\)The strategies refer to the side of the street where players drive with their vehicles.
equilibria is thus a question of social convention, which we already raised. But any Nash equilibrium in pure strategies, once established, is a stable convention that every rational player will accept.

**Example 2: A Game of Conflict.** A different problem structure ("Matching Pennies") refers to two players who simultaneously choose strategies "Heads" or "Tails" and the payoffs are as follows.⁴

<table>
<thead>
<tr>
<th></th>
<th>Heads</th>
<th>Tails</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heads</td>
<td>(1^*, -1)</td>
<td>(-1, 1^*)</td>
</tr>
<tr>
<td>Tails</td>
<td>(-1, 1^*)</td>
<td>(1^*, -1)</td>
</tr>
</tbody>
</table>

The Matching Pennies.

This game belongs to the class of zero-sum games and is characterized by antagonistic interests, in other words, pure conflict. There exist no Nash equilibria in pure strategies, and so there is no way that any pair of pure strategies constitute a stable outcome. Instead, making the own choice unpredictable by choosing each strategy with probability \(1/2\) is the best response for every player, and this is the only Nash equilibrium available.

So while the first example supports cooperation of rational players in form of choosing the same strategy as Nash equilibrium (abstracting from mixed strategies, again), the second example’s only stable convention is conflict: Rational players randomize over strategies because each player’s gain comes at the other player’s expense. In both cases, there is no room for Pareto-improvement because the equilibrium outcomes are all efficient. This is in contrast to the third type of problem structure, which is of particular relevance in the following.

**Example 3: A Game without Cooperation.** The "Prisoners’ Dilemma" has two players who choose strategies "Dove" or "Hawk", representing broad forms of cooperative and aggressive/defective behavior.

<table>
<thead>
<tr>
<th></th>
<th>Dove</th>
<th>Hawk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dove</td>
<td>(2, 2)</td>
<td>(0, 3^*)</td>
</tr>
<tr>
<td>Hawk</td>
<td>(3^*, 0)</td>
<td>(1^<em>, 1^</em>)</td>
</tr>
</tbody>
</table>

The Prisoners’ Dilemma.

⁴Both players toss a coin. Player 1 wins if both coins show either “Heads” or “Tails”, player 2 wins if the outcomes of both coins differ.
Rational players choose both the strategy pair “Hawk” which is the only Nash equilibrium of the game. This social convention is a problem of cooperation: It is in no player’s best interest to choose the strategy “Dove”, which would lead to a Pareto-superior, “cooperative” agreement than the strategies actually chosen. So in this third type of problem structure, rational players choose an outcome which is inefficient. But the dice to overcome inefficiency by cooperation is loaded to the negative extreme because there is no other Nash equilibrium available.5

There are two basic options to overcome the social dilemma, that is, to reach efficiency: The first is the introduction of a third party, e.g. an institution, which is able to enforce the cooperative solution, e.g. by making contracts explicit and binding and therefore deviations from cooperation costly. We should underline here that we do not neglect the possibility that certain social conventions have been codified by the law. But ignoring the processes and developments that potentially lead to a destabilization of once established conventions implies ignoring political majorities, which have the power to reform social conventions on a legal basis. Hence, we abstract from the assumption of outside enforcement and consider the second option, which is the introduction of repeated interaction between players.

**Repeated Games.** We begin with the most simple argument, which is the repetition of the same static game for a defined number of rounds. That is, this version of a dynamic game is characterized by the requirement that the “physical environment” remains constant over time (cf. Fudenberg and Tirole, 1991, p. 501).

If the “Prisoners’ Dilemma” is played for \(M\) rounds, it is straightforward by a backward induction argument that the non-cooperative Nash equilibrium will be played in the last round of the game and so in all previous sub-games. The repetition of the same static game for an *infinite number of rounds* is called a supergame (e.g. Friedman, 1986). Note first that the time dimension is equivalent to the more intuitive requirement of some positive probability that the game will end at each period, making the infinitely repeated game an indefinitely repeated. That is, in what follows it will be sufficient if players expect the game to continue a further round.

The sum of utilities of each player is determined by the sequence of behavior strategies that make players’ future strategy choices depend on current actions. One simple possibility is that players use grim-trigger strategies: A single deviation from the cooperative agreement (“Dove”) triggers the punishment phase where players choose the strategy that induces the inefficient Nash equilibrium (“Hawk”), which persists forever. With this behavior strategy,
players maximize the discounted sum of utilities over the time horizon where \( \delta \in [0, 1) \) denotes the common discount factor.

- Continued cooperation yields: \( \sum_{t=0}^{\infty} \delta^t \cdot 2 = \frac{2}{1-\delta} \)

- A single deviation and the resulting punishment yield: \( 3 + \sum_{t=1}^{\infty} \delta^t \cdot 1 = 3 + \frac{\delta}{1-\delta} \)

Comparing both payoffs we get

\[
\frac{2}{1-\delta} \geq 3 + \frac{\delta}{1-\delta}
\]

A little algebra tells us that the condition to sustain cooperation for all periods and both players is that the actual discount factors of both players must be \( \geq 0.5 \). In this case, the efficient outcome \((2,2)\) is a Nash equilibrium of the supergame. More precisely, it is a sub-game perfect Nash equilibrium, which requires that players behave sequentially rational by choosing a Nash equilibrium in every subgame of the original game (where the subgame here is identical in every round). Selten (1965) has introduced this solution concept, which rules out non-credible threats.

In summary, the set of Nash equilibria of an infinitely repeated game includes outcomes not supported by the static game. The basic intuition for the emergence of stable cooperative outcomes here is that if players are sufficiently patient, any finite one-period gain from deviation is outweighed by some loss in every future period (cf. Fudenberg and Tirole, 1991, p. 153). So cooperation is enabled in the “shadow of conflict” because the basic mechanism to modify incentives is that players have the opportunity to punish opportunistic behavior. It is actually the threat of a punishment that suffices to deter players from non-cooperative behavior because—by assumption—any deviation from equilibrium is always publicly observable.

The extension of Nash equilibrium in this particular example is in a much more general way referred to as the Folk theorems, which are the main results in the theory of repeated games. They establish that for games played ad infinitum any feasible and individually rational payoff vector can be sustained and enforced as a Nash equilibrium in an essentially non-cooperative world if only players are sufficiently patient. Folk theorems are available for many classes of games and for a variety of preference relations. The seminal contributions to the literature establishing Folk theorems are, e.g., Aumann and Shapley (1976) for the case of no discounting, Friedman (1971) with Nash punishments, discounting and perfect information, Fudenberg and Maskin (1986) in case of discounting and incomplete information.

---

6 Instead of “feasible and individually rational payoffs”, Osborne and Rubinstein (1994, p. 143), for instance, use the terminus “enforceable payoffs”. Informally, the main point is that in either case any payoff that is larger than the lowest payoff that another player can force upon player \( i \) is individually rational and feasible and therefore, enforceable.

7 Although the results demonstrated by the Folk theorems are quite intuitive (that is the basic reason for their name) it was only “folk wisdom” among game theorists long before they have been formally proved.
as well as Fudenberg et al. (1994) for discounting and imperfect public monitoring. Apart from the two player case, Folk theorem arguments also work on the level of society, that is, they can be generalized from a “personal” enforcement mechanisms between two players to “community” enforcement mechanisms with only frequent interactions of players. This has the implication that cooperative behavior can also unfold when any given pair of players does not meet very often to play a specific game and even if defective play can only be imperfectly observed by all players (see Kandori, 1992). The reason for this is the prevalence of “social norms” which cause any undesirable behavior against one player to be sanctioned by other players in society, even when not directly affected by opportunistic play.

For the somewhat extreme case of a Folk theorem where players are completely patient, that is, future payoffs count as much as current payoffs, Binmore (2005, p. 81) concludes

“[then,] [e]very contract on which rational players might agree in the presence of external enforcement is available as an equilibrium outcome of infinitely repeated games.”

Games with evolutionary dynamics. Evolutionary dynamics provide a rationale for the selection of specific equilibria whose multiplicity is demonstrated by the Folk theorems. The basic intuition for these games is that not all equilibria supported by the Folk theorems appear to be equally likely, given the inefficiency of some outcomes. In games which are frequently played and sufficiently important, agents will adjust their behavior (cf. Samuelson, 1997, p. 15). For instance, the evolutionary dynamics in the repeated Prisoner’s Dilemma, prominently analyzed by, e.g. Axelrod and Hamilton (1981) or Axelrod (1984), have underlined that evolutionary stability rules out completely uncooperative, “aggressive” strategies over time. In such games, the solution concept is that of evolutionary stable strategies (ESS), which are Nash equilibria that fulfill an additional condition of stability.

However, it has also been stressed in the literature that the predictive power of evolutionary stability in terms of restricting equilibria may not be very large. For instance, Fudenberg and Maskin (1990) argue that completely non-cooperative behavior in the repeated Prisoner’s Dilemma can be approximated by an evolutionary stable but otherwise “almost completely” non-cooperative strategy profile. They establish that if punishments are not too drastic, then inefficient, non-cooperative strategies can be replaced by more efficient ones in the infinitely

---

8A survey on repeated games can be found, e.g., in Sorin (1992), an overview of Folk theorems is in Mailath and Samuelson (2006, ch. 3). Finally, note that Folk theorem-arguments also carry over to stochastic games, which are generalizations of repeated games (Dutta, 1995).

9Informally, a strategy is evolutionary stable if it cannot be invaded by a mutation of strategy. The seminal contribution is due to the biologist Maynard Smith (1976, 1978). Linster (1992) identifies the weaknesses in Axelrod’s (1984) contribution and re-runs the infinitely repeated Prisoner’s Dilemma in a more general setting.
repeated game with evolutionary dynamics. Here, relatively cooperative strategies are in this sense self-enforcing because they appear to be “good” strategies in terms of payoffs.

In more general terms, Binmore and Samuelson (1992) apply evolutionary refinements to infinitely repeated games played by meta-players, which are a metaphor for an evolutionary process. These players choose (finite) automata (e.g. grim-trigger strategies) which refer to the modeling of bounded rationality of players; that is, players are programmed to execute strategies like machines. Following Abreu and Rubinstein (1988) they do not impose ex-ante an upper bound on the complexity of an automaton which they define to be the number of states the machine can have, e.g. cooperation and defection are two states.\textsuperscript{10} Assuming that utilities of players decrease in the complexity of automata and increase in the achieved payoffs, the main finding of this paper is that \textit{any} evolutionary stable strategy has both players earning the utilitarian payoff. This is a remarkable result, placing the notion of cooperation into a sharp perspective (of course, under the specified circumstances of the model).

\textbf{The rationale for conflicts and differential games.} While we have stressed how efficient outcomes can be achieved as “cooperative” equilibria in long-term interactions or evolutionary dynamics there are more specific arguments for why it could be rationale for agents to turn to “a strategy of conflict”.

For instance, Tullock (1974, p. 2, emphasis added) notes that

\begin{quote}
[i]n general conflict uses resources, hence it is socially inefficient, but entering into the conflict may be individually rational for one or both parties. [...] The social dilemma, then, is that we would always be better off collectively if we could avoid playing this kind of negative sum game, but \textit{individuals may make gains by forcing such a game on the rest of us}.
\end{quote}

Severe conflicts induce dynamics on their own leaving doubts about whether the mere prospect of future interaction really enables cooperation or a peaceful outcome. Garfinkel and Skaperdas (2000, p. 795) suggest that “in a rapidly changing external environment in which the stronger can be expected to get even stronger [...] a long shadow of the future is more likely to intensify conflict.” That is, because the future is so important, players have an incentive to engage in conflicts as it is a way to change the future balance of power to their favor (cf. Konrad, 2009, p. 182).\textsuperscript{11}

\textsuperscript{10}Hence, “grim-trigger” is more complex than the strategy “always cooperate”.

\textsuperscript{11}See Garfinkel and Skaperdas (2007) for an excellent overview of the economic perspective on conflicts. The seminal contributions to the literature are Hirshleifer (1991, 1995), Skaperdas (1992) and Grossman and Kim (1995). A dynamic analysis of conflict has been conducted, e.g., in the models by Garfinkel (1990) (infinitely repeated game with productive and fighting activities), Maxwell and Reuveny (2005) (differential game with two groups in competition over a stock of common resources, where both popula-
As already indicated, one essential condition for the argument that individuals may gain from conflict is that property rights can only be imperfectly enforced (cf. Garfinkel and Skaperdas, 2007). As a consequence, agents face a choice between enlarging the social total of wealth, e.g. by a peaceful, “cooperative” production, or redistributing that total, e.g. by a “non-cooperative” strategy of appropriation (cf. Hirshleifer, 2001, p. 1). While appropriation can be achieved in legal ways, e.g. via politically induced redistribution and rent-seeking, its most dramatic and characteristic form is violent conflict (cf. Hirshleifer, 2001, p. 329). That is, economic agents turn to conflict to secure rents, e.g. in form of territory, access to natural resources or, similarly, to induce changes in the distribution of power, control and wealth. These kind of dynamics associated with an intended redistribution of property rights have the implication that changes in the environment affect an economic agent’s choice between conflict or cooperation in a fundamental way. It is then intuitively straightforward that, as the “economic pie” grows, agents might become greedier securing their respective piece and, hence, might choose more aggressive strategies.

With respect to our previous discussion, neither repeated nor evolutionary games can account for these effects. Instead, differential games provide a theoretical framework as they capture the impact of the “physical state” of the game on agents’ incentives. In what follows, we will shortly discuss such a state space model by Eggert et al. (2011) whose underlying game represents a fairly general model of conflict.

The model by Eggert et al. (2011) is based on a differential game where forward-looking agents decide about the allocation of their (time) endowment with respect to two polar activities: the production of a durable common pool stock (which is the state variable) and/or the appropriation hereof in the attempt to convert claims on the stock into effective property rights. More precisely, agents face the trade-off between the temptation of an immediate gain versus a future bigger share of the common-pool stock given that its size (i.e., the price of this contest) accumulates relative to collective efforts. The question is then whether and under which conditions property rights of the common-pool stock might implicitly be sustained when there is no legal authority which can enforce them, that is, when there is anarchy. The solution concept here is stationary Markov perfect equilibrium (MPE), which is another refinement of Nash equilibrium. It implies that strategies are functions of the current payoff-relevant state variable but not of past play. Maskin and Tirole (2001) introduce a general treatment of MPE.¹²

Within our context the following results are important: First, as the common pool stock...
1.2 Repeated Interaction, Multiple Equilibria and Further Dynamics Explaining Conflict ...

grows so that the price of the contest becomes larger, the choice of the appropriation activities varies: Agents become greedier because the marginal gain of appropriation increases. Second, and in contrast to the driving forces in repeated games, here, neither explicit threats nor punishments are needed to sustain cooperative behavior, at least to some degree. Rational agents will turn to partial cooperation, that is, the combination of both productive and appropriative activities at the same time, as this is a best response to the risk of appropriation in the long run.\textsuperscript{13} So a possible and a unique equilibrium of this game lies in between full cooperation and non-cooperation which is mainly due to the durability of the common-pool stock and the fact that players are forward-looking. Third, in the steady state, the level of partial cooperation decreases as either the conflict technology gets more effective and/or the number of players competing for the resource becomes larger while the level of aggression decreases with more far-sighted, patient players. This effect closes the gap to the much simpler mechanisms in repeated games, where the patience of players determines the availability of the more or less cooperative equilibria, as well.

\textbf{Concluding remarks}

We may conclude that—in an essentially non-cooperative world—there are various dynamic mechanisms that induce rational agents to pursue "cooperative", "non-cooperative", or a mixture of both behavior strategies. We have underlined the multiplicity of outcomes and the spectrum of social behavior which \textit{can} be obtained in equilibrium, where the final choice of one specific equilibrium is thus a matter of social convention. On the other hand, there are environments that induce unique equilibria with the more or less cooperative strategy finally adopted. In either case, once established, these outcomes are stable social conventions in various societal coordination processes and have direct implications for reform. In particular, cooperative outcomes must be self-enforcing, that is, cooperation must unfold as an implicit contract in all type of games, in the absence of outside enforcement that makes cooperative contracts explicit.

The papers presented in this dissertation are all distinct applications but they share the idea that the economic mechanisms introduced are important lessons from a political perspective: On the one hand, political conflicts cannot be circumvented when the basic incentives which induce agents to resort to this specific strategy are ignored. On the other hand, even when legal regulation can enforce specific elements and institutions within society, the ignorance of self-enforcing agreements has the implication that "[...]

\textsuperscript{13}"Partial cooperation" can also be established based on the seminal, static models by Hirshleifer (1991, 1995), as well as Skaperdas (1992). Note that in the literature on differential games, the emergence of cooperative behavior has also been analyzed based on trigger strategies (which are non-Markovian), see Dockner et al. (2000, ch. 6).
an opposition can coalesce.” (Binmore, 2005, p. 89). Apparently, the sustainability of institutions, which are subject to political processes over the course of time, also requires an understanding of the determinants that drive political preferences in the first place.
1.3. The Three Worlds of Welfare Capitalism Revisited

We begin with the study of a coordination problem between heterogeneous type of agents in society to determine the design of their social insurance systems. The institutional environment has three possible outcomes, characterizing different systems and thus different social conventions, that feature more or less degrees of cooperation (i.e., “solidarity”). The question which system will finally be adopted is driven by the distribution of risk and income in society. Indeed, most advanced economies have different types of social insurance systems which are highly complex and interrelated with other welfare policies. The way of organizing social insurance is similar as private insurance since “[e]very insurance contract involves a redistribution of resources from the lucky to the unlucky” (Sinn, 1995, p. 495). The point is that the general dimensions of redistribution are quite specific for different systems, where redistribution basically works via a pooling of agents with heterogeneous risks and heterogeneous incomes.

We focus on this very characteristic feature of welfare states and analyze the logic leading to the choice of three specific system. This choice, that is, the outcome of the coordination process within society, is also driven by the positive or normative criterion that aggregates individual preferences, the risk pooling characteristics of the different systems as well as the heterogeneity of agents. One particular aspect of our model is that we introduce heterogeneity of agents in three dimensions, imposing only mild assumptions on the functional forms of distribution.

A further unique characteristic is the dimension of pooling risks in the Bismarckian systems (that will be introduced in the next section), which is a mechanism that so far seems to not have been properly understood in the literature. In our paper, it basically refers to an exogenously form of cooperation by groups of agents. Interestingly, this risk pooling mechanism in relatively small groups refers to the emergence of informal insurance contracts. We discuss the literature which establishes that this form of cooperation may have been obtained in equilibrium before social insurance actually became compulsory. In addition, we briefly discuss the implications of reforming social insurance given the challenges these systems face.

1.3.1. Background

The most influential classification approach of welfare states has been introduced by Esping-Andersen’s (1990), who proposes three archetypes of systems. We concentrate on the differences in the redistributive design of these systems they shape the agents’ preferences for the choice of a specific system. These are the following:
1.3 The Three Worlds of Welfare Capitalism Revisited

- “Social-democratic systems” are characterized by “equality of the highest standard” (Esping-Andersen, 1990, p. 27) which is achieved by a high degree of income redistribution due to flat benefits but proportional tax rates. Such systems of universal solidarity are predominantly found in Scandinavian countries. In the economic literature, these systems are called after the British economist William H. Beveridge.¹⁴

- “Liberal systems” provide only modest social insurance benefits and accordingly encourage private insurance. These systems are typical for the United States, Canada and Great Britain. More precisely, Liberal systems are not social but primarily private insurance systems.

- “Conservative systems” offer benefits proportional to income. These are strongly corporatist regimes, that is, their unifying element is their organizational foundation, for instance on the basis of professional groups. This is reflected in the fact that Bismarckian systems consist of a wide range of insurance funds. Again, the economic literature keeps with the nomenclature of the founder of such systems, Otto von Bismarck.

According to this characterization, the following redistribution patterns can be differentiated. First, the Beveridgean system is characterized by a considerable redistribution of income (i.e. from the rich to the poor), which does not appear in case of the Liberal or the Bismarckian system.

Second, the Beveridgean and the Bismarckian systems feature a substantial redistribution of risk in society. Indeed, this mechanism refers to the main innovation of social insurance as to pool risks on a large scale. As Baldwin (1992, p. 2) puts it:

> “Once risks are pooled, the individual faces uncertainty no longer alone but as a part of a larger group. The novelty of social insurance was the extension of this confrontation of risk in community from a small circle, sometimes self-selected to its advantage, sometimes isolated to its own peril, not only to a much larger group—possibly society as a whole—but even, through intergenerational transfers, to the still unborn.”

A Beveridgean system pools risk within the entire society, that is, there is a global redistribution of risk from low-risk to high-risk people. The corporatist, Bismarckian system leads to a pooling of risk within groups, that is, it features redistribution from low-risk to high-risk agents within a single group, not within society. This implies that each group (more exactly, ¹⁴Lord William Henry Beveridge was the author of the report “Social Insurance and Allied Services” which had a significant impact on the establishment and the design of the British social insurance systems in the mid of the 20th century. Today, the UK’s social insurance is not classified as “Beveridgean” but as Liberal because of its predominantly modest social benefits.
1.3 The Three Worlds of Welfare Capitalism Revisited

Each insurance fund) is characterized by a specific average risk. The Liberal system approximately does not redistribute because, in principle, private insurance can charge premiums that are proportional to individual risk.

1.3.2. Contribution

In the paper “The Three Worlds of Welfare Capitalism Revisited” Brockhoff/Rossignol/Taugourdeau develop a theory that characterizes the conditions under which the three archetypical types of social insurance systems are chosen, referring to Esping-Andersen’s (1990) seminal classification. We focus on the redistributive design of such systems, analyzing social insurance that offers cash benefits due to e.g. unemployment, sickness and disability.\(^{15}\) This paper adds to the literature by explicitly modeling a corporatist Bismarkian system by introducing a risk-sharing mechanism within groups, which seems to be an essential condition for the existence of these type of systems.\(^{16}\) The model consists of \(N\) agents who are heterogenous in individual risk, income and group-risk. The distributions of these factors are the main driving forces for the determination of individual preferences which we obtain by pairwise comparison. The choice of the system is analyzed within a two-stage model where the type of insurance system is chosen first and the level of the tax rate is chosen second employing both a positive (majority voting) and a normative criterion (utilitarian social planner). The game is solved by backward induction.

Studying individual preferences, first, we find that the Beveridgean system is preferred by poor agents that support a relatively small risk if the effect of a high income redistribution dominates. Second, the Liberal system is preferred by low-risk agents that are relatively rich because low-risk agents disfavor redistribution of risks and rich agents are against the redistribution of income. Additionally, such a system is preferred by low-risk but poor agents under specific circumstances (because the Liberal system has an individual tax/contribution rate). Finally, sufficiently rich agents with a certain threshold of risk prefer the Bismarkian system because of the redistribution of risks that works inside the different funds. Moreover, the higher the average group risk, the less likely is the choice of such a system.

Aggregating these preference by a majority voting rule we establish that the choice of the system depends on the relative degree of (i) income inequality (similar to Meltzer and Richard, 1981) and (ii) risk inequality as well as on (iii) the proportion of agents that belong to groups with a low average risk. More specifically, the lower the inequality of income, the higher is the political support for a Liberal system. If the inequality of income

\(^{15}\) The French unemployment insurance is also of a corporatist type. This is not the case in Germany. Here, the corporatist feature is most evident for health insurance.

\(^{16}\) The Liberal and the Beveridgean system are standard models from the literature on social insurance (see, e.g. Casamatta et al., 2000 for similar modeling).
increases, then the political support for the Beveridgean system increases, as well. Finally, the support for the Bismarckian system is higher when there is a higher proportion of agents belonging to “good groups”, that is, groups with a low average risk.

The utilitarian criterion leads to different results. First, the Beveridgean system is always strictly preferred to both Bismarckian and Liberal systems even if almost all agents have a lower than average risk. This is mainly due to the concavity of the social planner’s utility function where the poor always gain more than the rich lose, speaking for maximal redistribution (i.e. the Beveridgean system).\(^\text{17}\) Second, the Bismarckian system is preferred to the Liberal system because of the intra-group redistribution of risk in the Bismarckian case.

### 1.3.3. Elaboration on the topic

In the following, we discuss the literature on informal risk-sharing mechanisms and the implications for reforming systems of social insurance.

**Informal risk-sharing within groups.** From a historical perspective, it seems reasonable that informal risk-sharing agreements within groups of agents have provided the organizational nexus in Bismarckian systems providing later on formal insurance contracts for specific professional groups (cf. Tennstedt, 1976).\(^\text{18}\) For instance, in the German case, before Otto von Bismarck passed the law on worker’s health insurance in 1883, insurance was not compulsory.\(^\text{19}\) This was reflected in the fact that only five per cent of the population were covered or at least registered in some of the protection systems for workers. These had evolved from relatively informal kinds of insurance provided by guilds, labor unions or local communities, given that “real” insurance markets have been underdeveloped in those days (cf. Tennstedt, 1976, pp. 385-390). As Arrow (1963, p. 947) puts it: “[…] when the market fails to achieve an optimal state, society will, to some extent at least, recognize the gap, and non-market social institutions will arise attempting to bridge it.”

There exist considerable evidence that informal insurance is self-enforcing, that is, insurance can arise and be sustained in equilibrium even if it is not compulsory. Today, this is most

\(^\text{17}\)In an extension of this paper, we determine the choice of a Rawlsian social planner (maximin criterion) for the type of social insurance system chosen. With this criterion we obtain the following: When there are only two groups and the most disadvantaged individual (poorest and with highest risk) can be found in the group where average group risk is smaller than in the other group, we prove that a Rawlsian planner votes for the Bismarckian and not the Beveridgean system. This result is somewhat counter-intuitive as one would expect a Rawlsian social planner to vote for a Beveridgean system, which is generally the most redistributive.

\(^\text{18}\)For the German case, this organizational principle was called “berufsmäßiges Organisationsprinzip”. In 1890 there were about 21,200 health insurance funds (cf. Tennstedt, 1976, pp. 385-390).

\(^\text{19}\)In German, “Gesetz betreffend die Krankenversicherung der Arbeiter”.

16
visible in agrarian or underdeveloped societies. For instance, Townsend (1994) finds empirical evidence for the existence of a substantial degree of informal insurance at the community level in rural villages whose harvest is prone to weather extremes. On the theoretical side, Kimball (1988) provides a model under which a non-market risk sharing mode of insurance might have been self-enforcing, referring to the example of farmer’s cooperatives in English medieval times. These cooperatives had an informal system of granting consumption loans and hence represented a form of mutual assistance when output is subject to stochastic perturbations. Kimball’s (1988) model is based on a repeated game where the agents’ trade-off is the choice between temptation to default on the obligation to pay versus the threat of expulsion from the cooperative. By a careful calibration of parameters with historical data this paper concludes that risk averse agents could have formed self-enforcing informal insurance (compared to other mechanisms that spread risk) even at very high interest rates. In a related model, Coate and Ravallion (1993) conclude that the performance of such informal risk-sharing agreements is relatively bad compared to first-best risk sharing, adding an efficiency argument for contract enforcement. Both models account, however, for self-enforcing agreements in the sense that they are proof from defection by a single member of the group. This constraint is relaxed in Genicot and Ray (2003) focusing on the process of such group formation and endogenously derive the extent of insurance for given groups. They study—in their words—“truly” self-enforcing insurance agreements proof to the deviation of a whole subgroup of agents. This has the implication that the threat of a subgroup must also be credible as to also constitute a self-enforcing agreement. An important insight of this study is that only a finite number group sizes can be stable, that is, there are limits to group size for stable insurance agreements within communities.

What this suggests is that implicit contracts for risk-sharing can but need not always be sustained in the long run while there are further reasons of efficiency to make insurance compulsory. On the other hand, the existence of informal risk-sharing arrangements, as the organizational nexus before insurance in the corporatist system became compulsory, may have been due to the fact that agents shared similar risks as they worked in similar environments. Also the limited group size may have contributed to the stability of such agreements. Going to post-Bismarckian times, as a result of compulsory health insurance for workers and employees, more than 60 per cent of the population were directly or indirectly protected against income losses due to health problems in 1913 (cf. Tennstedt, 1976, pp. 385-390), marking the beginning of the decline for informal insurance.

---

20The relationship between the discount rate $\delta$ and the rate of interest $i$ is $\delta = \frac{1}{1+i}$. High interest rates induce low discount rates, making future payoffs less interesting. Generally, it is difficult to evaluate whether the market interest rate of these times shared a lot with today’s interest rate, given that various forms of risk were much higher in those days.
1.3 The Three Worlds of Welfare Capitalism Revisited

**Political dimension.** Like other measures of the welfare state, any reform of social insurance systems must somehow be reconcilable with preferences of voters. Demographic changes forecast future burdens on the systems that are caused by internal developments. Across countries, an increasing mobility of labor is another major problem raising the question whether once established types of welfare states can survive within system competition (e.g. Casamatta et al., 2000). The overall picture is that these developments increase average risk levels in particular groups as well as across the board, lead to higher tax/contributions rates or have good risks opt out of the system. Furthermore, a more unequal distribution of income in many societies also matters to the question whether a generous design of social welfare policy can be sustained. For our model this has the implication that the dynamics associated with future burdens need to be accounted for, and the static framework that we have introduced is a useful starting point for an analysis. With such a model we might then be better prepared to evaluate policy proposals in order to sustain different types of social insurance in the long run.

1.3.4. Conclusion

In summary, this paper has provided a microeconomic foundation for Esping-Andersen’s (1990) three types of welfare systems. In particular, a more precise way of modeling the Bismarckian system has been introduced. In light of the findings, we may conclude that the dominance of the Beveridgean system in case of the utilitarian preferences might explain why Bismarckian countries have increasingly adopted Beveridgean characteristics. In line with our previous discussion, future research needs to account for the new way of modeling a Bismarckian system when studying the sustainability of different systems of social insurance given the challenges that systems competition or demographic changes create. For reforming these systems, the implications of self-enforcing insurance contracts cannot be ignored by designers of public policy as to sustain reliable mechanisms of protection and redistribution also for future generations.
1.4 Stability of Coalitional Equilibria within Repeated Tax Competition

The basic structure of the second paper relates to a problem of cooperation between economic agents facing a Prisoner’s Dilemma. We regard international tax competition, which is a field of high academic interest and many variations on the theme. As globalization proceeds, competition between countries with different tax regimes is likely to intensify, which poses serious challenges for national fiscal authorities to sustain their tax revenues.

The negative fiscal spillovers, which are induced by strategically manipulating tax rates, are at the center of the economic mechanism in the standard tax competition framework. The non-cooperative behavior of authorities may be overcome by coordinating tax policies, that is, by forming coalitions with other governments. This exogenously form of cooperation is incorporated in a general way into our framework, that is, without imposing restrictions on the type of coalition structure. It has a straightforward impact on the externalities produced, e.g., larger coalitions coordinate on comparatively larger tax rates. The spillovers also shape the agents’ incentives to ignore the cooperative solution and act opportunistic, again, given that the political game between countries has no definite end. In this sense, we focus on the point of cooperation in a second important dimension, analyzing the sustainability of cooperation when countries have formed coalitions using Folk theorem-arguments.

After introducing the background and the contribution of our paper, two basic strands of the literature on coalition formation and the sustainability of cooperation in capital tax competition will be briefly discussed.

1.4.1 Background

One of the key insights of the seminal contributions to the literature in the field of tax competition, e.g. Wilson (1986) and Zodrow and Mieszkowski (1986), is that public goods are under-provided in equilibrium. It is in the best interest of governments not to coordinate their policies in the presence of international capital movements. See e.g. Keen and Konrad (2011) or Wilson (1999) for literature overviews. The incentive that drives this outcome is that, in an open economy, each country can increase its tax base, and hence attract capital, by lowering tax rates. As it is a best response for all countries to sequentially act in this way, the game between countries resembles a Prisoner’s Dilemma. In equilibrium, tax rates are inefficiently low compared to a coordinated, cooperative solution.

On the other hand, with regard to empirical evidence, one of the stylized facts for international corporate taxation is the “tax cut cum base broadening” phenomenon for OECD countries. That is, there has been pressure on statutory corporate tax rates since the early
1.4 Stability of Coalitional Equilibria within Repeated Tax Competition

1980s but at the same time, tax bases were broadened between 1980 and the end of the 1990s. The overall effect in terms of tax revenues is that, on average, unweighted revenues have declined as a proportion of total tax revenues until 1995. But since then, they have risen implying that effective tax rates remained relatively constant (cf. Devereux and Sørensen, 2006, pp. 6-12). Checking for the validity of the “race to the bottom”-hypothesis, Devereux and Sørensen (2006, p. 5) conclude that “[...] there is some truth in the claim but on the whole corporation taxes have survived pretty well, at least until now.”

When the standard models cannot capture the recent experience in OECD countries one may ask for an explanation why the taxation of capital continues to exist. In general, there is no international fiscal authority that can enforce national measures of public policy. However, sovereign countries sign bilateral tax agreements and support institutions like the EU or the OECD in order to enforce their tax laws. These facts reflect the rough direction of many countries’ political efforts to cooperate with respect to tax policies, if not at the international level, then at least within a subgroup of countries, within coalitions in other words. It is clear that such partial tax harmonization is politically easier to achieve, which has the implication that competition between different coalitions might still prevail. The question is then, whether repeated interaction can serve as an informal enforcement mechanism to sustain cooperation also within coalitions.

1.4.2. Contribution

In the paper “Stability of Coalitional Equilibria within Repeated Tax Competition” Brange-witz/Brockhoff analyze whether fiscal cooperation between sovereign countries that have formed coalitions can be supported as an implicit contract. Whereas the degree of tax competition is alleviated by the formation of coalitions, incentives to deviate from the coalitional agreements continue to exist because lower tax rates attract capital. We contribute to the literature that employs repeated interaction in tax competition by a model that accounts for any feasible, but given coalition structure, and analyze the incentives of a subset of regions to deviate from the coalition to increase their tax base. We use a stylized but otherwise standard model of capital tax competition that requires specific assumptions about the functional form of production to get explicit solutions. The cooperative behavior between regions is characterized by a joint maximization of tax revenues within one coalition. Although regions are economically identical, coalitions are asymmetric with respect to the number of regions included.

The structure of the repeated game is that all regions play symmetrically and cooperatively within the coalitions and non-cooperatively across coalitions by setting their respective equi-

\[\text{21} \text{For instance, the most recent initiative of the EU is the implementation of the \text{“common corporate consolidated tax base”}, whereas the OECD pursues similar goals by declaring \text{“harmful tax practices”}.\]
librium tax rate. The threat which should convince regions to support the symmetric coalitional equilibrium is that any deviation by a sub-coalition (including one single region) is punished by playing the non-cooperative Nash equilibrium in tax rates.

Our main results are as follows: First, we find that sub-coalitions which belong to relatively small coalitions have a higher incentive to deviate from cooperation in relation to sub-coalitions in relatively large coalitions. This is essentially due to the general observation that larger coalitions coordinate on relatively high tax rates but have low tax revenues in comparison to smaller coalitions. Therefore, in order to make deviation from a relatively large coalition profitable, a sub-coalition needs to underbid the remaining regions more than when deviating from a smaller coalition.

Second, we prove that deviations of single regions require a higher minimum discount factor to sustain cooperation than deviations of sub-coalitions. This implies that it is more attractive for single regions to deviate than for sub-coalitions. Moreover, we find that the minimum discount factor increases for deviations from larger coalitions. In order to sustain a coalitional equilibrium, that is, an equilibrium where no region in any coalition deviates, the comparison of the maximal minimum discount factors over all coalitions and all possible deviations of sub-coalitions yields the following result: The stability of a coalition structure is only affected by the size of the largest coalition subject to deviations by singleton regions. This has the implication that all other coalitions do not have an impact on the stability of the coalition structure. Finally, we find that cooperation is easier to sustain the more cooperative behavior between the regions exists ex-ante. This can be seen, e.g., by the comparison of a coalition structure where the size of the largest coalition is fixed and two countries are either singleton or build a coalition: For the former case, we find that the corresponding discount factor is larger.

We provide two extensions. First, we derive a condition that ensures that all previous results hold true for a more forgiving form of punishment where all coalitions outside the deviating sub-coalition or the sub-coalition itself may continue with the cooperative behavior. Second, we establish by a numerical example that the chosen objective function of the government (tax revenue maximization) is not too restrictive for our main results as compared to a welfare maximizing criterion.

1.4.3. Elaboration on the topic

In order to clarify how this paper contributes to the analysis of cooperation in tax competition, we introduce the basic related strands of the literature in the following.
1.4 Stability of Coalitional Equilibria within Repeated Tax Competition

Coalition formation (endogenous and exogenous). In the field of fiscal competition, there are two perspectives to coalitions in static or sequential frameworks: The formation process itself and the impact of coalition formation.

The first perspective, that is, the rationale why tax-harmonizing coalitions should (endogenously) form, has first been analyzed by Burbidge et al. (1997). Their model combines three stages: First, a coalition formation stage with forward-looking countries choosing coalition partners. Second, a stage of interactions among coalitions where each coalition sets a capital tax rate against non-members which determines the Nash equilibrium level of aggregate consumption available to each coalition. Third, a bargaining stage where the aggregate consumption is allocated among the members in the coalitions. The main insight of this model is that the grand coalition (complete federation) may not be an equilibrium coalition structure when more than two countries and production asymmetries are involved.

The literature which focuses on the second perspective, so the impact of coalitions within the standard tax competition game, has stronger assumptions, one of them being that the process of coalition formation is considered done. Konrad and Schjelderup (1999) analyze whether harmonizing tax rates is beneficial within a coalition of $S$ countries whilst $N - S$ stay out as a singleton. In principle, the coalition’s gain depends on two points: First, the size of the coalition that harmonizes and, second, the response of the other countries not in the harmonized area. They prove that partial cooperation in $S$ is beneficial in a quite general framework.

By help of a more stylized model Bucovetsky (2009) derives Nash equilibrium outcomes when $N$ jurisdictions that differ with respect to their population sizes set tax rates non-cooperatively. He defines an index of capital tax competition which depends on the size distributions of the population and determines the average tax rate in the federation. This model makes three important points: First, any tax harmonization by a group of countries benefits residents of those jurisdictions who did not join. Second, it benefits the residents of the largest jurisdiction in the group. Finally, concerning the stability of the grand coalition, which Pareto dominates all other coalition structures, the biggest threat to this coalition is when the $N - 1$ largest jurisdictions form a bloc while the smallest jurisdiction opts out.

---

22 This is justified on the grounds that “the formation of a given coalition may also be founded on historical, social, political and economic factors outside the model.” (Konrad and Schjelderup, 1999, p. 160).

23 Beaudry et al. (2000) provide a more general model that analyzes the desirability of partial coordination when there are strategic spillovers. There is also a relation to the Industrial Organization literature: Deneckere and Davidson (1985) analyze the incentives to merge when firms engage in price competition within a partial-equilibrium model. Also here, a merger allows members of the coalition to absorb a negative externality. A price increase of the coalition is followed by a price increase of the competitors. In the end, all prices will have risen: “[w]ith price as the strategic variable, mergers have very natural effects: mergers of any size are profitable, and are so increasingly, i.e., large mergers yield higher profits than smaller ones.” (Deneckere and Davidson, 1985, p. 474).

24 Note that we also get a related concentration index. However, our model slightly differs from Bucovetsky (2009) as we have revenue maximizing governments.
This small jurisdiction benefits from the high tax rates on which the large bloc coordinates while it can guarantee a low tax rate itself.

**Sustainability of cooperation in tax competition.** The analysis of the existence of implicit contracts within repeated tax competition goes back to Coates (1993) in the case of property tax competition. Since then, three strands of the literature can be considered.

The first strand of the literature analyzes infinitely repeated interaction between two countries and focuses on various forms of asymmetries between countries. These papers likewise employ trigger strategies to induce cooperative behavior. For capital tax competition, Cardarelli et al. (2002) and Catenaro and Vidal (2006) show that regional asymmetries provide difficulties in sustaining implicit tax coordination. However, Itaya et al. (2008) establish that this result may not be confirmed, relaxing some of the assumptions of the former papers: Instead, there may exist cases where increases in regional asymmetries make cooperation more likely. The asymmetries included in this model account for regions to be either capital exporters or importers, regardless of their endowment sizes, while there is a further effect due to the possibility of the exporter (or importer) to subside (or tax) capital in order to strategically manipulate the terms of trade at the one-shot non-cooperative equilibrium. For corporate tax competition where multinational firms engage in (illegal) profit-shifting, Eggert and Itaya (2011) study whether here cooperation is self-enforcing, as well. They characterize both equilibria under trigger and weakly renegotiation-proof strategies (WRP). The type of production asymmetry in this model affects the sustainability for cooperation so that the less productive country has a stronger incentive to deviate. Furthermore, here, increasing asymmetry makes tax harmonization more difficult (for both trigger and WRP strategies).

Our model belongs to the second strand of the literature with more than two countries and the standard capital tax competition framework. Itaya et al. (2010b) analyze the sustainability of a coalition structure studying a model with one coalition and the rest of the world acting as a singleton. Their main finding is that partial tax harmonization is more likely to prevail if the number of regions in the coalition is smaller and the number of existing regions in the entire economy is larger. This suggests that there is a form of optimal intermediate coalition size to implement cooperation because of the trade-off between welfare levels and sustainability. Our paper is actually based on Itaya et al.’s (2010b) work, extending their model for an arbitrary number of given coalitions and coalitional deviations (which turns out to be less attractive than singleton deviations).25 Kiss (2011) raises the question how

---

25Our model cannot determine some of the comparative static effects as in Itaya et al. (2010b) because we would affect the coalition structures. For instance, increasing the number of regions does not make a lot of sense in our framework.
an agreement about a minimum tax affects the sustainability of implicit contracts establishing that such a lower bound restricts the degree of punishment for deviators, making cooperation actually harder.

Finally, progress has been made with respect to a combination of these two strands. Itaya et al. (2010a) set-up a model with three countries and asymmetries with respect to capital endowments. For any combination of the three countries they prove that sustainability depends on the capital endowments of the median country relative to both other countries. Interestingly, they find that in specific cases tax harmonization becomes more likely when the median country is excluded from the coalition.

1.4.4. Conclusion

By help of a stylized model we have shown that cooperation in tax competition among subgroups of countries can be sustained as a self-enforcing agreement. For any arbitrary coalition structure, the central force that determines the stability of cooperation is directly related to a kind of “market power” of the largest coalition. In addition, the degree of cooperation ex-ante has an effect on the sustainability of the implicit contract between coalitions. Clearly, the model needs to be extended by incorporating further asymmetries. For instance, heterogenous preferences regarding an optimal public policy of countries (e.g. Cnossen, 1990) or differences in productivity and endowments (e.g. Peralta and van Ypersele, 2005) will induce limits to cooperation. In summary, it is surely true that in times where markets have internationalized “[t]he price of maintaining national jurisdictional sovereignty [...] is that politics have to be exercised of a much narrower domain” (Rodrik, 2000, p. 182). But given that countries play the tax game over and over again, it is likely that cooperation is self-enforcing, even within different coalition structures. We may conclude that various forms of partial harmonization become easier, once efforts have been made to create broad coalitional structures.
1.5 The Strategy of Terror—Elaboration on the Topic

The focus of analysis of both papers in the second part of this dissertation is on specific determinants in conflicts, hereby combining the economic with a political perspective. The view we adopt here is that “strategies of conflict” can be a reasonable behavior adopted by rational agents.

We focus on terrorism as a particular form of political violence, hence, it is reasonable to allocate some more time to introduce the subject instead of discussing the related literature. Terrorism is commonly defined as “the premeditated use or threat to use violence by individuals or subnational groups in order to obtain a political or social objective through the intimidation of a large audience beyond that of the immediate victims” (Enders and Sandler, 2006, p. 3). That is, terrorism differs from ordinary crime by sending a political message to a target audience. On their side, an important observation may be that “there are few incentives more powerful than the fear of random violence—which, in essence, is why terrorism is so effective.” (Levitt and Dubner, 2005, p. 62). By this intimidation, the aim of terrorists is to make political leaders concede their demands by wide, popular pressure (cf. Enders and Sandler, 2006, p. 4).

Terrorism is a highly asymmetric form of conflict. The comparative costs of the conflict technology is in favor of the perpetrators which is illustrated, e.g., by the imbalance between multiplicity of targets and the inability to protect these targets on the side of the government (cf. Shughart, 2011, p. 141). The rational choice perspective on the calculus of terrorists is that these are driven by similar incentives and constraints that shape behavior in more ordinary circumstances (cf. Shughart, 2011, p. 143). For instance, Shughart (2011, p. 143) states that “[terrorism] emerges from inter-group conflict over things such as the distribution of land or other natural resources and the control of the levers of political power, including [...] access to the largesse of the welfare state.” In this sense, with the prospect to gain (or to avoid losing) something we are back at the common reason to engage in any form of conflict (cf. Tullock, 1974, p. 87).

A variety of root causes that have an impact on an agent’s cost-benefit considerations to turn to terrorism have been put forward; for an overview see Gassebner and Luechinger (2011) or Krieger and Meierrieks (2011). In brief, these factors are inter alia related

---

26With regard to strategic interactions between terrorists and governments there is some very interesting game-theoretical literature, e.g. analyzing the credibility of a policy not to negotiate with hostage-takers (Sandler and Lapan, 1988). A repeated interaction model is employed by Bueno de Mesquita (2005) studying the rationale of governments to make concessions and providing a theoretical underpinning for the observation that concessions are followed by an increase in terrorist activity. See Enders and Sandler (2006) for more game-theoretic insights in the case of terrorism.

27Schneider et al. (2010a,b) provide a comprehensive survey of the economic analysis of terrorism and counter-terrorism efforts.
to the schools of thought advanced by political scientists on the causes of violence with a political background. These focus on personal frustrations and grievances, which might stem from economic deprivation (e.g. Gurr, 1970). That is, inequality and poverty induce such feelings, for instance. A further potential source are dynamic changes in the socio-economic environment, subsumed under the notion of “modernization” creating economic “winners and losers” (e.g. Ross, 1993).

So, very abstractly, modernization (e.g. globalization) and relative economic deprivation (e.g. more unequal income distributions) underline the impact of (induced) changes with respect to material final ends on the individual level in relation to society. That is, the state of the economy, its growth and the distribution of the “economic pie” are, for instance, possible but of course not solely relevant fundamental root causes in explaining terrorist activity. We have encountered these mechanisms in the more general model of conflict by Eggert et al. (2011). For a model that employs these basic economic mechanisms, as well, and explicitly differentiates between low-intensity violence (terrorism) and high-intensity violence (civil war) see Blomberg et al. (2004).

This paper studies the social origins of specific types of terrorism, testing a set of various socio-economic and political conditions. We consider the underlying motivational bonds of terrorist groups. In principle, these motivational bonds might induce a bias on the choice between productive and appropriative strategies for agents that turn to this strategy of conflict. Moreover, the intensity of conflict might be affected by the overall goal that distinct forms of terrorism seek to pursue. In theoretical terms, this basically refers to the divisibility of the contest price, for instance, as to mirror binary decisions about the political regime type. We test whether these and further effects, which will be introduced in the next section in more detail, can be supported by empirical evidence.

We find that distinct forms of terrorism are indeed differently affected by certain conditions. So given the large efforts that have been made in previous studies in understanding root causes of terrorism using macro data, our paper calls for a more nuanced view with respect to averaging effects by pooling distinct types ex-ante. In comparison to the literature, one may also add that this paper (as well as the next one) adds to the literature by studying domestic terrorism which is a far more common phenomenon than transnational terrorism but has only recently become feasible due to the release of new databases.  

1.6.1. Background

There exist many classification approaches of political terrorism, many of them make a difference between left-wing, right-wing, nationalist-separatist or religiously motivated terrorist movements. It is evident that different types of terrorism are characterized by unique historic roots, specific goals, the degree of negotiability of these goals, the adopted politico-military strategies, the potential coalition size, the degree of internationalization etc. Accordingly, it seems plausible that heterogenous forms of terrorism are also differently affected by social conditions and their changes. Nevertheless, this differentiation has been largely ignored in the comparative studies analyzing the causes of terrorism by means of large-N panel data, hereby implicitly assuming that one behavioral model can explain any type of terrorism. Accounting for the role of political motivations might add to a better understanding of the social origins of terrorism, given the inconclusive evidence in previous large-N studies (e.g. Gassebner and Luechinger, 2011).

28Domestic terrorism involves citizens, groups, territory, etc. of a single country, transnational terrorism affects more than one country.
After the end of World War II, a number of Western European countries have had major episodes of terrorist activity whereas others were relatively spared from this political violence. The most severe forms in terms of casualties were left-wing as well as nationalist-separatist terrorism. Left-wing terrorism is ideologically motivated, historically rooted in anti-capitalism movements and the protests of 1968, among others. The extreme goals of left-wing terrorism, that is, a political regime change to implement their Marxist-Leninist vision of society has two consequences. First, it limits their popular support to a “modernist avantgarde”. Second, it makes their goals non-negotiable. Left-wing terrorists are driven by their “supreme values” possibly making them less responsive to short-term cost-benefits considerations (Bernholz, 2006). Commonly, left-wing terrorists look for international support while resorting to a “revolutionary vanguard”-strategy with targeted killings (Shughart, 2006).

Nationalist-separatist terrorism is ethnically motivated and has country-specific roots. Characteristic for this form of terrorism is that it aims at a territorial change by the creation of an independent state (or, the prevention hereof). Importantly, this is a negotiable goal, e.g. the government could make concessions by granting autonomy or independence. This also implies that the communal bonds of ethnic terrorist groups may translate into a possibly broad coalition, that is, they can expect substantial popular support by creating distinct communal identities and providing “ethnic infrastructure”, e.g. public goods. The modus operandi is characterized by attrition warfare but also negotiations by political wings.

Given the inconclusive evidence in the literature and the fact that only few studies have tried to account for the role of motivational bonds, the following paper sheds some light on these issues. At the same time, it also contributes in a methodological manner in that it underlines the importance for adjusting the focus of statistical analysis to avert an averaging of effects.

1.6.2. Contribution

In the paper “Looking Back on Anger: Explaining the Social Origins of Left-Wing and Nationalist-Separatist Terrorism in Western Europe, 1970–2007” Brockhoff/Krieger/Meierrieks use a uniquely coded dataset to separately analyze the social origins of revolutionary (left-wing) and ethnic terrorism. We expect these heterogenous forms of terrorism to respond differently to specific conditions. At the same time we anticipate an intersecting set of conditions that simultaneously explains the genesis of both forms of terrorism.

We test this conjecture by four broad classes of hypotheses which systematically cover determinants that have been identified as potentially relevant causes to terrorism in the literature. Accordingly, our hypotheses cover
1.6 Explaining the Social Origins of Left-Wing and Nationalist-Separatist Terrorism ...

(H1) Socio-economic conditions (operationalized by e.g. the level of GDP p.c., level of unemployment)

(H2) Domestic political factors (e.g. support for the respective ideologies, existence of a right-wing government, prevalence of anti-government protests)

(H3) Politico-historic factors (e.g. Cold War era, age of democracy)

(H4) Demographic conditions (e.g. population size, degree of ethnic polarization)

We use data for 17 Western European countries for the time period between 1970 and 2007 on the basis of the *Global Terrorism Database* (GTD) employing generalized estimation equation (GEE) models for negative-binomially distributed panel count data, given that the dependent variable is a count number of domestic terrorist incidents. Using various sources we classify terrorist groups with respect to their primary goal, that is, whether the group pursues a predominantly social revolutionary agenda to induce a regime change (anarchist, communist/socialist, anti-globalization, leftist) or a nationalist-separatist agenda to seek territorial change.

Our main results are as follows: For left-wing terrorism we find that variables reflecting socio-economic imbalances (e.g. unemployment) tend to promote terrorism, that is, economic grievances seem to matter (due to opportunity costs and recruitment efforts), while broad measures of socio-economic development (GDP p.c.) have no statistical effect. Additionally, domestic politics (H2) seems to determine left-wing terrorism in that higher vote shares for radical left-wing parties increases the number of attacks. This means that there could be a mobilization effect due to a relatively strong political support. With respect to politico-historic factors (H3) we find that young democracies could have been prone to left-wing terrorism because of relatively weak institutions and the fact that many European countries have had fascist regimes. Also, left-wing terrorism was more likely during the Cold War era, e.g. due to political and financial support of the Soviet Union. Demographic conditions (H4) in terms of the population size correlates positively with left-wing terrorism while ethnic polarization does not have an impact.

For nationalist-separatist terrorism our results are rather different: Indicators of good socio-economic conditions (H1) suggest a negative effect on this kind of terrorism. Even more, this effect continues to hold checking robustness with further variables, e.g. by the inflation rate and the degree of trade openness. Vice versa, there may be a close and reinforcing relationship between underdevelopment, modernization strain (e.g. increasing unemployment) and ethnically motivated economic discrimination. Domestic politics (H2) are relevant in that increased vote shares for nationalist-separatist parties tend to reduce ethnic terrorism. As argued before, this might be due on the grounds that a higher political influence is likely to demand and achieve concessions since—ultimately—goals of ethnic terrorists are negotiable.
1.6 Explaining the Social Origins of Left-Wing and Nationalist-Separatist Terrorism ...

There is some evidence that a right-wing incumbency seems to trigger ethnic terrorism due to more hawkish policies and less granted concessions. In addition, anti-government demonstrations are a positive predictor of ethnic terrorism. For instance, non-violent protests may facilitate recruitment and financing of terrorist groups. Interestingly, ethnic terrorism is more likely the longer the period of democracy while the Cold War era has not significant impact (H3). Finally, population size and ethnic polarization (H4) are both robust and positive predictors of ethnic terrorism, for instance as they may signal the existence of politico-economic conflicts over scarce resources.

1.6.3. Conclusion

In summary, our findings indicate the need for a more nuanced analysis and distinction for the causes of different forms of terrorism. Terrorist groups differ with respect to specific determinants, which also seems to result from different underlying political goals. This has obvious implications for measures of counter-terrorism. Generally speaking, our findings suggest that conventional approaches to the analysis of terrorism determinants may yield inconsistent findings, masking the “true correlates” of different types.
1.7 The (Nontrivial) Impact of Education on Domestic Terrorism

1.7. Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism

The last paper empirically analyzes the role of education in terrorism, which is an important but ambiguous topic of political debate. In principle, we study the impact of education on conflict activity and analyze whether there exists a “sort of” separating equilibrium between agents with relatively low and high education. In theoretical terms, one effect might be that the better educated resort to conflict when their expected return on educational investment is not met, that is, when productive strategies yield comparatively low payoffs. Moreover, the better educated might have better conflict technologies, adding a demand side effect. The precise transmission channels of education will be introduced in the next section.

We analyze the choice to resort to terrorism by agents with different education levels and conditional upon overall economic performance, which is a major innovation of this paper. That is, we differentiate data ex-post by means of a cluster analysis, which provides more clear-cut and robust empirical effects in comparison to the previous literature.

1.7.1. Background

While after the 9/11 attacks policy makers and the general public widely agreed that education reduces terrorism, the literature has come to very inconclusive evidence. For instance, a very influential contribution by Krueger and Maleckova (2003), that uses micro data of the Arab-Israeli conflict, suggests that on the individual level many terrorists are rather well-educated whereas the generalization on a cross-country level is rejected. Other large-N studies that control for the effect of some education proxy yield ambiguous conclusions. The problem with these studies is that (1) they use only one specific out of a range of education proxies (e.g. school enrollment rates vs. illiteracy rates) and (2) they analyze different forms of terrorism (e.g. domestic vs. transnational terrorist events as well as country of origin vs. country of location perspective).

Following the rational-choice perspective, there are several transmission channels in which education may affect terrorist activity by inducing changes in costs and benefits. In general, one can differentiate between a supply side argument, where opportunity costs, perceived benefits and the direct costs of terrorism determine the participation in terrorist activity, and a demand side argument, where e.g. recruitment costs matter.

In line with the literature, the basic arguments why terrorism could reduce terrorism by increasing its opportunity costs are

- Education induces higher individual and aggregate national socio-economic success
1.7 The (Nontrivial) Impact of Education on Domestic Terrorism

- Education positively correlates with political participation which opens non-violent opportunities to foster political change
- A favorable combination between education, economic development and democracy leads to a positive politico-institutional outcome creating a further positive effect of education on economic growth

Additionally, perceived benefits of terrorism might decrease as education may change personal attitudes towards extremism and the legitimization of violence.

The basic arguments why education might fuel terrorism are:

- An unfavorable combination of poor socio-economic, politico-institutional or demographic conditions implies that advances in education may not (sufficiently) increase the opportunity costs of terrorism because the relevant transmission channels (income, political participation, economic growth) do not work
- Education may increase the (perceived) benefits of terrorism, e.g. the removal of existing social constraints might pay off for the educated in the long run
- Education may signal a higher terrorist success probability adding to the demand of educated recruits

The following paper will analyze whether cross-country data can provide evidence for these mechanisms.

1.7.2. Contribution

In the paper “Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism” Brockhoff/Krieger/Meierrieks reassess the impact of education on terrorism. We expect the role of education to be determined by the change in educational attainment relative to changes in politico-institutional and socio-demographic conditions.

Our hypotheses are as follows:

(H1) Countries with higher levels of education will (ceteris paribus) experience lower levels of terrorism (conventional wisdom).

(H2a) Countries with higher levels of education will (ceteris paribus) experience higher levels of terrorism when country-specific (socio-economic, political, institutional, demographic etc.) circumstances are poor.

(H2b) Countries with higher levels of education will (ceteris paribus) experience lower levels of terrorism when country-specific circumstances (see H2a) are favorable.
1.7 The (Nontrivial) Impact of Education on Domestic Terrorism

We use data for a panel of 133 countries for the years 1984–2007 to test these hypotheses employing a negative binomial model for count data as our dependent variable is a count number of domestic terrorist incidents. The explanatory variables consist of education indicators that systematically cover different levels, e.g. primary or secondary school and university enrollment as well as the literacy rate. We expect basic levels of education to be the most adequate proxy for countries with unfavorable economic and political conditions and higher education levels for countries with more favorable circumstances. Further controls account for the effect of variables that need to be included for obvious statistical reasons, or which determine education and terrorism at the same time.

Our results are as follows: Hypothesis H1 is rejected on the basis of the full sample, that is, education does not reduce terrorism across the board. Running a two-step cluster analysis on the basis of socio-economic development and performance, politico-institutional and demographic factors, two sub-samples of countries are identified. The first sub-sample consists of less developed countries. Here, we find support for hypothesis H2a in that variables reflecting lower education levels are positively associated with terrorism while higher education does not play a role. The second sub-sample covers developed countries and shows a significant negative effect of higher levels of education on terrorism, supporting H2b. Our core findings remain valid to a variety of methodological changes and robustness checks.

1.7.3. Conclusion

In summary, we propose a more nuanced view on the education-terrorism nexus: The impact of education on terrorism should be evaluated conditional upon country-specific circumstances. When these are poor (e.g. slow growth, poor human and economic rights), we find evidence that education may increase terrorism since advances in education do not sufficiently translate into higher opportunity costs. At the same time, education may increase the perceived benefits of terrorism and the probability of success. For more favorable circumstances, we find that education tends to reduce terrorism.
1. Bibliography

Bibliography


1. Bibliography


Friedman, J. (1986). *Game Theory with Applications to Economics*. Oxford University Press.


1. Bibliography


1. Bibliography


1. Bibliography


2. The Three Worlds of Welfare Capitalism Revisited

This chapter is joint work with Stéphane Rossignol and Emmanuelle Taugourdeau and refers to the working paper available as Documents de Travail du Centre d’Economie de la Sorbonne No. 2012.18, March 2012, Université Paris 1, Panthéon–Sorbonne.

2.1. Introduction

This paper compares the three main systems of welfare capitalism—Beveridgean, Bismarckian, Liberal—as analyzed by Esping-Andersen (1990) from both a positive and a normative perspective. To do this, we introduce a new way to model a Bismarckian type of social insurance to account for the fact that Bismarckian systems are organized around groups of agents. We aim to focus on the redistributive design of these different regimes and compare the preferred systems from both perspectives.

The background for our considerations is the following: In many countries with a Bismarckian system, such as Germany, Austria, France or Belgium, a variety of social protection funds for illness, occupational injury, family or pension cover specific groups of people. For instance, the set of French social insurance funds refers to professional groups such as railway and public transportation system employees, seamen, civil servants, agricultural workers, entrepreneurs, etc. For occupational injury, the German insurance system is similarly organized on a professional group basis: Specific employer’s mutual insurance associations cover the commercial, agricultural or the public sector as well as railway workers, firefighters and local authority employees etc.¹ There are other examples in Bismarckian countries where the formation of groups are a result of the agents’ choice. For instance, in Belgium or Germany, people can choose from a (large) range of health insurance funds. These funds are organized on the level of geographic coverage, employers, craft guilds, etc.²

¹German Social Security Law, Book Nr. VII
²In Germany, before the amendment to the Social Security Law in 1996, people had to insure themselves according to the selection criterion of the health insurance funds. Therefore, these funds covered only
2.1 Introduction

The recognition of this organizational and strongly corporatist feature of the Bismarckian system goes back to the seminal work of Esping-Andersen (1990): “corporatism was typically built around occupational groups seeking to uphold [...] status distinctions and used these as the organizational nexus for society and economy.” (p. 60). To be precise, Esping-Andersen (1990) clustered welfare states as “conservative”, “social-democratic” and “liberal” regime types. In line with the established economic literature we retain for the first two systems the nomenclature of “Bismarckian” and “Beveridgean” systems.

As well as other dimensions, one important aspect that distinguishes these systems is their degree of income redistribution. First, Liberal systems are associated with a very low degree of income redistribution since they mainly encourage private insurance. Second, Beveridgean systems, based on the principles of universality, uniqueness and uniformity of benefits, are associated with a high degree of income redistribution. This is due to proportional tax rates but flat benefits. Finally, Bismarckian systems are associated with a lower degree of income redistribution. Most often, they have been modeled in the literature as a global insurance system, organized by the state, where individuals pay taxes proportional to their incomes, but independent of their risks, and receive benefits proportional to their income.

The problem with this way of modeling the Bismarckian system is that it ignores the “corporatist” attribute of such systems: If individuals are differentiated by income and by risk, then a pooling of individuals with specific risks inside each fund leads to “intra-group horizontal redistribution” in the Bismarckian system, i.e. it leads to redistribution from low-risk to high-risk agents inside each fund.\(^3\) As a consequence, each fund is characterized by its specific average risk. Transferred to the level of individual preferences, this implies that individuals who bear a high risk may benefit from a low average group risk. In a similar vein, the introduction of both income and risk heterogeneity of individuals leads to another kind of horizontal redistribution inside the Beveridgean systems: Here, redistribution is based on individual risk and on the distribution of risks inside the entire society. In our terminology, this type is called “global horizontal redistribution” and it complements the usual vertical income redistribution of the Beveridgean system. Again, transferred to the level of individual preference, poor and/or high-risk individuals benefit from the Beveridgean system.

The Liberal system is characterized by neither horizontal nor vertical redistribution, since it consists of a private insurance mechanism, with a contribution rate that is proportional to individual risk and income. In the following, we provide a model which accounts for all people who exactly matched their selection criterion, e.g., they lived in a specific geographic region, they worked for a specific employer or in certain craft guilds etc. Nowadays, people can choose which fund they want to be insured in, cf. German Social Security Law, Book Nr. V. Further source: [www.prospeur.org](http://www.prospeur.org).

\(^3\)In our model, individuals can be thought of being differentiated with respect to risk along a horizontal axis and with respect to income along a vertical axis. The notion of “horizontal” refers to the redistribution of risk (i.e. from low-risk to high-risk people) with two aspects: within the entire society, or within groups. Accordingly, “vertical” refers to redistribution of income (i.e. from rich to poor people). See also Section 2.3.2.
of these redistribution patterns by analyzing individual and aggregate preferences for the three systems.

There are two strands of literature which are related to our model. The first strand has determined both the type and the size of social insurance or social security systems, respectively, and therefore refers to the explicit distinction between Bismarckian and Beveridgean systems, see Casamatta et al. (2000b) (for social insurance) and Pestieau (1999) (for social security). They analyze the optimal size of the system (in terms of the tax rate) with the type of system chosen at the constitutional stage. Their main result is that the degree of redistribution affects the political support for the size of the system.\(^4\) Rossignol and Taugourdeau (2004) study both the level of tax rate and the type of system within a probabilistic model of electoral competition. They proved that the chosen social insurance system is that which minimizes the contribution rate for a high relative risk aversion, and that the reverse is true for a low relative risk aversion. Moreover, Conde-Ruiz and Profeta (2007) provide an OLG model of social security where the size and the type of system is determined simultaneously, yet issue-by-issue. They find that the key determinant which shapes their analytical result is income inequality: The Beveridgean system can be supported by a coalition of low and high income individuals.

We complement this first strand of literature in two ways. First, the Bismarckian system is modeled as a corporatist one, which enables us to distinguish it more clearly from the Liberal system. Second, the choice of the system is determined alternatively according to a positive and a normative criterion, that we are able to compare.

The second strand of literature this paper refers to analyzes the link between income inequality and the level of redistribution inside society. Indeed, in our model, the degree of inequality of income and the distribution of risk crucially affect the choice of an agent, which affects the choice of the system for both positive and normative criteria. The link between income inequality and redistribution has first been highlighted in the well-known Meltzer and Richard (1981) general equilibrium model of a labor economy where the share of redistributed income is determined by majority voting.\(^5\) Their main finding is that if mean income rises relative to the income of the median voter, then redistribution increases. In other words, a more unequal income distribution leads to more redistribution. In addition to the standard redistributive mechanism from rich to poor, insurance motives have also been introduced in the analysis of welfare policies. For instance, Moene and Wallerstein (2001) show that the redistributive and the insurance mechanisms work in opposite directions in the sense that support for social insurance spending declines with increased income inequal-

\(^4\)See also Cremer et al. (2007) for the effect of myopic and non-myopic individuals on social security.

\(^5\)In addition, see Romer (1975) and Roberts (1977) on whose results Meltzer and Richard (1981) build upon.
2.1 Introduction

Finally, Kim (2007) extends the analysis of redistribution based on insurance motives by introducing a distribution of risks inside the society, where the level of risk depends on the agent’s sector of activity. The main result of this model is that political demand for unemployment insurance is clearly influenced by both the distribution of risks and income.

As already indicated, our model provides a complete differentiation of individuals along three dimensions: income, individual risk and group risk. This is a key point of our analysis. In the previous literature, Casamatta et al. (2000b) introduce heterogeneity of individuals by a one dimensional differentiation with three discrete levels of income but the same probability of receiving income or relying on social benefits. Casamatta et al. (2000a) and Conde-Ruiz and Profeta (2007) differentiate along two dimensions, namely age (working young vs. retired old) and the level of income (continuous in Casamatta et al., 2000a, discrete in Conde-Ruiz and Profeta, 2007). A related double differentiation of individuals with regard to income and likelihood of illness is found in Gouveia (1997) who analyzes the outcome of majority voting over the public provision of a private good (in particular, health care).

We concentrate on the case of insurance systems that cover unemployment, occupational injury or health risks. Individuals earn a wage income in the good state of the world and receive insurance benefits in the bad state of the world. Furthermore, they are members of a group which is characterized by a group-specific risk distribution. This implies that groups can be ranked according to the average risk of its members. We incorporate into our analysis a Liberal insurance system reflecting an actuarial fair private insurance, a Beveridgean system involving redistribution for the entire society and a Bismarckian system comprising redistribution between high-risk and low-risk individuals within a group. In a two stage model, first, the system of insurance is decided and second, the level of the tax rate is determined. The choice of the tax rate and the choice of the system are determined according to a positive criterion, then compared to a normative one.

In the following we show that by majority voting, the Liberal system wins if the inequality of income is low and the Beveridgean system wins if the inequality of income is high. Employing a utilitarian criterion, the Beveridgean system dominates both the Bismarckian and Liberal systems but the Bismarckian system is preferred to the Liberal one.

This paper is organized as follows: Section 2.2 introduces the model. In Section 2.3 we analyze the pairwise preferences of individuals and determine the type of welfare system chosen by majority voting. In Section 2.4 we analyze the outcome of a utilitarian social planner and compare the results of both criteria. We conclude in Section 2.5.

Moene and Wallerstein (2001) focus on the impact of income inequality on the support of welfare spending when welfare benefits are targeted towards the employed or the unemployed. See also Iversen and Soskice (2001) for a similar model analyzing social policy preferences which depend on different types of skill investments reflecting unemployment risks. Bénabou (2000) analyzes the impact of inequality and redistributive policies that enhance efficiency within a stochastic growth model.
2.2 The Model

The society is divided into groups which are denoted by \( k = 1, \ldots, M \) and there are \( N_k \) members per Group \( k \).\(^7\) There are \( N \) agents in the society with \( N = \sum_{k=1}^{M} N_k \). An agent \( i \) of Group \( k \) has an income \( w_i \) and a risk \( p_i \) to lose this income. A high level of \( p_i \) implies that agent \( i \) is risky in terms of bad health or unemployment, for instance. Each group \( k \) is characterized by a specific distribution function of risk \( f_k \). To concentrate our analysis on the heterogeneity of the distribution of risk, we suppose that the distribution function of income \( g \) is similar in each group. Moreover, for the sake of the readability of our results, we assume that the distribution of incomes and risks are independent. Therefore, groups are heterogeneous with respect to risks but homogeneous with respect to income distribution. We now describe the distribution of income and risk in more detail.

2.2.1. Distributions of income and risk

The distribution of income for each group is represented by the probability density function \( g \) defined on \([w_{\text{inf}}; w_{\text{sup}}]\) with average income \( \bar{w} = \int wg(w) \, dw \). The function \( g \) is positively skewed such that median income \( w_m \) is lower than average income \( \bar{w} \). Income levels can then be ranked as \( 0 \leq w_{\text{inf}} \leq w_m \leq \bar{w} \leq w_{\text{sup}} \).

The distribution of risk depends on the group \( k \) and implies a group-specific risk probability density function \( f_k \) defined on \([0; 1]\). This function \( f_k \) is positively skewed, as well, and produces a particular intra-group average risk \( \bar{p}_k \), where \( \bar{p}_k = \frac{1}{N_k} \int p f_k(p) \, dp \) and \( N_k = \int f_k(p) \, dp \) with \( f_k \geq 0 \). Let \( f \) be the risk probability density function of the entire society, i.e., \( f = \sum_{k=1}^{M} f_k \). We normalize \( N = 1 = \int f \). The average risk in the entire society is \( \bar{p} = \int p f(p) \, dp \).

We assume that the intra-group average risks are ranked as

\[
\bar{p}_1 < \bar{p}_2 < \bar{p}_3 < \ldots < \bar{p}_M
\]  

(2.1)

In addition, we postulate that \( p_{m,k} = p_m \) for every \( k \), i.e., the median risk of each group \( p_{m,k} \) corresponds to the median risk in society \( p_m \), even if the distribution of risk inside each group is different.

How can we justify these two assumptions? It is clear that there is a majority of low-risk people in each group. It is reasonable to assume that the groups are mainly differentiated by the distribution of their high-risk members. This implies that the groups have different

---

\(^7\)These groups could be professional groups (e.g. the service sector, the agricultural sector, the industrial sector etc.) or other types of groups.
average risks $p_k$ (i.e. $p_1 < ... < p_M$), but approximatively similar median risks $p_{m,k}$ (i.e. $p_{m,k} = p_m$ for every $k$).

Finally, based on the positive skewness of function $f_k$, we now postulate

$$\forall k, p_m < \bar{p}_k$$

which implies $p_m < \bar{p}$.

In the following, we will present empirical justification for the relationship between median risk and average risk.

### 2.2.2. Empirical evidence

It is a well-known stylized fact that income distributions in many developed countries exhibit positive skewness, see, e.g. Neal and Rosen (2000). To establish the positive skewness of the risk distribution we can refer to the same line of argument as before: We want to show that there is a majority of low-risk and a minority of high-risk members in each group. In our model, risk refers to the probability of having to rely on (social) insurance benefits due to unemployment or illness. We provide for each of these risk factors an empirically observable proxy.

For unemployment we compare median and average duration of unemployment using data from OECD countries for the years 2000 to 2010. We find that the proportion of countries where median duration of unemployment is clearly smaller than average duration is substantial for the whole time period, see Figure 2.1. Overall, less than 5% of total observations exhibit a reverse relationship with average risk lower than median risk.

For illness our basic hypothesis is that people affected by chronic health problems or disability bear a higher risk of having to rely on insurance payments. Since these people constitute a minority in society, average risk will be lower than median risk. Indeed, data from OECD (2010b) shows that the self-assessed prevalence of chronic health problems or disability is lower than 15% on OECD average for the whole working age population. Even for age group 50–64, the proportion of people with self-assessed chronic health problems or disability is lower than 25% on average and only for few countries a little higher than 30%. Given a minority of people bearing a high risk due to chronic health problems and disabilities, the majority of people has quite a low risk.

---

8 Early contributions to the literature analyzing functional forms of earnings capacities are Staehle (1942), Miller (1955), or Harrison (1981).
9 For reasons of comparability across all OECD countries we chose unemployment rates of male work force.
10 Data from OECD (2010a). Estimation of median and average duration of unemployment and calculations of average duration of unemployment are available from the authors upon request.
2.2 The Model

Moreover, if we consider health expenditures as a proxy of the health risk, then it clearly appears that mean health expenditures are consistently higher than median health expenditures (Jung and Tran, 2010).

2.2.3. The three systems

The agent \( i \) earns with probability \( (1 - p_i) \) an income \( w_i \) which is subject to a payroll tax \( t \), such that \( (1 - t)w_i \) is his net of tax income. With probability \( p_i \) the agent receives social insurance benefits \( b_i \) which, in the case of a Beveridgean system (BE), are identical for all agents \( b_i = b^{BE} \). In the case of the Bismarckian system (BI), social insurance benefits \( b_i \) are proportional to individual income but the coefficient of proportionality is identical for all agents inside the group \( k \), i.e. \( b_i = b^{BI}_k(w_i) = c_k \cdot w_i \). Finally, in the case of a Liberal system (L), benefits that an agent receives in the bad state of the world are actuarially computed, based on both his risk \( p_i \) and the wage \( w_i \) that he would receive in the good state of the world, i.e. \( b_i = b^L(p_i, w_i) \). No redistribution occurs in this last system.

Hence, under the Liberal system, the budget constraint for each agent \( i \) is given by \( (1 - p_i) tw_i = p_i b^L(p_i, w_i) \) which immediately implies

\[
b^L(p_i, w_i) = \frac{1 - p_i}{p_i} tw_i
\]

Under the Bismarckian system, the budget constraint in Group \( k \) is

\[
\frac{1}{N_k} \int \int ((1 - p)tw) f_k(p)g(w) dpdw = \frac{1}{N_k} \int \int pb^{BI}_k(w) f_k(p)g(w) dpdw
\]
2.2 The Model

and since $b^{BI}_k(w_i) = c_k w_i$ it implies $rac{1}{N_k} \int \int ((1 - p)tw) f_k(p)g(w) dp dw = \frac{1}{N_k} \int \int pc_k w f_k(p)g(w) dp dw$
thus $c_k = \frac{1 - p_k}{\bar{p}_k} t$, and finally

$$b^{BI}_k(w_i) = \frac{1 - p_k}{\bar{p}_k} tw_i$$

Lastly, under the Beveridgean system, the social insurance budget constraint satisfies the identity $\int \int ((1 - p)tw)f(p)g(w) dp dw = \int \int pb^{BE} f(p)g(w) dp dw$, which implies

$$b^{BE} = \frac{1 - \bar{p}}{\bar{p}} lw$$

with $\bar{p} = \int p f(p) dp$.

The welfare function under the Beveridgean system, for an individual $i$ of risk $p_i$ if the tax rate is $t$, is now:

$$W^{BE}(t, p_i, w_i) = (1 - p_i)U((1 - t)w_i) + p_i U\left(\frac{1 - \bar{p}}{\bar{p}} lw\right)$$

Analogously, the group-specific welfare function for the Bismarckian system for a member $i$ of Group $k$, is

$$W^{BI}_k(t, p_i, w_i) = (1 - p_i)U((1 - t)w_i) + p_i U\left(\frac{1 - p_k}{p_k} tw_i\right)$$

and the welfare function of an agent $i$ under the Liberal system is:

$$W^{L}(t, p_i, w_i) = (1 - p_i)U((1 - t)w_i) + p_i U\left(\frac{1 - p_i}{p_i} tw_i\right)$$

We aim to determine the preferred system according to two alternative criteria, i.e. a positive one, majority voting and a normative one, utilitarian criterion. In both cases, the timing of decisions is as follows: In the first stage, the welfare system is chosen. In the second stage, the level of the tax rate is chosen, according to the studied criterion. We will solve these games by backward induction.

For the sake of simplicity we specify the utility function to be $U(x) = \ln x$. 

47
2.3 Majority Voting

2.3.1. Choice of tax rate

Maximizing the level of the welfare of a given agent \( i \) with respect to the tax rate \( t_i \) yields the same preferred tax rate under the three systems:

\[
t_i^* = p_i
\]  
\[(2.2)\]

The preferred tax rate does not depend on income. Moreover, since agents are differentiated by their risk \( p_i \), their preferences are single peaked with respect to the tax rate. As a result, according to the majority rule, the tax rates that are chosen in both the Beveridgean and Bismarckian systems are those preferred by the median voter, i.e.:

\[
t_{BE}^* = t_{m}^* = p_m
\]
\[
 t_{BI}^* = t_{m,k}^* = p_{m,k}
\]

Since all groups have approximately similar median risks \( p_{m,k} \) (i.e. \( p_{m,k} = p_m \) for any \( k \)), the tax rate chosen by majority voting corresponds to the choice of the society’s median agent and is the same in both the Beveridgean and Bismarckian systems

\[
t_{BE}^* = t_{BI}^* = t_{m}^* = p_m
\]

In the Liberal system the choice of tax rate is made independently by each agent and corresponds to his personal level of risk\(^\dagger\)

\[
t_{L}^* = t_{i}^* = p_i
\]

Incorporating the chosen tax rates in the welfare functions gives:

\[
W_{BE}^*(t_{m}^*, p_i, w_i) = (1 - p_i) \ln((1 - p_m)w_i) + p_i \ln \left( \frac{1 - \bar{p}}{\bar{p} p_m w_i} \right)
\]  
\[(2.3)\]

\[
W_{BI}^{k}(t_{m}^*, p_i, w_i) = (1 - p_i) \ln((1 - p_m)w_i) + p_i \ln \left( \frac{1 - \bar{p}_k}{\bar{p}_k p_m w_i} \right)
\]  
\[(2.4)\]

\[
W_{L}(t_{i}^*, p_i, w_i) = (1 - p_i) \ln((1 - p_i)w_i) + p_i \ln \left( \frac{1 - p_i}{p_i w_i} \right)
\]  
\[= \ln ((1 - p_i)w_i)
\]  
\[(2.5)\]

\(^\dagger\)For the sake of simplicity we refer to the term “tax rate” also with regard to the Liberal system. “Contribution rate” would be a more precise term.
2.3 Majority Voting

2.3.2. Individual preferences on the system

Before determining the system that would be chosen by majority voting, we need to study individual preferences for the systems using the tax rates we have just determined. We focus on a pairwise comparison of the three systems to have a complete ranking of the systems for each agent.

Bismarck or Beveridge?

We start by comparing the Beveridgean and Bismarckian systems with the tax rates obtained by majority voting.

**Proposition 2.1.** Agent $i$ of Group $k$ prefers a Beveridgean system to a Bismarckian one iff $w_i < r_k w$, where $r_k = \frac{1-p_k}{1-p}$ is an increasing function of $p_k$, and thus of $k$.

This agent prefers the Bismarckian system iff $w_i > r_k w$.

**Proof.** From Equations (2.3) and (2.4)

$$W_{BE}^{BE}(t_m, p_i, w_i) > W_{BI}^{BI}(t_m, p_i, w_i) \iff p_i \ln \left( \frac{1-p}{p} p_m w \right) > p_i \ln \left( \frac{1-p_k}{p_k} p_m w_i \right)$$

which is equivalent to

$$\frac{1-p}{p} w > \frac{1-p_k}{p_k} w_i$$

i.e. equivalent to $w_i < r_k w$, where $r_k$ is clearly an increasing function of $p_k$, and $p_k$ is an increasing function of $k$ according to Inequality (2.1). □

Note that the coefficient $r_k$ is a measure of the average risk $p_k$ in Group $k$, relative to the average risk of society, $p$. If the average risk in Group $k$ coincides with the society’s average risk, then $r_k$ is equal to 1. If the average risk in Group $k$ is lower (higher) than the society’s average risk, then $r_k$ is strictly smaller (larger) than 1. Since $r_k$ is an increasing function of $k$, we can write:

$$r_1 < r_2 < \ldots < r_j < 1 < r_{j+1} < \ldots < r_M$$

With the usual way of modeling the Bismarckian system, there is only one group, i.e. $M = 1$. In this case, $p_1 = \bar{p}$ so that $r_1 = 1$. It immediately implies that an agent of income $w_i$ prefers a Beveridgean system if $w_i < \bar{w}$ and a Bismarckian one if $w_i > \bar{w}$. It is a particular case of our Proposition 2.1.
2.3 Majority Voting

With the more realistic way of modeling the Bismarckian system that we adopt here, the Bismarckian system is particularly interesting for agents who belong to low-risk groups, i.e. to Group $k$ with $k$ low. Agents who bear a high risk benefit from a group with a low mean risk because of the intra-group horizontal redistribution.

Both the Beveridgean and the Bismarckian systems imply horizontal redistribution (i.e. from low-risk to high-risk agents), but the only system with vertical redistribution (i.e. from rich to poor agents) is the Beveridgean one. Thus, poor agents prefer Beveridge to Bismarck.

An individual $i$ prefers a Beveridgean system if his income $w_i$ is such that $w_i < r_k \bar{w}$, as shown in Figure 2.2. In each group, there may be a proportion of agents who prefer the Beveridgean system and another that prefer the Bismarckian one. The proportion of agents who prefer the Beveridgean system increases with the average risk of the group. As a consequence, according to the ranking of the $p_k$, the proportion of agents who prefer a Beveridgean system is the lowest in Group 1 and the highest in Group $M$. Note that the individual choice of the system only depends on the group the individual belongs to, and on his individual income $w_i$, but not on his individual risk $p_i$. Finally, every agent of Group $k$ prefers a Beveridgean system if

$$ w_{sup} < r_k \bar{w} $$

which is more likely to be true for high $k$ (that is for a high average risk), whereas every agent prefers a Bismarckian system if

$$ w_{inf} > r_k \bar{w} $$

which is more likely to be true for low $k$ (that is for a low average risk).

Bismarck or Liberal?

Now we compare the Bismarckian and Liberal systems. An agent $i$ of Group $k$ prefers a Bismarckian system if

$$ W^{BI}_k(t^*_m, p_i, w_i) > W^L(t^*_i, p_i, w_i) $$

which leads to the following proposition:

**Proposition 2.2.** Agent $i$ of Group $k$ prefers a Bismarckian system to a Liberal one iff $p_i > \hat{p}_k$, where $\hat{p}_k$ only depends on the group of the agent, and is an increasing function of $k$.

This agent prefers the Liberal system iff $p_i < \hat{p}_k$

*Proof. See Appendix 2.A.*
2.3 Majority Voting

Figure 2.2.: Individual preferences: BE or BI?

Figure 2.3.: Individual preferences: L or BI?
2.3 Majority Voting

Note that the choice between L and BI does not depend on the income earned by the agent in the good state of the world, because in both systems there is no vertical redistribution.

A Bismarckian system implies intra-group horizontal redistribution (i.e. from low-risk to high-risk agents) in opposition to the Liberal system. As a result, high-risk people prefer the Bismarckian system to the Liberal one. For a given agent of risk $p_i$, the Bismarckian system is more interesting if the other agents of the group are low risk. If $k$ is low (i.e. $p_k$ low), Group $k$ is a very low-risk group. It is then interesting to have a Bismarckian system for an agent of this group, as it appears in Figure 2.3.

**Beveridge or Liberal?**

Now we compare the Beveridgean and Liberal systems. An agent $i$ prefers the Beveridgean system iff

$$W^{BE}(t^*, p_i, w_i) > W^L(t^*, p_i, w_i)$$

which leads to the following proposition:

**Proposition 2.3.** Agent $i$ prefers a Beveridgean system to a Liberal one iff

$$w_i < \hat{w}(p_i)$$

where $\hat{w}(p_i)$ is an increasing function of $p_i$, with $\hat{w}(0) = 0$ and $\hat{w}(1) = +\infty$

This agent prefers the Liberal system iff

$$w_i > \hat{w}(p_i)$$

*Proof. See Appendix 2.B.*

Figure 2.4 presents the partition of the population between those who prefer a Liberal system and those who prefer a Beveridgean system. The preference depends both on the income and the risk supported by the agent. The curve representing the function $\hat{w}$ characterizes the boundary between both regimes. Therefore, a combination of income and risk on the boundary makes the agent indifferent to both regimes.

An agent $i$ of income $w_i$ and risk $p_i$ prefers a Beveridgean system against a Liberal one iff

$$w_i < \hat{w}(p_i)$$

where $\hat{w}$ is an increasing function of $p_i$. Agents with a sufficiently high income and relatively low risk prefer the Liberal system. Agents with a sufficiently low income and relatively high risk prefer the Beveridgean system because they benefit from vertical and horizontal redistributions.

A Beveridgean system implies both global horizontal and vertical (i.e. from rich to poor agents) redistribution. Both high-risk and/or poor agents have an incentive to choose a Beveridgean system to benefit from redistribution. Conversely, low-risk and/or rich agents benefit more from supporting their preferred tax rate. In addition, these agents do not benefit from redistribution. Therefore, they are in favor of a Liberal system.
2.3 Majority Voting

Summary of individual preferences

Overall, there are three types of redistribution mechanisms which essentially determine individual preferences. They are summarized in Table 2.1.

<table>
<thead>
<tr>
<th>Redistribution mechanism</th>
<th>Effective in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical redistribution</td>
<td>BE</td>
</tr>
<tr>
<td>Global horizontal redistribution</td>
<td>BE</td>
</tr>
<tr>
<td>Intra-group horizontal redistribution</td>
<td>BI</td>
</tr>
</tbody>
</table>

Table 2.1.: Summary of redistribution mechanisms

Figure 2.5 gives an overview of the partition functions for individual preferences for a given Group $k$. First, the Beveridgean system is clearly preferred by agents who are characterized by a combination of very low income and very high risk. However, Beveridge is also preferred by poor agents who support a relatively small risk if the “income effect” of a high vertical redistribution dominates.

Second, the Liberal system is preferred by agents with a low risk, from the “quite rich” to the very rich agents because low-risk agents are against horizontal redistribution and rich agents are against vertical redistribution. However, a Liberal system is also preferred by poor agents who have a very low risk: If this “low-risk effect” dominates the income effect
from vertical redistribution inside the Beveridgean system, then these agents also prefer Liberal to Beveridge. The additional advantage of a Liberal system is that the tax rate is not chosen by a decision-maker, but is the one preferred by the agent.

Third, agents are in favor of a Bismarckian system if they are sufficiently rich and have a level of risk beyond a certain threshold since the Bismarckian system features intra-group horizontal redistribution but no vertical redistribution.

The impact of a higher group risk on the partition space of individual preferences can be seen by considering preferences of Group $k + 1$. Compared to Group $k$, the indifference curves of agents in this group will move for $BE = BI$ upwards and for $BI = L$ to the right. This is indicated in Figure 2.5. As a consequence, the space where the Bismarckian system is preferred becomes smaller because a Bismarckian system is more favorable for lower group risk.

### 2.3.3. Choice of the system under majority voting

Before studying the choice of a utilitarian planner we first focus on a simple positive decision rule: majority voting. We restrict our analysis to pairwise comparisons of the choice of the
2.3 Majority Voting

systems. Note that there is not necessarily unanimity within a group regarding a preferred system.

**Bismarck or Beveridge?**

In the following we define as the “poor” those agents whose income is lower than the average income \((w_i < \bar{w})\) and as the “rich” those agents who have a higher-than-average income \((w_i > \bar{w})\). We study the impact of a “mean preserving spread” (hereafter referred to as MPS).\(^{12}\) This means that rich people become richer, poor people become poorer, but the average income remains unchanged.

Recall that the indicator of risk of Group \(k\) relative to society’s risk, \(r_k\), is ranked as follows:

\[
r_1 < \ldots < r_j < 1 < r_{j+1} < \ldots < r_M
\]

**Proposition 2.4.** (i) If the inequality of income is low, i.e., here, if \(r_j \bar{w} < \underline{w} < \bar{w} < r_{j+1} \bar{w}\), then in Groups 1, 2, \ldots, \(j\), there is unanimity in favor of the Bismarckian system, and in Groups \(j+1\), \ldots, \(M\), there is unanimity in favor of the Beveridgean system.

(ii) A Mean Preserving Spread (MPS) of the distribution of incomes implies a lower political support for the Bismarckian system in Groups 1, \ldots, \(j\), and a lower political support for the Beveridgean system in Groups \(j+1\), \ldots, \(M\).

(iii) With a sufficiently large MPS, there is a majority in favor of the Beveridgean system.

**Proof.** See Appendix 2.C

The decisive factor which determines the type of system is income inequality.

An interpretation of this Proposition is as follows:

(i) If the inequality of income is low, the impact of vertical redistribution can be neglected. In this case, comparing BI and BE systems means that two different types of horizontal redistribution are compared: intra-group horizontal redistribution in the BI system and global horizontal redistribution in the BE system. The intra-group horizontal redistribution is more favorable for groups 1, \ldots, \(j\) because for them \(\underline{p}_k < \bar{p}\) holds true. Therefore, each member in these groups prefers a BI system.

The reverse is true for groups \(j+1\), \ldots, \(M\): They benefit more from global horizontal redistribution since \(\bar{p} < \bar{p}_k\). Consequently, all agents in these groups prefer a BE system.

(ii) Let us consider Groups 1, \ldots, \(j\) after an MPS. The rich agents of these groups will still prefer the BI system. The same is true for the “rather” poor people, because they benefit

\(^{12}\)Note that an MPS is related to second-order stochastic dominance, this is well defined in Mas-Colell et al. (1995), chapter 6.D.
2.3 Majority Voting

from their low intra-group risk \( p_k \) in the BI system. The poorest people become even poorer with the MPS, so that they finally prefer BE because it allows vertical redistribution.

For agents who belong to Groups \( j + 1, \ldots, M \), again, the reverse is true. With an MPS, the poor agents of these groups will still prefer BE, and also the “rather” rich people. The richest agents become even richer with the MPS, so that they finally prefer BI because it does not imply vertical redistribution. Therefore, if a majority of people belongs to Groups 1, \ldots, j, then BI is adopted by majority voting. BE is adopted if the reverse is true.

(iii) In case of a very large inequality of income (i.e. very large MPS), the effect of vertical redistribution dominates horizontal redistribution: people with an income \( w_i \) lower than \( \bar{w} \) almost all prefer BE. Then, there is a majority for BE since \( w_m < \bar{w} \).

This effect is in line with the result from Meltzer and Richard (1981) which states that when the share of redistributed income is determined by majority voting, a more unequal income distribution leads to more redistribution.

Bismarck or Liberal?

We now focus on the choice between a Bismarckian and a Liberal system. The inequality of income has no impact on the political support of the Liberal system against the Bismarckian one, because in both systems the social benefit is proportional to the income, i.e. there is no vertical redistribution.

Recall we have assumed that the median voter is the same in each group, i.e. \( p_{m,k} = p_m \) for every \( k \).

**Proposition 2.5.** According to the majority voting criterion a Liberal system is adopted against a Bismarckian one.

**Proof.** We can set

\[
    h_k (p_m) = W_k^{BI} (t_{m,k}^*, p_m, w_i) - W_k^L (t_{i}^*, p_m, w_i) = p_m \ln \left( \frac{1 - \tilde{p}_k}{\tilde{p}_k} \frac{p_m}{1 - p_m} \right)
\]

Since \( p_{m,k} = p_m \) for every \( k \), and \( p_m < \tilde{p}_k \) for every \( k \), then \( h_k (p_m) < 0 \).

From Proposition 2.2 and its proof, we are then able to state that for all agents \( i \) with \( p_i \leq p_m \), that represent at least 50% of the voters of each group, the Liberal system is preferred. \( \Box \)
2.3 Majority Voting

The main advantage of the Liberal system is that agents can choose their individually preferred tax rate. The main advantage of the Bismarckian system is intra-group horizontal redistribution; however, this advantage only applies to a minority of people. As a result, the Liberal system is preferred by a majority of agents.

Beveridge or Liberal?

Let us now study the majority choice between the Beveridgean and Liberal systems.

According to Proposition 2.3, we know that an agent of income \( w_i \) and risk \( p_i \) prefers the Beveridgean system against the Liberal one iff \( w_i < \hat{w}(p_i) \). The function \( \hat{w} \) depends on \( p_m, \bar{p}, \) and \( \bar{w} \). In the following proposition, we show that the political support for BE (against L) depends on the level of inequality of income in the society.

**Proposition 2.6.** (i) If the inequality of income is low, here more precisely, if \( \frac{w_{\inf}}{\bar{w}} > \eta \), where \( \eta \) only depends on the distribution of risks, and \( 0 < \eta < 1 \), then a majority of agents prefers a Liberal system to a Beveridgean one.

(ii) A Mean Preserving Spread (MPS) of the distribution of income implies a higher political support for the Beveridgean system.

(iii) With a sufficiently large MPS, there is a majority in favor of the Beveridgean system.

*Proof.* See Appendix 2.D.

Again, there is a precise interpretation of this proposition.

(i) If the inequality of income is low, vertical redistribution does not matter. In this case, BE vs. L means global horizontal redistribution vs. no redistribution at all. Global horizontal redistribution is in favor of high-risk agents which are a minority. In turn, there is a majority for the L system.

(ii) The higher the inequality of income, the stronger the vertical redistribution. Poor agents are in favor of vertical redistribution. Since they constitute more than 50% of the population, the support for BE increases.

(iii) With a sufficiently large inequality of income, the effect of vertical redistribution dominates, so poor agents will be in favor of BE.
2.4 Utilitarian Criterion

In this section, we focus on a normative criterion, analyzing the choice of a utilitarian social planner.

2.4.1. Choice of tax rate

The Liberal system is characterized by total liberty of choice for any individual. Similarly to the majority voting analysis, the individually preferred tax rate is applied, i.e.

\[ t^*_L = t^*_i = p_i \]

Under the Beveridgean system, the utilitarian planner determines the common optimal tax rate, \( t^*_u^{BE} \), by maximizing the average of the individual welfares. Since

\[
U^{BE} = \int \int W^{BE}(t^*_u^{BE}, p, w) f(p) g(w) dp dw
\]

\[
= \int \int \left[ (1 - p) \ln((1 - t^*_u^{BE})w) + p \ln \left( \frac{1 - \bar{p}}{\bar{p}} t^*_u^{BE} \right) \right] f(p) g(w) dp dw
\]

\[
= (1 - \bar{p}) \ln(1 - t^*_u^{BE}) + \bar{p} \ln \left( \frac{1 - \bar{p}}{\bar{p}} t^*_u^{BE} \right) + (1 - \bar{p}) \ln w + \bar{p} \ln \bar{w}
\]

where \( \ln \bar{w} \) stands for the mean of \( \ln w_i \). Then \( \max_{t^*_u^{BE}} U^{BE} \) implies \( t^*_u^{BE} = \bar{p} \).

Under the Bismarckian system, the utilitarian planner determines the optimal tax rate of Group \( k \), \( t^*_u^{BI,k} \), by maximizing the average of the individual welfares of Group \( k \).\(^{13}\) Since

\[
U^{BI,k} = \frac{1}{N_k} \int \int W^{BI}_k(t^*_u^{BI,k}, p, w) f_k(p) g(w) dp dw
\]

\[
= \frac{1}{N_k} \int \int \left[ (1 - p) \ln((1 - t^*_u^{BI,k})w) + p \ln \left( \frac{1 - \bar{p}_k}{\bar{p}_k} t^*_u^{BI,k} \right) \right] f_k(p) g(w) dp dw
\]

\[
= (1 - \bar{p}_k) \ln(1 - t^*_u^{BI,k}) + \bar{p}_k \ln \left( \frac{1 - \bar{p}_k}{\bar{p}_k} t^*_u^{BI,k} \right) + \bar{p}_k \ln t^*_u^{BI,k} + \bar{p}_k \ln \bar{w}
\]

then maximizing \( U^{BI,k} \) yields the optimal tax rate \( t^*_u^{BI,k} = \bar{p}_k \).

\(^{13}\)Generally, in Bismarckian countries, tax rates differ across funds.
2.4 Utilitarian Criterion

2.4.2. Choice of the system

The Beveridgean system yields the following social welfare:

\[ U^{*}_{BE} = (1 - \overline{p}) \ln(1 - t^{BE}_u) + \overline{p} \ln \left( \frac{1 - \overline{p}}{\overline{p}} \right) + (1 - \overline{p}) \ln \overline{w} + \overline{p} \ln \overline{w} \]

\[ = (1 - \overline{p}) \ln(1 - \overline{p}) + \overline{p} \ln \left( \frac{1 - \overline{p}}{\overline{p}} \right) + (1 - \overline{p}) \ln \overline{w} + \overline{p} \ln \overline{w} \]

\[ = \ln(1 - \overline{p}) + (1 - \overline{p}) \ln \overline{w} + \overline{p} \ln \overline{w} \quad (2.6) \]

The Bismarckian system produces the social welfare:

\[ U^{*}_{BI} = \sum_{k=1}^{M} N_k U^{*}_{BI,k} \]

where

\[ U^{*}_{BI,k} = (1 - \overline{p}_k) \left[ \ln (1 - \overline{p}_k) + \ln \overline{w} \right] + \overline{p}_k \ln \left( \frac{1 - \overline{p}_k}{\overline{p}_k} \right) + \overline{p}_k \ln \overline{p}_k + \overline{p}_k \ln \overline{w} \]

\[ = \ln (1 - \overline{p}_k) + \overline{p}_k \ln \overline{w} \]

thus

\[ U^{*}_{BI} = \sum_{k=1}^{M} N_k [\ln (1 - \overline{p}_k)] + \ln \overline{w} \quad (2.7) \]

The Liberal system gives the social welfare:

\[ U^{*}_{L} = \iint W^{L}(t^*; p; w) f(p) g(w) \, dp \, dw \]

\[ = \iint \ln ((1 - p) \, w) f(p) g(w) \, dp \, dw \]

\[ = \ln \overline{w} + \ln (1 - \overline{p}) \quad (2.8) \]

The comparison of the different welfare functions leads to the following proposition.

**Proposition 2.7.** A utilitarian planner has the following preferences: \( BE > BI > L \)

**Proof.** Comparing (2.6) and (2.7) gives

\[ U^{*}_{BE} - U^{*}_{BI} = \ln(1 - \overline{p}) + (1 - \overline{p}) \ln \overline{w} + \overline{p} \ln \overline{w} - \left[ \sum_{k=1}^{M} N_k [\ln (1 - \overline{p}_k)] + \ln \overline{w} \right] \]

\[ = \ln(1 - \overline{p}) - \sum_{k=1}^{M} N_k [\ln (1 - \overline{p}_k)] + \overline{p} [\ln \overline{w} - \ln \overline{w}] > 0 \]
2.4 Utilitarian Criterion

due to the Jensen inequality.

Comparing (2.7) and (2.8) gives

\[
U_{BI}^* - U_L^* = \left[ \sum_{k=1}^{M} N_k \ln (1 - \bar{p}_k) + \ln w \right] - \left[ \ln w + \ln (1 - p) \right] \\
= \sum_{k=1}^{M} N_k \ln (1 - \bar{p}_k) - \ln (1 - p) > 0
\]

\[ U_{BI}^* - U_L^* \] is positive due to the Jensen inequality.

Under the utilitarian criterion, the Beveridgean system is always preferred even if the distribution of risk is strongly asymmetric in favor of low-risk agents (say, 85% of agents have a risk lower than the average risk).

If we compare BE and BI using a utilitarian criterion, two effects are clearly in favor of BE:

- the vertical redistribution that benefits poor people more than it hurts rich people,
- the global horizontal redistribution that benefits agents belonging to high-risk groups more than it can hurt agents belonging to low-risk groups.

Note that even if there is no inequality of income, BE is still preferred because of this second effect.

Similarly, if we compare BI and L, the intra-group horizontal redistribution is only at work in BI so that it is preferred by the utilitarian policy-maker.

2.4.3. Do the positive results meet the normative recommendations?

In order to compare the results obtained under both criteria, we need to evaluate the impact of every redistribution mechanism (vertical and horizontal) either with our positive or normative criterion.

A utilitarian planner is in favor of vertical redistribution since it benefits low income agents more than it hurts high income agents. This argues for BE rather than for BI or L. Similarly, the majority voting rule supports any vertical redistribution because high income agents are a minority in the society. Again, this argues for BE.

On the one hand, a utilitarian planner is also in favor of any horizontal redistribution since it benefits high-risk agents more than it hurts low-risk agents. This argues for BE or BI rather than L. On the other hand, the majority voting rule does not support any horizontal
redistribution because high-risk agents constitute a minority in the society. This argues for L.

In addition, the utilitarian planner gives priority to global horizontal redistribution compared to intra-group horizontal redistribution since the first one is a broader type of redistribution. This argues for BE against BI. The intra-group horizontal redistribution is preferred under a majority voting rule if and only if there is a majority of agents in “good groups”, i.e. Group $k$ such that $p_k < \bar{p}$. This last case argues for BI.

As a consequence of all these redistribution effects, the utilitarian planner prefers a more redistributive system, i.e. BE. The preferred system under a majority voting rule depends on the relative sizes of income inequality and risk inequality as well as on the proportion of agents belonging to “good groups”.

More precisely:

– the lower the income inequality, the higher the political support for L,
– the higher the income inequality, the higher the political support for BE,

so that the majority voting choice corresponds to the utilitarian choice if the inequality of income is sufficiently high.

Moreover, the higher the proportion of agents belonging to “good groups”, the higher the political support for BI. More precisely, when comparing BE and BI, a majority voting rule leads to adopt BI if the inequality of income is low, which is in opposition to the utilitarian choice.

Finally, when only BI and L are compared, the utilitarian criterion leads to prefer BI since it allows horizontal redistribution. This is in opposition to the result with majority voting, since with $p_m < \bar{p}$ only a minority of the society benefits from horizontal redistribution.

\section*{2.5. Conclusion}

We have studied the three main types of welfare capitalism within a simple economic model which incorporates specific groups. In particular, we have introduced a more accurate way to model the corporatist Bismarckian system, taking into account the fact that this system allows intra-group horizontal redistribution, as outlined by Esping-Andersen (1990).

For the choice of the welfare system using the majority voting rule, we have shown the influence of the inequality of income, distribution of risk and the group structure. Under a utilitarian criterion, the Beveridgean system is always preferred. Moreover, the Bismarckian is always preferred to a Liberal one.
2.5 Conclusion

The utilitarian preference for the Beveridgean system may explain the evolution of the Bismarckian countries towards mixed systems incorporating an increasing part of Beveridgean characteristics.

This paper offers preliminary results which allows us to state that the main results concerning the choice of the welfare system are crucially modified under the new way of modeling the Bismarckian system. This is a first step in a research program that should be encompassed by the development of new studies incorporating this new way of modeling.
2. Bibliography

Bibliography


2. Bibliography


Appendix

2.A. Proof of Proposition 2.2

According to (2.4) and (2.5), \( W^B_k(t^*_m, p_i, w_i) > W^L_k(t^*_i, p_i, w_i) \) is equivalent to

\[
(1 - p_i) \ln (1 - p_m) + p_i \ln \left( \frac{1 - \nu_k}{\nu_k} p_m \right) > \ln (1 - p_i) \tag{2.9}
\]

We set

\[
h_k(p_i) = (1 - p_i) \ln (1 - p_m) + p_i \ln \left( \frac{1 - \nu_k}{\nu_k} p_m \right) - \ln (1 - p_i)
\]

We have

\[
h_k(0) = \ln (1 - p_m) < 0\quad \text{and}\quad h_k(1) \to +\infty
\]

and

\[
h'_k(p_i) = \frac{1}{1 - p_i} + \ln \left( \frac{1 - \nu_k}{\nu_k} p_m \right) \frac{1 - p_m}{1 - p_m}
\]

\[
h''_k(p_i) = \frac{1}{(1 - p_i)^2} > 0
\]

\( h_k \) is a convex function on \([0, 1]\), with \( h_k(0) < 0 \) and \( \lim_{p \to 1} h_k(p) = +\infty \) so that there is clearly a unique \( \nu_k \) such that \( h_k(\nu_k) = 0 \). Note that \( \nu_k \) depends only on \( \nu_k \) and \( p_m \).

In addition, \( h_k(\nu_k) = (1 - p_m) + \nu_k \ln \left( \frac{1 - \nu_k}{\nu_k} p_m \right) - \ln (1 - \nu_k) = 0 \)

According to the implicit function theorem, \( \frac{\partial \nu_k}{\partial p_k} = -\left( \frac{\partial h_k}{\partial \nu_k} \right)^{-1} \times \frac{\partial h_k}{\partial p_k} > 0 \), and \( \nu_k \) is an increasing function of \( k \), so that \( \nu_k \) is an increasing function of \( k \).

2.B. Proof of Proposition 2.3

According to (2.3) and (2.5) we have

\[
H(p_i, w_i) = W^B^E(t^*_m, p_i, w_i) - W^L(t^*_i, p_i, w_i)
\]

\[
= (1 - p_i) \ln ([1 - (p_m) w_i] + p_i \ln \left( \frac{1 - \nu}{\nu} p_m w \right) - \ln [(1 - p_i) w_i]
\]

\[
= \ln (1 - p_m) - \ln (1 - p_i) + p_i \ln \left( \frac{1 - \nu}{\nu} p_m \frac{w}{1 - p_m w_i} \right)
\]
Moreover, \( H(p_i, w_i) = 0 \iff \ln \left( \frac{1-p}{p} \frac{p_m}{1-p_m} w_i \right) = \frac{1}{p_i} \ln \left( \frac{1-p_i}{1-p} \right) \)

i.e. \( H(p_i, w_i) = 0 \iff \frac{1-p}{p} \frac{p_m}{1-p_m} w_i = \left( \frac{1-p_i}{1-p} \right)^{1/p_i} \)

Then, an agent \( i \) prefers BE to L iff \( H(p_i, w_i) \geq 0 \), i.e. iff \( w_i \leq \hat{w}(p_i) \), where \( \hat{w}(p_i) = \frac{1-p}{p} \frac{p_m}{1-p_m} \left( \frac{1-p_m}{1-p} \right)^{1/p_i} \)

Let us show that \( \hat{w}(p_i) \) is an increasing function of \( p_i \), with \( \hat{w}(0) = 0 \) and \( \lim_{p \to 1} \hat{w}(p) = +\infty \)

\( \hat{w}(p_i) = C \times \exp (a(p_i)) \), where \( C = \frac{1-p}{p} \frac{p_m}{1-p_m} > 0 \) and \( a(p_i) = \frac{1}{p_i} \ln \left( \frac{1-p_m}{1-p} \right) \)

Clearly, we can write that \( a(0) = \lim_{p_i \to 0} a(p_i) = -\infty \), and \( a(1) = \lim_{p_i \to 1} a(p_i) = +\infty \), thus \( \hat{w}(0) = 0 \) and \( \hat{w}(1) = +\infty \)

We just have to show that \( a(p_i) \) is an increasing function of \( p_i \).

\[
a(p_i) = \frac{1}{p_i} \ln (1 - p_m) - \frac{1}{p_i} \ln (1 - p_i)
\]

\[
a'(p_i) = -\frac{1}{p_i^2} \ln (1 - p_m) + \frac{1}{p_i^2} \ln (1 - p_i) + \frac{1}{p_i (1 - p_i)}
\]

\[
p_i^2 a'(p_i) = -\ln (1 - p_m) + \ln (1 - p_i) + \frac{p_i}{(1 - p_i)}
\]

\[
= -1 - \ln (1 - p_m) + \ln (1 - p_i) + \frac{1}{1 - p_i}
\]

Let us show that \( p_i^2 a'(p_i) \geq 0 \) for any \( p_i \in [0; 1] \).

We set \( b(p_i) = p_i^2 a'(p_i) = -1 - \ln (1 - p_m) + \ln (1 - p_i) + \frac{1}{1 - p_i} \) where

\[
b'(p_i) = -\frac{1}{p_i} + \frac{1}{(1 - p_i)^2} = \frac{p_i}{(1 - p_i)^2} > 0 \quad \text{and} \quad b(0) = -\ln (1 - p_m) > 0
\]

Thus \( b(p_i) > 0 \) on \( p_i \in [0; 1] \), so that \( p_i^2 a'(p_i) > 0 \) and \( a(p_i) \) is an increasing function of \( p_i \).

\[\square\]

2.C Proof of Proposition 2.4

(i) According to Proposition 2.1, an agent \( i \) of Group \( k \) prefers BE to BI iff \( w_i < r_k \bar{w} \) where \( r_1 < ... < r_j < 1 < r_{j+1} < ... < r_M \).

By assumption, \( r_j \bar{w} < w_{\text{inf}} \), then for any agent \( i \) of Group \( k \) with \( k \leq j \), we have \( w_i \geq w_{\text{inf}} > r_j \bar{w} \geq r_k \bar{w} \). Thus, there is unanimity in favor of BI in Groups 1, 2, ..., \( j \).

Similarly, by assumption, \( w_{\text{sup}} < r_{j+1} \bar{w} \), then for any agent \( i \) of Group \( k \) with \( k \geq j + 1 \), we have \( w_i \leq w_{\text{sup}} < r_{j+1} \bar{w} \leq r_k \bar{w} \). Thus there is unanimity in favor of BE in Groups \( j + 1, ..., M \).

(ii) Impact of an MPS.
For $k \leq j$, the agent $i$ prefers BE iff $w_i < r_k \bar{w}$, where $r_k < 1$.

With an MPS, the proportion of people with $w_i < r_k \bar{w}$ increases, so that the political support for BE increases.

For $k \geq j + 1$, the agent $i$ prefers BI iff $w_i > r_k \bar{w}$, where $r_k > 1$.

With an MPS, the proportion of people with $w_i > r_k \bar{w}$ increases, so that the political support for BI increases.

(iii) Impact of a sufficiently large MPS.

For $k \leq j$, with a large MPS, the proportion of people of income $w_i \in [r_k \bar{w}; \bar{w}]$ becomes very small, so that the proportion in favor of BE becomes arbitrarily near that of people of income $w_i < \bar{w}$.

For $k \geq j + 1$, with a large MPS, the proportion of people of income $w_i \in [\bar{w}; r_k \bar{w}]$ becomes very small, so that the proportion in favor of BI becomes arbitrarily near that of people of income $w_i > \bar{w}$.

Finally, whatever the group, if the MPS is sufficiently large, then the proportion of people in favor of BE is arbitrarily close to the proportion of people of income $w_i < \bar{w}$. Since the median income $w_m$ is lower than $\bar{w}$, we can conclude that with a sufficiently large MPS, there is a majority of people in favor of BE against BI.

\textbf{2.D. Proof of Proposition 2.6}

(i) For any agent $i$ of risk $p_i$ and income $w_i$:

$$H(p_i, w_i) = W^B(t^*_m, p_i, w_i) - W^L(t^*_i, p_i, w_i)$$

$$= \ln (1 - p_m) - \ln (1 - p_i) + p_i \ln \left( \frac{1 - \bar{p}}{1 - p_m} \right) + p_i \ln \left( \frac{\bar{w}}{w_i} \right)$$

$$= \tilde{h}(p_i) + p_i \ln \left( \frac{\bar{w}}{w_i} \right)$$

where $\tilde{h}(p_i) = \ln (1 - p_m) - \ln (1 - p_i) + p_i \ln \left( \frac{1 - \bar{p}}{1 - p_m} \right)$

For an individual of income $\bar{w}$ and risk $p_i$, $\tilde{h}(p_i)$ is the difference of welfares under BE and L. $\tilde{h}'(p_i) = \frac{1}{(1-p_i)^2} > 0$, and $\tilde{h}(0) = \ln(1 - p_m) < 0$, and

$\tilde{h}(p_m) = p_m \ln \left( \frac{1 - \bar{p}}{1 - p_m} \right) < 0$ because $p_m < \bar{p}$.

$\tilde{h}$ is a convex function with $\tilde{h}(0) < 0$ and $\tilde{h}(p_m) < 0$, thus $\tilde{h}(p_i) < 0$ for all $p_i \leq p_m$. $\tilde{h}$ is a continuous function, then max$_{0 \leq p \leq p_m} \tilde{h}(p) < 0$.

Setting $\eta = \exp \left[ \max_{0 \leq p \leq p_m} \tilde{h}(p) \right]$, we have then $0 < \eta < 1$. By assumption, $\eta < \frac{w_m}{\bar{w}}$, thus
2.D Proof of Proposition 2.6

max_{0 \leq p \leq p_m} \tilde{h}(p) < \ln \left( \frac{w_{\text{inf}}}{w_i} \right)

For every \( p_i \), with \( p_i \leq p_m \), we have

\[ H(p_i, w_i) = \tilde{h}(p_i) + p_i \ln \left( \frac{w_i}{w_i} \right) \leq \max_{0 \leq p \leq p_m} \tilde{h}(p) + \ln \left( \frac{w_i}{w_{\text{inf}}} \right) < 0 \]

Then, any agent \( i \) such that \( p_i \leq p_m \) prefers L to BE, i.e. a majority of people are in favor of L.

(ii) An MPS implies that \( \ln \left( \frac{w_i}{w} \right) \) increases for a majority of people because \( w_m < w \), thus it increases the political support for the Beveridgean system.

(iii) With a sufficiently large MPS of the distribution of income, we have

\[ p_i \ln \left( \frac{w_i}{w} \right) \geq p_i \ln \left( \frac{w_i}{w_m} \right) > -\tilde{h}(p) \text{ for } 50\% \text{ of the population.} \]

Then, clearly \( H(p_i, w_i) > 0 \) for a majority of people. \( \square \)
3. Stability of Coalitional Equilibria within Repeated Tax Competition

This chapter is joint work with Sonja Brangewitz and is a slightly modified version of the working paper available as
Institute of Mathematical Economics Working Paper No. 461, February 2012, Bielefeld University.

3.1. Introduction

This paper studies the stability of capital tax harmonization agreements in a model where countries have formed coalitions to avoid the inefficient fully non-cooperative Nash equilibrium. As incentives for deviations from the cooperative behavior continue to exist, we analyze the stability of any given but arbitrary coalition structure by means of a repeated game setting accounting for deviations by a whole subgroup of countries.

Capital tax competition has been the subject of increasing political and academic interest since the mid-1980s. Next to Wilson (1999) and Wilson and Wildasin (2004) recent surveys of the literature are given by, e.g., Griffith et al. (2008) and Keen and Konrad (2011). It is well established that the structure of payoffs in a standard tax competition model resembles a classical “prisoner’s dilemma”. In such a static, one-shot model the non-cooperative Nash equilibrium of tax rates is inefficiently low compared to harmonized tax rates. Therefore, a coordination of tax policies can avoid the negative externality that is associated with mobile capital tax bases. For example, the contributions by Zodrow and Mieszkowski (1986), Wildasin (1989), Bucovetsky (1991) and Wilson (1991) analyze if there are Pareto-improving reforms which harmonize capital income taxes.

Given the high costs of tax competition, global tax harmonization is desirable but very unlikely because some countries, e.g., tax havens, prefer lower taxes for commercial reasons.\footnote{Other, well-known factors that add to the reluctance of countries concerning tax harmonization efforts are asymmetries in, e.g., endowments or technologies.}

From a political perspective, partial harmonization among a subgroup of countries is therefore easier to achieve (cf. Konrad and Schjelderup, 1999). This is what has been promoted
3.1 Introduction

by a variety of policy efforts from several countries, economic unions and international institutions. A very recent example is the announcement of the Council of the European Union to reinforce fiscal stability as a response to the financial crisis by the coordination of a common band of fiscal policy measures, for instance, by the introduction of a common corporate tax base (Council of the European Union, 2011). Other examples include the efforts by the OECD’s Center for Tax Policy and Administration, for instance, the list of harmful tax practices. In fact, even if no explicit agreements on the political agenda have been made, there may well be implicit agreements between countries or federations that are linked via policies or institutional arrangements in other fields in order to keep tax competition low (cf. Konrad and Schjelderup, 1999).

In this paper we abstract from the question how these cooperative agreements have been made, although this is surely a related topic. Rather, we focus on the stability of cooperation taking into account the particular incentives that fiscal spillovers and cooperation among subgroups of countries induce in the long run. In the long run, i.e., if the tax game is played repeatedly, there are strong incentives to raise the tax rates above the inefficient fully non-cooperative Nash equilibrium because deviations from cooperation will be punished. This is what a number of recent studies, e.g., Cardarelli et al. (2002), Catenaro and Vidal (2006) as well as Itaya et al. (2008) have analyzed by applying repeated interactions to the capital tax competition framework. This strand of the literature focuses on the question whether fiscal coordination is sustainable among two asymmetric countries employing grim trigger strategies for the punishment phase of the game. However, these papers deal with the sustainability of overall (global) tax coordination. We analyze the sustainability of tax coordination when there are several tax agreements co-existing, e.g., when there are larger and smaller groups of countries that cooperate.

Konrad and Schjelderup (1999) argue that gains from tax harmonization depend on the response from countries outside the harmonized area and on the size of the tax harmonized area relative to the global economy. Accordingly, they study whether a single subgroup of countries can gain from harmonizing their capital income taxes provided that all other countries do not follow suit by playing non-cooperatively. They show that tax harmonization is Pareto improving for all countries if the tax rates are strategic complements. Itaya et al. (2010) analyze the sustainability of this form of partial tax coordination (within a single subgroup of countries) in a repeated game setting. Also here, all other countries not in the coalition behave non-cooperatively but symmetrically and only singleton regions are allowed to deviate from the cooperative behavior. The main finding of Itaya et al. (2010) is that

\(^2\)Kiss (2011) adds to this literature by analyzing how the introduction of a minimum tax affects the stability of cooperation among N symmetric countries. See also Kessing et al. (2006) who analyze the effect of vertical tax competition on FDI. Here, repeated interaction enables governments and firms to solve the hold-up problem.
3.1 Introduction

partial tax coordination is more likely to prevail if the number of regions in the coalition subgroup is smaller and the number of existing regions in the entire economy is larger.\footnote{Note that, using a numerical analysis with imperfect capital mobility, Rasmussen (2001) finds that the critical mass of countries needed for partial coordination to have a significant impact is a large number of the overall number of economies.}

This paper investigates the more general case relaxing two constraints of Itaya et al. (2010): First, we allow for any given coalition structure (not only one single coalition). Second, we analyze coalitional deviations in the repeated game, i.e., we analyze the incentives of sub-coalitions to deviate from cooperation.

Let us elaborate on two related papers of the literature strand that analyzes the process or the impact of coalition formation or tax harmonization, respectively.\footnote{Konrad and Schjelderup (1999) offer a brief discussion about the link between tax harmonization and the literature on the profitability of mergers in industrial organization (cf. the references given therein, in particular, Deneckere and Davidson, 1985).}

The process of coalition formation is analyzed by Burbidge et al. (1997). In this fairly general model, different regions may form coalitions to capture efficiency gains by tax rate harmonization. Joining a coalition implies first, choosing a harmonized tax rate such that the coalition’s payoff is maximized, and second, committing to a fixed division scheme for the gains from cooperation. Burbidge et al. (1997) study equilibrium coalition structures based on the model of coalition formation from Hart and Kurz (1983) using the concept of a coalition-proof Nash equilibrium (cf. Bernheim et al., 1987). Their main finding is that the grand coalition is not necessarily the equilibrium coalition structure in a setting with more than two regions. This is illustrated by an example with three regions having asymmetric production functions.

Bucovetsky (2009) considers a model of tax competition among regions of different population size. The regions’ objective is to maximize the utility of its inhabitants, which depends on the consumption of a private good and the provision of a public good. Bucovetsky (2009) proves that any tax harmonization by a group of jurisdictions benefits the residents of all jurisdictions that are not in the group. He also demonstrates that harmonization increases the average payoff of all regions harmonizing their tax rate. Most remarkably, Bucovetsky (2009) finds that the “biggest threat to the grand coalition” (p. 740) is the coalition structure where \( N - 1 \) regions cooperate and the smallest region remains singleton. Bucovetsky’s (2009) work is based on an earlier paper which is quite related to our framework (see Bucovetsky, 2005). For instance, we share the Leviathan type of government\footnote{Also Kanbur and Keen (1993) use this kind of objective function.} and have a similar production function in the one-period game.

In our model, we want to handle explicit solutions so we need to impose specific assumptions: We postulate that (1) the aggregate supply of capital is fixed; (2) each jurisdiction
is inhabited by economically identical residents; (3) output in each region is a quadratic function of capital employed. The point of departure is that each region chooses a tax rate to levy on locally employed capital to manipulate its tax base in form of capital movements. Consequently, regions have an incentive to capture the benefits of policy coordination. We allow for any coalition structure to form and derive the equilibrium tax rates and equilibrium tax revenues for a given coalition structure in a first step. In a second step we employ a repeated game setting in order to analyze the stability of cooperation in terms of the related discount factors.

To preview our main finding: We establish that singleton regions have the highest incentive to deviate from the cooperative solution. Furthermore, cooperation is easier to sustain if the environment was acting “more cooperatively” ex-ante.

This paper is organized as follows. In Section 3.2 we set up the basic tax competition model. In Section 3.3, we introduce cooperation and derive the equilibrium tax rates and equilibrium tax revenues for different coalition structures. In Section 3.4, we introduce the repeated game setting and study the dynamics, in particular, the stability of coalitional equilibria in the tax competition game. Section 3.5 illustrates our results by means of a numerical example. We conclude in Section 3.6.

### 3.2. The Tax Competition Model

We employ a standard tax competition framework with $N$ identical regions, indexed by $i \in \mathbb{N} = \{1, ..., N\}$. Each region is characterized by a regional government, a representative household and a single firm. The household (labor) is supposed to be immobile, whereas capital is perfectly mobile. Both capital and labor are input factors for the production of a single homogeneous good. The overall capital stock is given by $K$ which is equally distributed in the regions. Hence, each region owns $k = K/N$ units of capital. The production is described by a constant-returns-to-scale type of production function following, e.g., Bucovetsky (1991), Bucovetsky (2009), Grazzini and van Ypersele (2003), Haufler (1997) or Devereux et al. (2008). The production function of region $i \in \mathbb{N}$ is $f(k_i) = (A - k_i)k_i$, where $A > 0$ is the level of productivity, and $k_i$ the per capita amount of capital employed in region $i$. We assume $A > 2k_i$ for all possible $k_i \leq K$. This means that the level of productivity $A$ needs to be sufficiently large such that the equilibrium interest rate is positive.\(^6\)

Public goods are financed by a source-based unit tax on capital $\tau_i$ for region $i$.\(^7\) As firms

---

\(^6\)The given level of productivity needs to be sufficient large to ensure capital levels to be strictly smaller than the capital level at which the production function has its maximum.

\(^7\)Lockwood (2004) has shown that in the (standard) tax competition model by Zodrow and Mieszkowski (1986) there are different Nash equilibria in capital taxes depending on the structure of taxes, i.e., ad valorem or unit taxes. For the sake of readability of our results we employ the unit tax.
3.2 The Tax Competition Model

behave perfectly competitively the production factor prices equal their respective marginal productivity

\[ r = f'(k_i) - \tau_i = A - 2k_i - \tau_i \quad (3.1) \]

\[ w_i = f(k_i) - k_i f'(k_i) = k_i^2 \quad (3.2) \]

where \( r \) is the net return on capital and \( w_i \) is the region-specific wage rate. The no-arbitrage condition in equilibrium for capital is \( f'(k_i) - \tau_i = r = f'(k_j) - \tau_j \) for all regions \( i, j \) where \( i \neq j \). The demand function for capital, depending on the arbitrage-free interest rate \( r \) and the regional tax rate \( \tau_i \), is then given by \( k_i = \frac{A - r - \tau_i}{2} \). To determine the equilibrium interest rate, capital demand need to equal capital supply, \( \sum_{i=1}^{N} k_i = N \bar{k} \). Let \( \tau = (\tau_1, ..., \tau_N) \) be the vector of tax rates chosen by the regions. We obtain the equilibrium interest rate \( r^*(\tau) \) by

\[ r^*(\tau) = A - 2\bar{k} - \tau \quad (3.3) \]

where \( \tau = \frac{\sum_{h=1}^{N} \tau_h}{N} \) is the average capital tax of all regions. Combining (3.1) and (3.3) yields the capital demand in equilibrium for region \( i \):

\[ k_i^*(\tau) = \bar{k} + \frac{\tau - \tau_i}{2} \quad (3.4) \]

The effects of a changing tax rate on equilibrium capital demand and the equilibrium interest rate are as follows:

\[ \frac{\partial r^*(\tau)}{\partial \tau_i} = -\frac{1}{N} < 0 \quad (3.5) \]

\[ \frac{\partial k_i^*(\tau)}{\partial \tau_i} = -\frac{N - 1}{2N} = \frac{1}{2N} - \frac{1}{2} < 0 \quad (3.6) \]

\[ \frac{\partial k_j^*(\tau)}{\partial \tau_i} = \frac{1}{2N} > 0 \quad (3.7) \]

for all regions \( i, j \in N \) and \( i \neq j \). When a region \( i \) augments its own tax rate \( \tau_i \), the equilibrium interest rate \( r^*(\tau) \) and the capital demand \( k_i^*(\tau) \) of this country decreases. However, if another country \( j \) increases its tax rate, this has a positive influence on the equilibrium capital demand \( k_i^*(\tau) \) of country \( i \). Note that we have the following effect

\[ \frac{\partial k_i^*(\tau)}{\partial \tau_i} = -\sum_{j \neq i} \frac{\partial k_j^*(\tau)}{\partial \tau_i} = -\frac{N - 1}{2N}. \]
The objective of the regional government is to maximize its tax revenue given by

$$\tau_i k^*_i(\tau).$$

(3.8)

Tax revenues are entirely used to finance public goods. Alternatively, tax revenues could be
directly transferred to the representative household. In either case—in contrast to Edwards
and Keen (1996)—the Leviathan type of government here does not produce a “waste of
resources”. A change of the tax rate affects the tax revenue in two respects: First, there is
the direct effect of the change in the tax rate itself and second, there is the indirect effect
because the equilibrium capital demand responds.

With every region pursuing to maximize its own tax revenue, potential gains of cooperation
are ignored. In the next section, we extend the model such that cooperation between the
regional governments is allowed for. The standard model will be a special (benchmark) case
of this more general setting, namely where regions act as a singleton.

3.3. Cooperative Behavior

Now, we modify the tax competition framework allowing regions to build any form of coali-
tion structure. For such a given coalition structure, we determine the tax rate, the capital
demand and the tax revenues in equilibrium.\(^8\) Before, we have a few words on the concept
of a coalition structure and the notion of coalitional equilibrium.

A coalition structure is a partition of the set of players, more precisely a set of coalitions
\(\{S_1, ..., S_M\}\) such that their pairwise intersection is empty, \(S_m \cap S_\ell = \emptyset\) for all \(m \neq \ell\), and
such that their union equals the grand coalition, \(\bigcup_{m=1}^{M} S_m = N\). For instance, for three
regions we have five possible coalition structures, whereas for five regions we already have
52 possible coalitions structures.\(^9\)

As regions are symmetric, the different coalition structures depend on the number of regions
in one coalition and on the overall number of coalitions. Thus, if we consider a specific
coalition structure, it is enough to know how many regions there are in which coalition.
Therefore, our succeeding analysis depends on the sizes of the coalitions. We can associate
a coalition structure \(\{S_1, ..., S_M\}\) to a vector indicating the sizes of the coalitions in the

---

\(^8\)Here, we adopt the same view as Konrad and Schjelderup (1999) who justify the omission of the analysis
of the coalition formation process as follows: “the formation of a given coalition may ... be founded on
historical, social, political, and economic factors outside the model.” (p.160)

\(^9\)To determine how many coalition structures for a given number of players, \(N\), exist is a combinatorial
question. The number of ways a set of \(N\) elements can be partitioned into non-empty subsets is the “Bell
number”. The Bell numbers can be recursively determined by

\[ B_{n+1} = \sum_{k=0}^{n} \binom{n}{k} B_k \]

where \(B_0 = B_1 = 1\). The first few Bell numbers for \(n = 1, 2, 3, 4, 5, 6, 7, 8, ...\) are \(1, 2, 5, 15, 52, 203, 877, 4140, ...\).
following way: Coalition $S_1$ consists of regions 1, ..., $S_1$, coalition $S_2$ of regions $S_1 + 1, ..., S_1 + S_2$ and so on. We (usually) denote in non-bold the size of coalition, $S_m$, and in bold coalition, $S_m$, containing $S_m$ regions.

**The equilibrium concept**

The ability of regions to form coalitions implies that we assume regions to behave cooperatively and symmetrically within a coalition but non-cooperatively across coalitions. Our analysis is based on the notion of a “coalitional equilibrium”.\(^{10}\) In our setting, we assume that by forming a coalition the members of this coalition behave symmetrically and agree to set a common tax rate maximizing the coalitional tax revenue.

**Definition** (symmetric coalitional equilibrium). Given a coalition structure $\{S_1, ..., S_M\}$ an action profile of tax rates $(\tau_{S_1}, ..., \tau_{S_M})$ is a symmetric coalitional equilibrium if for no coalition $S_m$ in the coalition structure $\{S_1, ..., S_M\}$ there is a choice of a common tax rate $\tilde{\tau}_{S_m}$, symmetric within coalition $S_m$, that strictly increases the individual tax revenues of all members of the coalition $S_m$.

Consequently, here, a symmetric coalitional equilibrium is a Nash equilibrium of the game where the different coalitions are interpreted as individual players (maybe differing in a size factor) maximizing joint revenue of the coalition’s members. We assume that a coalition sets the tax rate and each region gets an equal share of the tax revenues. This is a reasonable assumption as all regions are symmetric: By agreeing on a common tax rate within the coalition there are no differences in the allocation of capital between the regions in this coalition.

**Coalition structures with at least two coalitions**

Having defined the equilibrium concept, we analyze a given coalition structure, denoted by $\{S_1, ..., S_M\}$, which consists of at least two coalitions, $M \geq 2$. This includes—as a special case—the fully non-cooperative behavior where the number of coalitions is $M = N$. This excludes, however, the grand coalition $\{N\}$ which is the efficient outcome from an economic perspective for a tax revenue maximization objective. For the grand coalition there are no external effects in terms of capital movements and all available production is absorbed as

\(^{10}\)The formal definition of this idea can be found in Ichiishi (1981), Zhao (1992), Ray and Vohra (1997) or later on Ray (2007). A recent, different application of the coalitional equilibrium can be found in, e.g., Biran and Forges (2011).
3.3 Cooperative Behavior

tax revenues. From a political perspective, however, this scenario is a minor interesting case since an overall (worldwide) harmonization of tax rates is unrealistic.¹¹

The regional governments of each coalition maximize the sum of the members’ regional tax revenues by choosing a common tax rate within the coalition:

$$\sum_{h \in S_m} \tau_h k^*_h(\tau) = S_m \tau S_m \left( \frac{k}{2} + \frac{\tau S_m}{2} \right)$$

Note that the tax rate and with that the capital demand and the tax revenue depend on the given coalition structure. For the ease of notation we omit this dependence in the notation for this section.

Define

$$\alpha := M \sum_{\ell=1}^{M} \frac{S_\ell}{2N - S_\ell} \in \left( \frac{1}{2}, 1 \right). \tag{3.9}$$

We can associate a specific $\alpha$ to every coalition structure depending on the sizes of the coalitions. In Lemma 1, later on, we analyze this factor in more detail. Before, we determine the optimal tax rates:

$$\tau_{S_m} = 2Nk \left( \frac{1}{1 - \alpha} \right) \left( \frac{1}{2N - S_m} \right) \tag{3.10}$$

The computation can be found in Appendix 3.A.

The average tax rate is given by

$$\overline{\tau} = \frac{\sum_{\ell=1}^{M} S_\ell \tau S_\ell}{N} = 2k \left( \frac{\alpha}{1 - \alpha} \right) \tag{3.11}$$

and equilibrium capital demand by

$$k^*_{S_m}(\tau) = \frac{k}{1 - \alpha} \left( \frac{N - S_m}{2N - S_m} \right).$$

Then, the tax revenue is

$$R_{S_m} = \tau_{S_m} k^*_{S_m}(\tau) = 2Nk^2 \frac{(N - S_m)}{(1 - \alpha)^2(2N - S_m)^2}. \tag{3.12}$$

¹¹There is an additional technical restriction as the joint tax revenue of all regions have no inner solution for the grand coalition. If all regions cooperate, they will choose a boundary solution for the tax rate so that there is no capital movement across the regions. Thus, the tax rate of the grand coalition is equal to $A - \overline{\tau}$. 

76
3.3 Cooperative Behavior

It is immediately clear:

**Proposition 3.1.** Coalitions of the same size in the same coalition structure set the same tax rate and have the same tax revenue.

This result is not surprising as all regions are economically identical. Moreover, we obtain:

**Proposition 3.2.** Given a coalition structure \( \{S_1, ..., S_M\} \) with \( 2 \leq M \leq N \). The larger a coalition in this coalition structure, the higher its equilibrium tax rate and the smaller its equilibrium tax revenue.

Proposition 3.2 shows that cooperation induces higher tax rates. However, taking externalities in form of capital movements into account, the equilibrium tax revenues are lower for larger coalitions. Consider a specific coalition which is relatively large in comparison to the other coalitions. In equilibrium this coalition coordinates on a relatively high tax rate which leads to an outflow of capital given that there are smaller coalitions who coordinate on a relatively low tax rate.\(^{12}\) This is in line with the findings of Wilson (1991, Proposition 2) for two countries and has been extended by Bucovetsky (2009, Lemma 1) to \( N \) countries in a related setting where regions differ in population size.

**Proof.** For a fixed coalition structure the equilibrium tax rate of the coalitions differ in the factor

\[
\frac{N}{2N - S_\ell}
\]

for \( \ell = 1, ..., M \). This factor increases if the coalition size increases. Hence, the larger the coalition the higher the equilibrium tax rate.

Similarly, for the equilibrium tax revenue we have to look at

\[
\frac{N - S_\ell}{(2N - S_\ell)^2}
\]

for \( \ell = 1, ..., M \). Taking the derivative with respect to \( S_\ell \) gives

\[
\frac{\partial}{\partial S_\ell}\left(\frac{N - S_\ell}{(2N - S_\ell)^2}\right) = -\frac{S_\ell}{(2N - S_\ell)^3} < 0.
\]

Hence, the larger the coalition the smaller the equilibrium tax revenue. \( \square \)

\(^{12}\)In general the change of the equilibrium tax revenues for coalitions of different size can be divided into two effects: a tax-rate effect and a tax-base effect. As we consider a coalition structure as given, in what follows we focus on the overall effect.
3.4 Dynamic Stability of Cooperation

Let us re-consider $\alpha$ in detail.

**Lemma 1.** Given a coalition structure $\{S_1, ..., S_M\}$ with $2 \leq M \leq N$. If two coalitions decide to merge, then $\alpha$, given by $\sum_{\ell=1}^{M} \frac{S_\ell}{2N-S_\ell}$, strictly increases.

The factor $\alpha$ is a measure of concentration for coalition structures. It represents the level of cooperation between regions and therefore reflects the intensity of capital tax competition. Moreover, $\alpha$ is related to the index of capital tax competition as defined in Bucovetsky (2009).

**Proof.** Assume two coalitions merge. Without loss of generality suppose coalition $S_{M-1}$ and coalition $S_M$ decide to form one coalition. We show that $\alpha$ strictly increases. To see this it is sufficient to compare the last two summands of $\alpha$ given by

$$\frac{S_{M-1}}{2N-S_{M-1}} + \frac{S_M}{2N-S_M}$$

and

$$\frac{S_{M-1}+S_M}{2N-S_{M-1}-S_M}.$$

Subtracting the first from the second term yields

$$\frac{(4N-S_{M-1}-S_M)S_{M-1}S_M}{(2N-S_{M-1})(2N-S_M)(2N-S_{M-1}-S_M)} > 0.$$ 

So, $\alpha$ strictly increases if two coalitions merge. $\square$

### 3.4. Dynamic Stability of Cooperation

#### 3.4.1. The setting

In what follows, we analyze under which conditions coalitional equilibria can be sustained as a sub-game perfect equilibrium of the repeated game. Let $\delta \in [0,1)$ denote the common discount factor. Regions have either implicitly or explicitly agreed to choose their tax rates cooperatively within their coalitions. We assume that the coalition structure $\{S_1, ..., S_M\}$ is given. Following the trigger strategies as introduced by Friedman (1971), first of all, each region in each coalition sets the equilibrium tax rate, i.e., all regions act cooperatively within their coalitions if they do not observe any deviation from this behavior. In case a sub-coalition of regions “defects” by breaching the cooperation agreement this will be public
information because the equilibrium tax revenues of all regions are affected through capital movements. Define a deviating sub-coalition of regions as follows:

**Definition** (sub-coalition). Given a coalition $S_\ell$ of size $S_\ell \geq 2$. We define $S_\ell^D \subset S_\ell$ with $1 \leq S_\ell^D < S_\ell$ as a sub-coalition of $S_\ell$.\(^{13}\)

The reaction to deviation of all coalitions is to resort to the punishment strategy in the period after the deviation has occurred. This punishment ends up in the fully non-cooperative Nash equilibrium. Here, a word about the punishment strategy is in order.

First of all, the threat which should guarantee cooperation needs to be sufficiently severe and it is not necessarily restricted to a single political dimension. Within a federation or an economic union, like the EU, there are several ways to punish a defection since countries are linked via (other) common policies and institutional arrangements (cf. Konrad and Schjelderup, 1999). This implies that the threat of punishment can be really high if it also affects other political dimensions.

Second, given that a subset of regions may deviate from its coalition, one could ask why all coalitions adopt the fully non-cooperative strategy although the deviation might come from another coalition. Suppose, only the coalition where the deviation has occurred employs the fully non-cooperative strategy. Then, there still exist substantial incentives to deviate from any other cooperative agreement in all other coalitions (as the succeeding analysis shows). These incentives continue to exist until —ultimately— all regions play fully non-cooperatively.

Therefore, the chosen punishment strategy that we adopt here constitutes a sub-game perfect Nash equilibrium of the repeated game. It satisfies the condition that the threat which induces cooperation must be sufficiently severe, we nevertheless provide a discussion of alternative punishment strategies at the end of this section.

Denote by $S_\ell^D$ the size of a deviating sub-coalition, $S_\ell^D$, from coalition $S_\ell$, where the superscript $D$ indicates deviating behavior. Figure 3.1 summarizes the structure of the repeated game.

To judge if a deviation is profitable or not, sub-coalition $S_\ell^D$ needs to compare the discounted payoffs for deviating vs. for playing cooperatively. Let the subscript of the tax revenue $R_{S_\ell}^{S_\ell^D}$ indicate the coalition from which the sub-coalition $S_\ell^D$ has deviated and let the superscript refer to the size of the deviating sub-coalition $S_\ell^D$. Deviating implies that each region in

\(^{13}\)This definition of a deviating sub-coalition reflects the idea of “internal blocking” used by Ray and Vohra (2012). In their model, that combines the coalition formation and the blocking approach, they assume that “[...] blocking is internal: only sub-coalitions of existing coalitions are permitted to make further ‘moves’.” (p. 32) Note that our definition also accounts for deviations of singleton regions and they will be of particular importance in the course of our analysis.
3.4 Dynamic Stability of Cooperation

\{S_1, \ldots, S_M\}

All regions play symmetrically and cooperatively within the coalitions and non-cooperatively across coalitions by setting the equilibrium tax rate.

\[ \{S_1, \ldots, S_\ell \ \setminus \ S^D_\ell, S^D_\ell, \ldots, S_M\} \]

Sub-coalition $S^D_\ell$ (from coalition $S_\ell$, with $S_\ell \geq 2$, $1 \leq S^D_\ell < S_\ell$) deviates. All other regions continue with cooperative behavior but observe the deviation of sub-coalition $S^D_\ell$.

\[ \{\{1\}, \ldots, \{N\}\} \]

All other regions play fully non-cooperative “Nash” as a reaction to the deviation of sub-coalition $S^D_\ell$.

Figure 3.1.: Structure of the Repeated Game.

Sub-coalition $S^D_\ell$ receives a payoff of $R^S_{SP}$ once. From the next period onwards until infinity the payoff is then

\[ R^P_{SP} = 2N \bar{e}^2 \frac{(N - 1)}{(1 - \bar{\alpha})^2(2N - 1)^2} \]

with $\bar{\alpha} = \frac{S^D_\ell}{2N-1} + \frac{N - S^D_\ell}{2N-1} = \frac{N}{2N-1}$. This means the total payoff from deviating is given by

\[ R^S_{SP} + \sum_{t=1}^{\infty} \delta^t R^P_{SP} = R^S_{SP} + \frac{\delta}{1 - \delta} R^P_{SP}. \]

If sub-coalition $S^D_\ell$ does not deviate, every region $i \in S^D_\ell$ will receive a payoff of $R_{S_\ell}$ from now, in $t = 0$, until infinity. The total payoff from not-deviating is given by

\[ \sum_{t=0}^{\infty} \delta^t R_{S_\ell} = \frac{1}{1 - \delta} R_{S_\ell}. \]

If the following condition holds, no sub-coalition $S^D_\ell$ has an incentive to deviate from the coalitional equilibrium in the infinitely repeated game:

\[ \frac{1}{1 - \delta} R_{S_\ell} \geq R^S_{SP} + \frac{\delta}{1 - \delta} R^P_{SP}. \]  (3.13)
3.4 Dynamic Stability of Cooperation

In order to sustain a coalitional equilibrium we need to find a discount factor that satisfies inequality (3.13). Such a discount factor \( \delta \in (0, 1] \) is “non-trivial” for a payoff structure which satisfies

\[
R_{S_t}^{\ell} \geq R_{S_t} \geq R_{S_t}^P.
\]  
(3.14)

3.4.2. Cooperation and punishment tax revenues

First, let us analyze the second inequality in (3.14). By means of Lemma 1 the following proposition establishes that gains from cooperation always exist.

**Proposition 3.3.** Given a coalition structure \( \{S_1, ..., S_M\} \) with \( 2 \leq M \leq N \). We have

\[
R_{S_t} \geq R_{S_t}^P.
\]

Here, we have the well-known inefficiency of the fully non-cooperative Nash equilibrium, when departing from the fully non-cooperative solution by forming coalitions every region is better off.

**Proof.** Let \( \alpha = \sum_{\ell=1}^{M} \frac{S_\ell}{2N - S_\ell} \in \left( \frac{1}{2}, 1 \right) \). The equilibrium tax revenue of the coalition structure \( \{S_1, ..., S_M\} \) with \( 2 \leq M \leq N - 1 \) is given by equation (3.12),

\[
R_{S_t} = 2Nk^2 \frac{(N - S_m)}{(1 - \alpha)^2(2N - S_m)^2}
\]

for \( m = 1, ..., M \).

The equilibrium tax revenue of the punishment is

\[
R_{S_t}^P = \frac{2Nk^2}{N - 1}
\]

for \( i = 1, ..., N \). To prove that gains from cooperation exist it is enough to show

\[
(N - 1) > \frac{(1 - \alpha)^2(2N - S_m)^2}{(N - S_m)}.
\]

We know that \( \alpha \) strictly increases if two coalitions merge. Moreover, the right-hand side decreases if \( \alpha \) increases. Thus, considering the coalition structure with coalition \( S_m \) and the remaining regions as singletons we obtain a lower bound for \( \alpha \) given by

\[
\alpha \geq \frac{S_m}{2N - S_m} + \frac{N - S_m}{2N - 1}.
\]
This is equivalent to

\[ 1 - \alpha \leq \frac{(N - S_m)(2N + S_m - 2)}{(2N - 1)(2N - S_m)}. \]

The claim follows if we take this upper bound for \(1 - \alpha\) and establish

\[ (N - 1) > \frac{(N - S_m)(2N + S_m - 2)^2}{(2N - 1)^2}. \]

We obtain

\[ (2N - 1)^2(N - 1) - (N - S_m)(2N + S_m - 2)^2 \]

\[ = (S_m - 1)((3S_m - 1)(N - 1) + S_m^2) > 0. \]

\[ \square \]

### 3.4.3. Deviation tax rates and tax revenues

The next step is to compute the revenues from deviation: We allow one sub-coalition \(S^D_\ell \subsetneq S_\ell\) to change its tax rate while all other regions remain acting cooperatively in the period where the deviation occurs. Assume from now on \(S_\ell \geq 2\) and let \(\tau\) denote the average tax rate for the coalition structure \(\{S_1, ..., S_M\}\) where each region in each coalition sets the equilibrium tax rate. Sub-coalition \(S^D_\ell\) optimally sets the deviation tax rate

\[ \tau^{S^D_\ell}_{S_\ell} = \frac{Nk}{N - S^D_\ell}(\frac{2N - S_\ell - S^D_\ell}{2N - S_\ell})\left(\frac{1}{1 - \alpha}\right) \]

and obtains a tax revenue of

\[ R^{S^D_\ell}_{S_\ell} = \frac{Nk^2}{2(N - S^D_\ell)}\left(\frac{2N - S_\ell - S^D_\ell}{2N - S_\ell}\right)^2\left(\frac{1}{1 - \alpha}\right)^2. \]

The computation can be found in Appendix 3.B.

**Proposition 3.4.** Given a coalition structure \(\{S_1, ..., S_M\}\) with \(2 \leq M < N\). Fix a size of a sub-coalition. The larger the coalition from which a sub-coalition with fixed size deviates, the smaller the deviation tax rate and the smaller the deviation tax revenue.

This suggests that sub-coalitions which belong to relatively small coalitions have a higher incentive to deviate from cooperation compared to sub-coalitions in relatively large coalitions. From Proposition 3.2 we know that larger coalitions set higher tax rates but obtain less tax revenues.
revenues than smaller coalitions. Therefore, in order to make deviating from a larger coalition with relatively low tax revenues profitable, a deviating sub-coalition needs to underbid the remaining regions more than when deviating from a relatively small coalition.

Proof. For a fixed coalition structure the deviation tax rates of the coalitions differ in the factor

$$\frac{2N - S_\ell - S^D_\ell}{2N - S_\ell}$$

for \( \ell = 1, \ldots, M \). The derivative of this expression with respect to \( S_\ell \) is

$$\frac{\partial}{\partial S_\ell} \left( \frac{2N - S_\ell - S^D_\ell}{2N - S_\ell} \right) = -\frac{S^D_\ell}{(2N - S_\ell)^2} < 0,$$

i.e., the larger the coalition the smaller the deviation tax rate.

Similarly, for the equilibrium tax revenue we have to look at

$$\frac{(2N - S_\ell - S^D_\ell)^2}{(2N - S_\ell)^2}$$

for \( \ell = 1, \ldots, M \). This factor decreases if the size of the coalition increases, i.e., larger the coalition, from which a sub-coalition (of fixed size) deviates, the smaller the equilibrium tax revenue.

Proposition 3.5. Given a coalition structure \( \{S_1, \ldots, S_M\} \) with \( 2 \leq M < N \). The deviation tax rate of sub-coalition \( S^D_\ell \subseteq S_\ell \) is strictly smaller than the tax rate of regions in coalition \( S_m \) if and only if

$$\frac{S_m}{S^D_\ell} > \frac{2N - 2S_\ell}{2N - S_\ell - S^D_\ell}.$$

Moreover, the deviating sub-coalition always strictly underbids its own coalition.

Note that for \( S^D_\ell = 1 \) the above inequality is always satisfied.\(^{14}\)

The deviating region acts optimally given the cooperative behavior in the coalitional equilibrium of all other regions. To attract the maximal amount of capital the deviating region certainly needs to underbid the tax rate of its own previous coalition. For all other coalitions it depends—inter alia—on their coalition sizes.

---

\(^{14}\)This can be seen as follows: \( S_m(2N - S_\ell - S^D_\ell) - S^D_\ell(2N - 2S_\ell) = (N - S_\ell)(S_m - 2) + S_m(N - 1) > 0 \).
For \( S_m \geq 2 \) this is true. For \( S_m = 1 \) we obtain: \((-N - S_\ell) + (N - 1) = S_\ell - 1 \). This expression is strictly greater than 0 as the coalition \( S_\ell \) consists of at least two regions.
3.4 Dynamic Stability of Cooperation

Proof. The tax rate for the deviating sub-coalition $S^D_\ell$ is given by

$$\tau^{D}_{S_\ell} = \frac{N-\bar{k}}{N-S^D_\ell} \left( \frac{2N-S_\ell-S^D_\ell}{2N-S_\ell} \right) \left( \frac{1}{1-\alpha} \right)$$

and for the remaining regions by

$$\tau_{S_m} = 2\bar{k}\left( \frac{1}{2N-S_m} \right) \left( \frac{1}{1-\alpha} \right).$$

We need to establish that

$$\tau^{D}_{S_\ell} < \tau_{S_m},$$

which is equivalent to

$$\frac{1}{N-S^D_\ell} \left( \frac{2N-S_\ell-S^D_\ell}{2N-S_\ell} \right) < 2 \left( \frac{1}{2N-S_m} \right).$$

Manipulating yields

$$(2N-S_\ell-S^D_\ell)(2N-S_m) < 2(N-S^D_\ell)(2N-S_\ell)$$

$$\Leftrightarrow 0 < S_m(2N-S_\ell-S^D_\ell) - S^D_\ell(2N-2S_\ell).$$

It is easy to find a counter example for which the right-hand side is negative, this is the case for, e.g., $N = 10$, $S_\ell = 5$, $S^D_\ell = 3$ and $S_m = 1$. Therefore, the inequality does not hold in general. Nevertheless, for $S_m = S_\ell$ we get

$$S_\ell(2N-S_\ell-S^D_\ell) - S^D_\ell(2N-2S_\ell) = (2N-S_\ell)(S_\ell-S^D_\ell) > 0.$$ 

This proves the claim. \hfill \Box

The following proposition establishes that the sub-coalition $S^D_\ell$ indeed has an advantage from deviating from the cooperative behavior.

**Proposition 3.6.** Given a coalition structure $\{S_1, \ldots, S_M\}$ with $2 \leq M < N$. The deviating sub-coalition $S^D_\ell \subseteq S_\ell$ realizes a higher one-period deviation revenue than it would obtain from cooperation in $S_\ell$. We get

$$R^D_{S_\ell} > R_{S_\ell}.$$
3.4 Dynamic Stability of Cooperation

Proof. We consider
\[
\frac{Nk^2}{2(N - S_D^\ell)} \left( \frac{2N - S_\ell - S_D^\ell}{2N - S_\ell} \right)^2 \left( \frac{1}{1 - \alpha} \right)^2 > 2Nk^2 \frac{(N - S_\ell)}{(1 - \alpha)^2(2N - S_\ell)^2}
\]
which is equivalent to
\[
(2N - S_\ell - S_D^\ell)^2 > 4(N - S_\ell)(N - S_D^\ell)
\]
After some algebraic manipulation we obtain
\[
(S_\ell - S_D^\ell)^2 > 0
\]
which is per assumption on the sizes of the coalitions \(S_\ell\) and \(S_D^\ell\) always true. \(\Box\)

The deviating sub-coalition sets a relatively low tax rate and by that underbids the tax rate from the coalitional equilibrium. The lower tax rate is accompanied by an increase of the tax base. These two effects pointing in opposite directions result in an overall positive effect for the tax revenues, as Proposition 3.6 shows. Therefore, deviating is profitable in the short run meaning that no coalition structure can be considered as stable, in general. Non-trivial deviations are always profitable and there is no coalition structure that is absorbing in the sense that it leads to high tax revenues and no incentives to deviate.

3.4.4. The discount factor

In this section we determine the discount factors needed to sustain a coalitional equilibrium. It is clear that the severity of punishment determines the stability of cooperation. Although we study stability with respect to a fixed, jointly committed form of punishment, we can characterize coalition structures according to their degree of stability in the long run by comparing their respective discount factors.

Note that the minimum discount factor is obtained by rewriting equation (3.13),
\[
\delta_{S_D} = \frac{R_{S_D} - R_{S_\ell}}{R_{S_D} - R_{S_D^\ell}}
\]
\[
= \frac{(S_\ell - S_D^\ell)^2(N - 1)}{(2N - S_\ell - S_D^\ell)^2(N - 1) - 4(2N - S_\ell)^2(1 - \alpha)^2(N - S_D^\ell)^2}.
\] (3.15)
See Appendix 3.C for the computation.
Let us first study the impact of a sub-coalitional deviation on the discount factor.

**Proposition 3.7.** Given a coalition structure \( \{ S_1, ..., S_M \} \) with \( 2 \leq M < N \). Fix a coalition \( S_\ell \) with \( S_\ell \geq 2 \). The larger the deviating sub-coalition \( S^D_\ell \subset S_\ell \) is, the smaller the minimum discount factor \( \delta^{S^D_\ell}_{S_\ell} \).

**Proof.** First, we consider the tax revenue \( R^{S^D_\ell}_{S_\ell} \) as a function of the size of the deviating sub-coalition, \( S^D_\ell \). We obtain

\[
\frac{\partial R^{S^D_\ell}_{S_\ell}}{\partial S^D_\ell} = -\frac{1}{(1-\alpha)^2} \frac{N k^2 (S_\ell - S^D_\ell) (2N - S_\ell - S^D_\ell)}{2(N - S^D_\ell)^2 (2N - S_\ell)^2} < 0.
\]

Therefore, for larger coalitions \( S^D_\ell \) their corresponding deviating tax revenue \( R^{S^D_\ell}_{S_\ell} \) is smaller (given the coalition \( S_\ell \)). This fact together with the observation that the minimum discount factor \( \delta^{S^D_\ell}_{S_\ell} \) is increasing in \( R^{S^D_\ell}_{S_\ell} \) shows the claim. Note that the punishment tax revenue we use does not depend on \( S^D_\ell \). \( \square \)

Proposition 3.7 shows that deviations of single regions require a higher minimum discount factor than deviations of sub-coalitions. For the sustainability of cooperation all regions need to value future payoffs sufficiently high in the sense that singleton deviations are not profitable. In this case it is straightforward according to the previous results that there are no profitable deviations by sub-coalitions. We define the minimum discount factor of a coalition to be the one of singleton deviations,

\[
\delta_{S_\ell} := \max \left\{ \delta^{S^D_\ell}_{S^D_\ell} \mid S^D_\ell < S_\ell \right\} = \delta^1_{S_\ell}.
\]

Now, in order to sustain a **coalitional equilibrium**, no region is allowed to have a profitable deviation no matter to which coalition this region belongs. Therefore, given the coalition structure \( \{ S_1, ..., S_M \} \) we need to take the maximal minimum discount factor \( \delta \) over all coalitions and all possible deviations of sub-coalitions. For all discount factors larger or equal than \( \delta \) no region has an incentive to deviate from the cooperative behavior and the next proposition helps to determine it:

**Proposition 3.8.** Given a coalition structure \( \{ S_1, ..., S_M \} \) with \( 2 \leq M < N \). The larger the size of a coalition \( S_\ell \) from which a sub-coalition \( S^D_\ell \) (of fixed size) deviates, the larger the minimum discount factor \( \delta^{S^D_\ell}_{S_\ell} \).

**Proof.** We consider the minimum discount factor \( \delta^{S^D_\ell}_{S_\ell} \) as a function of the coalition size \( S_\ell \).
The numerator of the minimum discount factor \( \delta_{S_\ell} \) given by

\[
(S_\ell - S_\ell^D)^2(N - 1)
\]

is increasing in the coalition size \( S_\ell \). Thus, if we are able to show that the denominator given by

\[
(2N - S_\ell - S_\ell^D)^2(N - 1) - 4(2N - S_\ell)^2(1 - \alpha)^2(N - S_\ell^D)
\]

is a decreasing function in \( S_\ell \), we are done. To see this we take the derivative of the denominator with respect to \( S_\ell \) and obtain

\[
-2(2N - S_\ell - S_\ell^D)(N - 1) + 8(1 - \alpha)^2(2N - S_\ell)(N - S_\ell^D).
\]

The coalition structure is fixed, so the factor \( \alpha \) is fixed as well. If this derivative is strictly negative, the denominator of \( \delta_{S_\ell}^{S_\ell^D} \) is a decreasing function of \( S_\ell \) and hence \( \delta_{S_\ell}^{S_\ell^D} \) is increasing in the coalition size. To see this we show:

\[
(2N - S_\ell - S_\ell^D)(N - 1) - 4(1 - \alpha)^2(2N - S_\ell)(N - S_\ell^D) > 0.
\]

By Lemma 1 we have that \( \alpha \) increases if two coalitions merge and so \( (1 - \alpha)^2 \) decreases. It is sufficient to take the upper bound for \( (1 - \alpha)^2 \) which is the lower bound for \( \alpha \) and corresponds to the case where the regions outside the coalition \( S_\ell \) react non-cooperatively. Thus,

\[
(1 - \alpha)^2 \leq \left(1 - \frac{S_\ell}{2N - S_\ell} \right)^2 \leq \frac{(N - S_\ell)^2(2N + S_\ell - 2)^2}{(2N - 1)^2(2N - S_\ell)^2}.
\]

Hence, for our claim we require:

\[
(2N - S_\ell - S_\ell^D)(N - 1)(2N - 1)^2(2N - S_\ell) - 4(N - S_\ell)^2(2N + S_\ell - 2)^2(N - S_\ell^D) > 0.
\]

Expanding and rearranging the expression on the left-hand side yields

\[
(N - S_\ell) \left[8S_\ell^D N^2(N - 2) + 5S_\ell^D(N - S_\ell) + 11S_\ell(N - S_\ell^D) + S_\ell^D N \right]
\]

\[
+ (N - S_\ell^D)(N - S_\ell) \left[8S_\ell(S_\ell N - N - S_\ell) + 4S_\ell(S_\ell - 2)(N + S_\ell) \right]
\]

\[
+ 4S_\ell(S_\ell - S_\ell^D)(N - 2)N^2 + 4N [(N - 1)N - (S_\ell^D - 1)S_\ell]
\]

\[
+ S_\ell \left[N(N - S_\ell^D) - S_\ell \right] + S_\ell^D(N - S_\ell) + S_\ell^D N.
\]

This last expression is strictly positive as the assumptions on the coalition structure imply \( N \geq 3 \) and \( S_\ell \geq 2 \). This proves the claim.
3.4 Dynamic Stability of Cooperation

Allowing for deviations of sub-coalitions of arbitrary size using Proposition 3.7 and Proposition 3.8 we get immediately:

**Proposition 3.9.** Given a coalition structure \{S_1, ..., S_M\} with 2 ≤ M < N. The maximal minimum discount factor is given by

\[
\delta = \delta_{S_{\text{max}}} = \delta_{\frac{1}{S_{\text{max}}}} = \frac{(S_{\text{max}} - 1)^2}{(2N - S_{\text{max}} - 1)^2 - 4(2N - S_{\text{max}})^2(1 - \alpha)^2}
\]

where \(S_{\text{max}}\) is the size of the largest coalition, denoted by \(S_{\text{max}}\), in the coalition structure \{S_1, ..., S_M\}.

Consequently, the size of the largest coalition determines the sustainability of a coalition structure, i.e. the maximal minimum discount factor for a given coalition structure essentially depends on this parameter. All other coalition sizes have no direct impact on the sustainability of the coalitional equilibrium, except for the fact that the discount factor depends on the ex-ante level of cooperation through the factor \(\alpha\).

In addition, combining Proposition 3.7 and Proposition 3.8 yields that if, for example, institutional or political reasons (outside our model) require deviations of at least two countries to make defection “effective” we can associate the respective discount factor.

In the following we compare the maximal minimum discount factor between different coalition structures in each case allowing for deviations of sub-coalitions of arbitrary size.

**Proposition 3.10.** Given a coalition structure \{S_1, ..., S_M\} with 2 ≤ M < N let \(S_{\text{max}}\) be the size of the largest coalition, denoted by \(S_{\text{max}}\). Assume that coalition \(S_m \neq S_{\text{max}}\) splits up into smaller coalitions \(S_{m_1}, ..., S_{m_k}\) with \(k ≥ 1\). Then, the maximal minimum discount factor increases.

Obviously, the discount factors coincide if the given coalition structure consists of one coalition and singletons. Otherwise the increase of the maximal minimum discount factor is strict as shown in the proof:

**Proof.** From Proposition 3.9 we know:

\[
\delta = \delta_{\frac{1}{S_{\text{max}}}}.
\]

The general expression for the discount factor is given in Equation (3.15). It depends in particular on the size of the coalition and the factor \(\alpha\). Per assumption the sizes of the largest coalition in the two coalition structures coincide, which makes \(\alpha\) the crucial difference in the discount factor. From Lemma 1 we know that \(\alpha\) strictly increases if any two coalitions
merge. Therefore if a coalition splits up into smaller coalitions $\alpha$ strictly decreases. In this case $(1 - \alpha)^2$ strictly increases and so the denominator of the minimum discount factor in Equation (3.15) strictly decreases, so the discount factor strictly increases.

Proposition 3.10 establishes that cooperation is easier to sustain if there is ex-ante more “cooperative behavior” between the regions. For example, compare an arbitrary coalition structure with $S_{\text{max}}$ as the largest coalition with a coalition structure with $S_{\text{max}}$ and the remaining regions act fully non-cooperatively (analyzed by Itaya et al., 2010). Then, the discount factor for the second case (ex-ante less cooperative) is larger than for the first case (ex-ante more cooperative).

Considering the situation in Proposition 3.10 from the reverse point of view we obtain:

**Proposition 3.11.** Given a coalition structure $\{S_1, \ldots, S_M\}$ with $S_2 = \ldots = S_M = 1$ and $2 \leq M < N$. Suppose, some singleton regions start to form new coalitions. As long as they do not form a coalition with a size strictly larger than $S_{\text{max}}$, the maximal minimum discount factor decreases.\(^\dagger\)

**Proof.** This can be shown by a similar argument as in Proposition 3.10.

Finally, we briefly comment on the punishment, where the assumption, that every region outside the deviating sub-coalition acts non-cooperatively, is relaxed. Let $\hat{\alpha}$ refer to the coalition structure of the punishment. It needs to be shown that the punishment tax revenue,

$$2NE \frac{(N - S^D_t)}{(2N - S^D_t)^2(1 - \hat{\alpha})^2},$$

resulting from a less cooperative coalition structure where coalitions outside the deviating sub-coalition or the deviating sub-coalition itself are allowed to continue to act cooperatively, is indeed lower than the tax revenue from cooperation. This implies monotonicity in the tax revenues going from less cooperative coalition structures to more cooperative ones. For this it is necessary to establish the following inequality

$$(N - S_t)(2N - S^D_t)^2(1 - \hat{\alpha})^2 - (N - S^D_t)(2N - S_t)^2(1 - \alpha)^2 \geq 0.$$

\(^\dagger\)Note that Proposition 3.10 and Proposition 3.11 depart from two different points of view. In Proposition 3.10 we study for an arbitrary coalition structure how the maximal minimum discount factor changes if every region outside the maximal size coalition starts to act less cooperatively. In Proposition 3.11 we start with a coalition structure with one “big” coalition and singleton regions and analyze the influence on the maximal minimum discount factor when some singleton regions form new coalitions, whose size is no larger than the one of the “big” coalition.
3.5 Numerical Example

It can be shown that all our previous results remain valid, if this condition is satisfied. Also Section 3.5 indicates by means of a numerical example that this kind of monotonicity in the tax revenues holds. Therefore, we expect that our results can be generalized to other forms of punishment.

By the comparison of the maximal minimum discount factors of two alternative punishment scenarios we immediately observe that changing the punishment to a (maybe more realistic) less harsh scenario with $\bar{R}_{SP}^P \geq R_{SP}^P$ has of course an impact on the sustainability of cooperation: As the maximal minimum discount factor increases, it becomes more difficult to sustain cooperation.

3.4.5. Welfare maximization

For the sake of readability of our results we have analyzed a model where the region’s objective function is to maximize tax revenues. However, this is not an innocent assumption since the objective function determines the strategic game considerably. A more realistic assumption is to maximize welfare consisting of the region’s consumption of a private and a public good, which is financed by tax revenues. By an numerical example for five regions we find that the equilibrium tax rates and tax revenues for the cooperative behavior seem to follow a similar pattern as with the revenue maximization. The same holds true for the dynamic sustainability of cooperation. Overall, this indicates that our results are likely to be generalized with welfare maximization. See Appendix 3.D for details.

3.5. Numerical Example

3.5.1. Equilibrium tax rates and tax revenues for five regions

In order to illustrate our results we introduce in this section an example, where we compare the different coalition structures for five regions, $N = 5$. The number of possible coalition structures is 52 and Table 3.1 gives an overview. We skipped most of the variations of the coalition structures due to our symmetric setting and the fact that they can easily be obtained by re-naming the players.
3.5 Numerical Example

\begin{table}[h]
\centering
\begin{tabular}{ccccccc}
\hline
Coalition structure & 1 & 2 & 3 & 4 & 5 & \( \tau \) \\
\hline
\{1\} \{2\} \{3\} \{4\} \{5\} & 2.5k & 2.5k & 2.5k & 2.5k & 2.5k & 2.5k \\
\{1\} \{2345\} & 5k & 7.5k & 7.5k & 7.5k & 7.5k & 7k \\
\{12\} \{345\} & 3.89k & 3.89k & 4.44k & 4.44k & 4.44k & 4.22k \\
\{12\} \{34\} \{5\} & 3.21k & 3.21k & 3.21k & 2.86k & 3.14k \\
\{12\} \{3\} \{4\} \{5\} & 3k & 3k & 2.67k & 2.67k & 2.67k & 2.8k \\
\{123\} \{4\} \{5\} & 4.09k & 4.09k & 4.09k & 3.18k & 3.18k & 3.73k \\
\hline
\end{tabular}
\caption{Coalition structures and corresponding \( \alpha \) for \( N = 5 \)}
\end{table}

For the purpose of this example, it is sufficient to choose one coalition structure from every column of Table 3.1 and compute the corresponding tax rate, capital demand and tax revenue. The results of the equilibrium tax rates and the equilibrium tax revenues are summarized in Tables 3.2 and 3.3 below.

\begin{table}[h]
\centering
\begin{tabular}{ccccccc}
\hline
Coalition structure & 1 & 2 & 3 & 4 & 5 & \( \tau \) \\
\hline
\{1\} \{2\} \{3\} \{4\} \{5\} & 2.5k^2 & 2.5k^2 & 2.5k^2 & 2.5k^2 & 2.5k^2 & 12.5k^2 \\
\{1\} \{2345\} & 5k^2 & 5.63k^2 & 5.63k^2 & 5.63k^2 & 5.63k^2 & 32.5k^2 \\
\{12\} \{345\} & 4.54k^2 & 4.54k^2 & 3.95k^2 & 3.95k^2 & 3.95k^2 & 20.93k^2 \\
\{12\} \{34\} \{5\} & 3.1k^2 & 3.1k^2 & 3.1k^2 & 3.1k^2 & 3.27k^2 & 15.67k^2 \\
\{12\} \{3\} \{4\} \{5\} & 2.7k^2 & 2.7k^2 & 2.84k^2 & 2.84k^2 & 2.84k^2 & 13.92k^2 \\
\{123\} \{4\} \{5\} & 3.35k^2 & 3.35k^2 & 3.35k^2 & 4.05k^2 & 4.05k^2 & 18.15k^2 \\
\hline
\end{tabular}
\caption{Equilibrium tax rates for \( N = 5 \)}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{ccccccc}
\hline
Coalition structure & 1 & 2 & 3 & 4 & 5 & \( \sum \) \\
\hline
\{1\} \{2\} \{3\} \{4\} \{5\} & 2.5k^2 & 2.5k^2 & 2.5k^2 & 2.5k^2 & 2.5k^2 & 12.5k^2 \\
\{1\} \{2345\} & 5k^2 & 5.63k^2 & 5.63k^2 & 5.63k^2 & 5.63k^2 & 32.5k^2 \\
\{12\} \{345\} & 4.54k^2 & 4.54k^2 & 3.95k^2 & 3.95k^2 & 3.95k^2 & 20.93k^2 \\
\{12\} \{34\} \{5\} & 3.1k^2 & 3.1k^2 & 3.1k^2 & 3.1k^2 & 3.27k^2 & 15.67k^2 \\
\{12\} \{3\} \{4\} \{5\} & 2.7k^2 & 2.7k^2 & 2.84k^2 & 2.84k^2 & 2.84k^2 & 13.92k^2 \\
\{123\} \{4\} \{5\} & 3.35k^2 & 3.35k^2 & 3.35k^2 & 4.05k^2 & 4.05k^2 & 18.15k^2 \\
\hline
\end{tabular}
\caption{Equilibrium tax revenues for \( N = 5 \)}
\end{table}
3.5 Numerical Example

Starting from the point of no cooperation, each region receives the lowest values in absolute terms for both equilibrium tax rate and equilibrium tax revenue. This observation refers to the well-known fact that any kind of cooperation is profitable for all the regions. Clearly, this situation is the “classical” tax competition dilemma where tax rates and tax revenues are too low compared to a cooperative solution.

If two regions form a coalition while the remaining regions continue to act non-cooperatively, such that the resulting coalition structure is for example \{12\} \{3\} \{4\} \{5\}, there is a Pareto-improvement for all regions in terms of tax rates and tax revenues. As suggested by Proposition 3.2 we observe first, that the coalition of the two cooperating regions sets a higher tax rate, \(3\bar{k}\) vs. \(2.67\bar{k}\), and becomes a capital exporter where capital demand is \(0.9\bar{k}\). Second, the tax revenue of this coalition \{12\} is \(2.7\bar{k}^2\) and therefore lower compared to the singleton regions with \(2.84\bar{k}^2\), but still strictly higher than the non-cooperative payoff of \(2.5\bar{k}^2\).

### 3.5.2. A repeated game with five regions

Now, we apply the repeated game to this example.

<table>
<thead>
<tr>
<th>coalition structure</th>
<th>discount factor</th>
<th>sum of tax revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>{1} {2345}</td>
<td>(\delta^1_{2345} = 0.5031) (\delta = 0.5031)</td>
<td>(32.5\bar{k}^2)</td>
</tr>
<tr>
<td></td>
<td>(\delta^2_{2345} = 0.3750)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\delta^3_{2345} = 0.1837)</td>
<td></td>
</tr>
<tr>
<td>{12} {345}</td>
<td>(\delta^1_{12} = 0.0443) (\delta = 0.2539)</td>
<td>(20.93\bar{k}^2)</td>
</tr>
<tr>
<td></td>
<td>(\delta^1_{345} = 0.2539)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(\delta^2_{345} = 0.1019)</td>
<td></td>
</tr>
<tr>
<td>{12} {34} {5}</td>
<td>(\delta^1_{12} = 0.0972) (\delta = 0.0972)</td>
<td>(15.67\bar{k}^2)</td>
</tr>
<tr>
<td></td>
<td>(\delta^1_{34} = 0.0972)</td>
<td></td>
</tr>
<tr>
<td>{12} {3} {4} {5}</td>
<td>(\delta^1_{12} = 0.2195) (\delta = 0.2195)</td>
<td>(13.92\bar{k}^2)</td>
</tr>
<tr>
<td>{123} {4} {5}</td>
<td>(\delta^1_{123} = 0.3306) (\delta = 0.3306)</td>
<td>(18.15\bar{k}^2)</td>
</tr>
<tr>
<td></td>
<td>(\delta^2_{123} = 0.1414)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.4.: Discount factors for \(N = 5\).

According to Proposition 3.9 the discount factor associated to a coalition structure is the one for singleton deviations from the largest coalition.
3.6 Conclusion

The comparison of the coalition structure \{\{12\} \{345\}\} with an ex-ante less cooperative and hence more competitive environment, i.e., there is only coalition \{123\} whereas coalition \{4\} and \{5\} act as a singleton, shows that cooperation is more difficult to sustain. In Proposition 3.10 we established that this observation holds true in general, so cooperation is easier the more cooperative behavior exists ex-ante under the assumption that the size of the largest coalition is fixed.

Lastly, note that according to Proposition 3.11 the maximal minimum discount factor decreases from 0.3306 to 0.2539 going from coalition structure \{\{123\} \{4\} \{5\}\} to coalition structure \{\{12\} \{345\}\} where the two singleton regions form a coalition.

Interestingly, a comparison of all possible coalition structures for \(N = 5\) shows, that the most stable coalition structure, in the sense of the lowest discount factor, is not the one with the largest sum of tax revenues. This suggests that there is a trade-off between efficiency and stability.

3.6. Conclusion

This paper has analyzed the stability of coalitional equilibria within repeated tax competition. For any given coalition structure we have determined the equilibrium tax rates and the equilibrium tax revenues. The main contribution of this paper is the analysis of sustainability of cooperative behavior by means of a repeated game setting allowing for deviations of sub-coalitions.

We obtain the following results: First, the deviating sub-coalition underbids the tax rates of other regions continuing to act cooperatively and benefits from a one-shot deviation. Nevertheless, for a given form of punishment we have found that there exists a critical minimum discount factor that makes deviations unprofitable and sustains cooperation in the long run. Second, we have established that for an arbitrary coalition structure the discount factor needed to sustain a coalitional equilibrium crucially depends on the size of the largest coalition and the deviations of singleton regions. This implies that the central force that determines the stability of cooperation refers to the “market power” of the largest coalition. Third, the comparison of an arbitrary coalition structure where the largest coalition consists of at least two regions with a coalition structure where there is only the largest coalition and the remaining regions behave fully non-cooperatively, or, in general, with a less cooperative coalition structure but with the same coalition of maximal size, shows: Cooperation is easier to sustain for the first coalition structure with an ex-ante more cooperative behavior. Similarly, for a given coalition considering the behavior of the remaining regions, the discount factor needed to sustain cooperation decreases as long as the remaining regions do not form a
coalition larger than the given one. This means, once cooperative behavior has been broadly established it is also easier to sustain.

Finally, a comparison of all possible coalition structures for five regions showed, that the most stable coalition structure, in the sense of the lowest discount factor, is not the one with the largest sum of tax revenues. This suggests that a further investigation analyzing the trade-off between efficiency and stability for an arbitrary number of regions is one direction for future research. Clearly the model needs to be extended by incorporating further asymmetries. For instance heterogeneous preferences regarding an optimal public policy of countries, e.g. Cnossen (1990), or differences in productivity and endowments, e.g. Peralta and van Ypersele (2005), might induce limits to cooperation.
Bibliography


3. Bibliography


3. Bibliography


Appendix

3.A. Optimal tax rates with coalition structures

We provide the computation of how the best response function for the regional tax rate is determined. The characteristic feature of a coalition is that they agree to set a unique tax rate within the coalition. The coalitional revenue is distributed equally to its members. The objective function of the coalition $S_m$ is given by

$$\sum_{h \in S_m} \tau_h k_h(\tau) = \sum_{h \in S_m} \tau_{S_m} \left( \frac{k}{2} + \frac{\tau - \tau_{S_m}}{2} \right) = S_m \tau_{S_m} \left( \frac{k}{2} + \frac{\tau - \tau_{S_m}}{2} \right).$$

The coalitional tax rate is chosen in such a way that this function is maximized. The derivative with respect to $\tau_{S_m}$ is:

$$S_m \left( \frac{k}{2} + 1 \right) \sum_{\ell \neq m} S_{\ell} \tau_{S_{\ell}} N + \left( S_m \frac{1}{2} - \frac{1}{2} \right) \tau_{S_m} = S_m \left( \frac{k}{2} + \frac{1}{2} \sum_{\ell \neq m} S_{\ell} \tau_{S_{\ell}} N + \frac{S_m - N}{N} \tau_{S_m} \right).$$

Equating this term to 0 leads to

$$\tau_{S_m} = \frac{N}{N - S_m} \frac{k}{2} + \frac{1}{2} \sum_{\ell \neq m} \frac{S_{\ell} \tau_{S_{\ell}} N}{N - S_m}.$$

The existence of a Nash equilibrium is guaranteed due to the linearity of the best response functions and the fact that their slope is strictly smaller than one:16

$$\frac{\partial \tau_{S_m}}{\partial \tau_{S_{\ell}}} = \frac{1}{2} \frac{S_{\ell}}{N - S_m} < 1.$$

We compute the optimal tax rates in line with Bucovetsky (2009) as follows. Given the coalition structure \( \{ S_1, S_2, \ldots, S_M \} \), where for \( m \geq 2 \) the coalitions \( S_m \) are singletons. From

---

16According to the definition in Konrad and Schjelderup (1999, p.163) equilibrium tax rates are strategic complements, as \( \frac{\partial \tau_{S_m}}{\partial \tau_{S_{\ell}}} > 0 \).
the first order condition we have
\[ Sm \left( \bar{k} + \frac{\tau - \tau_{Sm}}{2} \right) + Sm \tau_{Sm} \left( \frac{Sm}{2N} - \frac{1}{2} \right) = 0. \]

The optimal tax rates are
\[ \tau_{Sm} = (2\bar{k} + \tau) \left( \frac{N}{2N - Sm} \right). \]

Multiplying both sides with \( Sm \), summing up over all coalitions and dividing by \( N \) gives
\[ \sum_{m=1}^{M} \frac{Sm \tau_{Sm}}{N} = (2\bar{k} + \tau) \left( \sum_{m=1}^{M} \frac{Sm}{2N - Sm} \right). \]

On the left-hand side we obtain the average tax rate \( \bar{\tau} \). Solving for \( \tau \) yields:
\[ \bar{\tau} = 2\bar{k} \left( \frac{\sum_{m=1}^{M} \frac{Sm}{2N-Sm}}{1 - \sum_{m=1}^{M} \frac{Sm}{2N-Sm}} \right). \]

Defining \( \alpha := \sum_{m=1}^{M} \frac{Sm}{2N-Sm} \), the average tax rate can be written as
\[ \bar{\tau} = 2\bar{k} \left( \frac{\alpha}{1 - \alpha} \right). \]

Inserting this expression for \( \bar{\tau} \) into the optimal tax rates we get
\[ \tau_{Sm} = 2N\bar{k} \left( 1 + \frac{\alpha}{1 - \alpha} \right) \left( \frac{1}{2N - Sm} \right) \]
\[ = 2N\bar{k} \left( \frac{1}{1 - \alpha} \right) \left( \frac{1}{2N - Sm} \right). \]

### 3.B. Optimal tax rate and revenue under deviating behavior

Suppose a sub-coalition \( S^D_\ell \) consisting of \( S^D_\ell \) regions (from coalition \( S_\ell \), \( S^D_\ell < S_\ell \)) deviates while all other regions continue to set the equilibrium tax rate from the coalition structure \( \{S_1, ..., S_M\} \). This means there are \( S_\ell - S^D_\ell \) regions setting the tax rate \( \tau_{S_\ell} \) and there are \( S_m \) regions setting \( \tau_{Sm} \) for \( m \neq \ell \).
The regions $S^D_t$ maximize their joint tax revenue given by

$$S^D_t \tau_{S^D_t} \left( \frac{k + \tau - S^D_t \tau_{S^D_t} + \frac{S^D_t \tau_{S^D_t}}{2} - \frac{S^D_t}{2}}{k} \right)$$

by deviating. The derivative of the joint tax revenue is

$$\frac{k + \tau - S^D_t \tau_{S^D_t} + \frac{S^D_t \tau_{S^D_t}}{2} - \frac{S^D_t}{2}}{2N} + \tau_{S^D_t} \left( \frac{S^D_t - N}{2N} \right)$$

Solving the first order condition we get the optimal deviation tax rate

$$\tau_{S^D_t} = \frac{N}{N - S^D_t} \left( \frac{k + \tau - S^D_t \tau_{S^D_t} + \frac{S^D_t \tau_{S^D_t}}{2} - \frac{S^D_t}{2}}{2N} \right).$$

Capital demand is given by

$$\frac{k + \tau - S^D_t \tau_{S^D_t} + \frac{S^D_t \tau_{S^D_t}}{2} - \frac{S^D_t}{2}}{2N}.$$
3.C Computation of the minimum discount factor

and

\[ R^{S^D}_{S_t} = \frac{N}{2(N - S^D_t)} \left( \frac{\bar{k} + \frac{\pi}{2} - S^D_t S_t}{2N} \right)^2 \]

\[ = \frac{Nk^2}{2(N - S^D_t)} \left( \frac{2N - S_t - S^D_t}{2N - S_t} \right)^2 \left( \frac{1}{1 - \alpha} \right)^2. \]

3.C. Computation of the minimum discount factor

To compute the minimum discount factor we first look at the numerator and obtain

\[ R^{S^D}_{S_t} - R_s = \frac{Nk^2}{2(N - S^D_t)} \left( \frac{2N - S_t - S^D_t}{2N - S_t} \right)^2 \left( \frac{1}{1 - \alpha} \right)^2 - 2Nk^2 \frac{(N - S_t)}{(1 - \alpha)^2(2N - S_t)^2} \]

\[ = \frac{Nk^2}{(1 - \alpha)^2(2N - S_t)^2} \left( \frac{2N - S_t - S^D_t}{2N - S_t} \right) - 2(N - S_t) \]

\[ = \frac{Nk^2}{(1 - \alpha)^2(2N - S_t)^2} \left( \frac{(S_t - S^D_t)^2}{2(N - S_t)} \right) \]

\[ = \frac{Nk^2}{(1 - \alpha)^2(2N - S_t)^2} \left( S_t - S^D_t \right)^2. \]

For the denominator we get

\[ R^{S^D}_{S_t} - R^{S^P}_{S_t} = \frac{Nk^2}{2(N - S^D_t)} \left( \frac{2N - S_t - S^D_t}{2N - S_t} \right)^2 \left( \frac{1}{1 - \alpha} \right)^2 - 2Nk^2 \frac{1}{N - 1} \]

\[ = \frac{Nk^2}{2} \left( \frac{2N - S_t - S^D_t}{2N - S_t} \right)^2 \left( \frac{1}{N - S^D_t} \right) \left( \frac{1}{1 - \alpha} \right)^2 - \frac{2}{(N - 1)} \]

\[ = \frac{Nk^2}{2(2N - S_t)^2(1 - \alpha)^2(N - 1)^2} \left( (2N - S_t - S^D_t)^2(N - 1) - 4(2N - S_t)^2(1 - \alpha)^2(N - S^D_t)(N - 1) \right) \]

\[ = \frac{Nk^2}{2(2N - S_t)^2(1 - \alpha)^2(N - 1)}. \]

Hence, the minimum discount factor is given by:

\[ \delta^{S^D}_{S_t} = \frac{R^{S^D}_{S_t} - R_s}{R^{S^D}_{S_t} - R^{S^P}_{S_t}} \]

\[ = \frac{(S_t - S^D_t)^2(N - 1)}{(2N - S_t - S^D_t)^2(N - 1) - 4(2N - S_t)(1 - \alpha)^2(N - S^D_t)}. \]
3.D Maximizing welfare

The government’s objective function determines the strategic game between countries considerably. Therefore, the assumption that regions maximize tax revenues is not innocent. In this section, we consider a numerical example for welfare maximization to get an idea whether our main results hold.


In line with Cardarelli et al. (2002), Itaya et al. (2008) or Devereux et al. (2008) we assume that the regional government’s objective is to maximize a linear utility function which depends on overall (private and public) consumption in society: Private consumption for region $i$ is given by the sum of the labor income and capital income

$$C_i^{private}(\tau) = f(k_i) - k_i f'(k_i) + r\overline{k}.$$ 

Public consumption is given by the tax revenues

$$C_i^{public}(\tau) = \tau_i k_i.$$ 

In equilibrium, the welfare in region $i$ is given by overall consumption (private and public) in region $i$ with a marginal cost of public funds $\gamma > 1$:

$$W_i(\tau) = C_i^{private}(\tau) + \gamma C_i^{public}(\tau) = f(k_i^*(\tau)) - k_i^*(\tau) f'(k_i^*(\tau)) + r^*(\tau) \overline{k} + \gamma \tau_i k_i^*(\tau) = (k_i^*(\tau))^2 + r^*(\tau) \overline{k} + \gamma \tau_i k_i^*(\tau).$$

Given a coalition structure $\{S_1, ..., S_M\}$ with $2 \leq M \leq N$. For coalition $S_m$ the objective function is given by

$$\sum_{h \in S_m} W_h(\tau) = \sum_{h \in S_m} (k_h^*(\tau))^2 + r^*(\tau) \overline{k} + \gamma \tau_{S_m} k_h^*(\tau) = S_m \left( \left( \frac{\overline{k} + \frac{\tau - \tau_{S_m}}{2}}{2} \right)^2 + \left( A - 2\overline{k} - \tau \right) \overline{k} + \gamma \tau_{S_m} \left( \frac{\overline{k} + \frac{\tau - \tau_{S_m}}{2}}{2} \right) \right)$$
3.D Maximizing welfare

Taking the derivative with respect to $\tau$ we obtain

$$S_m \left(2 \left( k + \frac{\tau - \tau_{S_m}}{2} \right) \frac{S_m}{2N} - \frac{1}{2} \right) - \frac{S_m}{N} k + \frac{\tau - \tau_{S_m}}{2} + \gamma \tau_{S_m} \left( \frac{S_m}{2N} - \frac{1}{2} \right)$$

$$= S_m \left( (\gamma - 1) k + \frac{S_m + N(\gamma - 1)}{2N} \tau + \frac{S_m(\gamma - 1) + N(1 - 2\gamma)}{2N} \tau_{S_m} \right)$$

Equalizing to 0 leads to

$$\tau_{S_m} = \frac{2N}{N(2\gamma - 1) - S_m(\gamma - 1)} \left( \frac{\gamma - 1}{k} + \frac{S_m + N(\gamma - 1)}{2N} \right)$$

$$= \frac{2N}{N(2\gamma - 1) - S_m(\gamma - 1)} \frac{S_m + N(\gamma - 1)}{N(2\gamma - 1) - S_m(\gamma - 1)}$$

Summing up over all coalitions and dividing by $N$ gives

$$\tau = \sum_{m=1}^{M} \frac{S_m(\gamma - 1)k}{N(2\gamma - 1) - S_m(\gamma - 1)} + \sum_{m=1}^{M} \frac{S_m(\gamma - 1)}{N(2\gamma - 1) - S_m(\gamma - 1)}$$

$\tau$ can be computed as follows:

$$\tau = 2k \frac{N(\gamma - 1)S_m}{1 - \sum_{m=1}^{M} \frac{N(2\gamma - 1) - S_m(\gamma - 1)}{N(2\gamma - 1) - S_m(\gamma - 1)}}$$

$$= \frac{2k}{1 - \sum_{m=1}^{M} \frac{S_m}{N(2\gamma - 1) - S_m(\gamma - 1)} - \sum_{m=1}^{M} \frac{S_m(\gamma - 1)}{N(2\gamma - 1) - S_m(\gamma - 1)}}$$

Define

$$\alpha : = \sum_{m=1}^{M} \frac{(\gamma - 1)S_m}{N(2\gamma - 1) - S_m(\gamma - 1)}$$

$$\beta : = \sum_{m=1}^{M} \frac{S_m}{N(2\gamma - 1) - S_m(\gamma - 1)}.$$

$\tau$ can be then be written in a more simpler way:

$$\tau = 2k \frac{\alpha}{1 - \alpha - \beta}.$$

Computing $\tau_{S_m}$ we get

$$\tau_{S_m} = 2k \left( \frac{N(\gamma - 1)(1 - \beta) + \alpha S_m}{N(2\gamma - 1) - S_m(\gamma - 1)} \right) \left( \frac{1}{1 - \alpha - \beta} \right).$$
3.D Maximizing welfare

For the capital demand we get

\[ k^*_S_m(\tau) = \bar{k} \frac{1}{1 - \alpha - \beta} \left( \frac{N\gamma(1 - \beta) - (\alpha + (\gamma - 1)(1 - \beta)) S_m}{N(2\gamma - 1) - S_m(\gamma - 1)} \right). \]

3.D.2. Repeated interaction

Suppose sub-coalition \( S^D_\ell \subset S_\ell \) considers to deviate from the coalitional equilibrium. We determine the optimal deviation tax rate of region \( j \) and the respective capital demand.

For the deviation tax rate observe that

\[
\frac{\partial}{\partial \tau_{S^D_\ell}} \left( (k^*_S)^2 + r^* \left( \frac{S^D_\ell}{N} \right) \right) = 2 \left( \bar{k} + \frac{\tau - \frac{S^D_\ell\tau_{S^D_\ell}}{N} + \frac{S^D_\ell\tau_{S^D_\ell}}{N} - \tau_{S^D_\ell}}{2} \right) \left( \frac{S^D_\ell - N}{2N} \right) - \frac{S^D_\ell}{N} \bar{k}
\]

\[ + \gamma \left( \bar{k} + \frac{\tau - \frac{S^D_\ell\tau_{S^D_\ell}}{N} + \frac{S^D_\ell\tau_{S^D_\ell}}{N} - \tau_{S^D_\ell}}{2} \right) + \gamma \tau_{S^D_\ell} \left( \frac{S^D_\ell - N}{2N} \right) \]

\[ = (\gamma - 1) \bar{k} + \left( \frac{S^D_\ell + N(\gamma - 1)}{N} \right) \left( \frac{\tau}{2} - \frac{S^D_\ell\tau_{S^D_\ell}}{2N} \right) + \left( \frac{S^D_\ell + N(2\gamma - 1)}{2N} \right) \left( \frac{\tau}{2} - \frac{S^D_\ell\tau_{S^D_\ell}}{2N} \right) \tau_{S^D_\ell}. \]

Solving the first order condition we get the optimal deviation tax rate given by

\[ \tau_{S^D_\ell} = \left( \frac{2N}{S^D_\ell + N(2\gamma - 1)} \right) \left( \frac{N}{N - S^D_\ell} \right) \left( \gamma - 1 \right) \bar{k} + \left( \frac{S^D_\ell + N(\gamma - 1)}{N} \right) \left( \frac{\tau}{2} - \frac{S^D_\ell\tau_{S^D_\ell}}{2N} \right) \]

\[ = \left( \frac{N}{N - S^D_\ell} \right) \left( \frac{2N(\gamma - 1)}{S^D_\ell + N(2\gamma - 1)} \right) \bar{k} + \left( \frac{2S^D_\ell + 2N(\gamma - 1)}{S^D_\ell + N(2\gamma - 1)} \right) \left( \frac{\tau}{2} - \frac{S^D_\ell\tau_{S^D_\ell}}{2N} \right). \]

Capital demand is given by

\[ \bar{k} + \frac{\tau - \frac{S^D_\ell\tau_{S^D_\ell}}{N} + \frac{S^D_\ell\tau_{S^D_\ell}}{N} - \tau_{S^D_\ell}}{2} = \frac{S^D_\ell + N\gamma}{S^D_\ell + N(2\gamma - 1) \bar{k}} \left( \frac{N\gamma}{S^D_\ell + N(2\gamma - 1)} \right) \left( \frac{\tau}{2} - \frac{S^D_\ell\tau_{S^D_\ell}}{2N} \right). \]

The welfare can then be computed using the equilibrium tax rate and capital demand. We will stick to a numerical example in what follows.
3.D Maximizing welfare

3.D.3. A numerical example for five regions

For the repeated game with five regions we employ different levels for the marginal costs of public funds $\gamma$. Results are reported in Table 3.5.

<table>
<thead>
<tr>
<th>coalition structure</th>
<th>discount factor</th>
<th>overall welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma = 1.1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>${{1} {2345}}$</td>
<td>$\delta^1_{{2345}} = 0.6286$</td>
<td>$\delta = 0.6286$</td>
</tr>
<tr>
<td></td>
<td>$\delta^2_{{2345}} = 0.6167$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\delta^3_{{2345}} = 0.5652$</td>
<td></td>
</tr>
<tr>
<td>${{12} {345}}$</td>
<td>$\delta^1_{{12}} = 0.0729$</td>
<td>$\delta = 0.3481$</td>
</tr>
<tr>
<td></td>
<td>$\delta^1_{{345}} = 0.3481$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\delta^2_{{345}} = 0.3062$</td>
<td></td>
</tr>
<tr>
<td>${{12} {34} {5}}$</td>
<td>$\delta^1_{{12}} = 0.1478$</td>
<td>$\delta = 0.1478$</td>
</tr>
<tr>
<td></td>
<td>$\delta^1_{{34}} = 0.1478$</td>
<td></td>
</tr>
<tr>
<td>$\gamma = 2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>${{1} {2345}}$</td>
<td>$\delta^1_{{2345}} = 0.5648$</td>
<td>$\delta = 0.5648$</td>
</tr>
<tr>
<td></td>
<td>$\delta^2_{{2345}} = 0.5581$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\delta^3_{{2345}} = 0.5198$</td>
<td></td>
</tr>
<tr>
<td>${{12} {345}}$</td>
<td>$\delta^1_{{12}} = 0.0567$</td>
<td>$\delta = 0.2984$</td>
</tr>
<tr>
<td></td>
<td>$\delta^1_{{345}} = 0.2984$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\delta^2_{{345}} = 0.2680$</td>
<td></td>
</tr>
<tr>
<td>${{12} {34} {5}}$</td>
<td>$\delta^1_{{12}} = 0.1197$</td>
<td>$\delta = 0.1197$</td>
</tr>
<tr>
<td></td>
<td>$\delta^1_{{34}} = 0.1197$</td>
<td></td>
</tr>
<tr>
<td>${{12} {3} {4} {5}}$</td>
<td>$\delta^1_{{12}} = 0.2819$</td>
<td>$\delta = 0.2819$</td>
</tr>
<tr>
<td></td>
<td>$\delta^1_{{34}} = 0.2819$</td>
<td></td>
</tr>
<tr>
<td>${{123} {4} {5}}$</td>
<td>$\delta^1_{{123}} = 0.3955$</td>
<td>$\delta = 0.3955$</td>
</tr>
<tr>
<td></td>
<td>$\delta^2_{{123}} = 0.3604$</td>
<td></td>
</tr>
</tbody>
</table>
In brief, there is a good indication that the tax revenue objective function we have chosen is not detrimental to our main results. Again, the comparison of all possible coalition structures for $N = 5$ shows that the most stable coalition structure, in the sense of the lowest discount factor, is not the one with the largest overall welfare.

This chapter is joint work with Tim Krieger and Daniel Meierrieks and refers to the working paper available as CESifo Working Paper No. 3789, April 2012, CESifo Group Munich.

4.1. Introduction

In recent years a plethora of large-N studies have tried to unveil the causes of terrorism (e.g., Abadie, 2006; Burgoon, 2006; Blomberg and Hess, 2008; Basuchoudhary and Shughart, 2010; Freytag et al., 2011).

Usually, these studies—in an effort to make use of datasets that are as large as possible—‘pool’ terrorism data, implicitly assuming that a single empirical and behavioral model can explain terrorist activity, irrespective of the underlying ideological, ethnic, religious or other motivations and goals of distinct terrorist organizations.

In this contribution we argue that underestimating the role of political motivations of terrorism might lead to biased findings in empirical research. In fact, there exists an array of typologies that classifies the spectrum of political terrorism according to its primary motivations and goals (cf. Schmid and Jongman, 2005). Among others, these approaches differentiate between ideologically motivated terrorism, such as left-wing or right-wing terrorism, ethnically motivated terrorism, such as nationalist-separatist terrorist movements, or religiously motivated terrorism (e.g., Post, 2005; Zimmermann, 2009). In this study, we account for the heterogeneity of terrorism by analyzing the mutual and distinct social

1See Krieger and Meierrieks (2011) and Gassebner and Luechinger (2011) for recent reviews of large-N studies on the causes of terrorism.
4.1 Introduction

origins of the two most prominent types of terrorism in 17 Western European countries\(^2\) between 1970 and 2007: (revolutionary) \textit{left-wing} and (ethnic) \textit{nationalist-separatist} terrorism. These types differ with respect to a number of traits (Table 1, which is inspired by Zimmermann, 2009).

— Table 1 here —

In Western Europe, left-wing terrorism is historically rooted in 19th and early 20th century anarchist terrorism (‘Propaganda of the Deed’), but also in the circumstances of the Cold War era (e.g., East-West conflict, Vietnam War, ‘New Left’). Its ultimate goal is a regime change, i.e., the establishment of a communist or anarchist society, where this objective is linked to—sometimes only vaguely articulated—visions of social justice, anti-imperialism and anti-capitalism (e.g., Shughart, 2006). Nationalist-separatist terrorism, by contrast, is more closely related to grievances and conflict associated with ethnic discrimination and the vision of national liberation (e.g., Shughart, 2006). While post-World War I political currents (anti-colonialism, anti-imperialism) surely mattered to the emergence of this kind of terrorism, it is also strongly rooted in country-specific circumstances, meaning that conflict may have its origins well in the past. Ultimately, nationalist-separatist terrorism aims at territorial change (or its prevention).\(^3\)

Importantly, the regime change goal of left-wing terrorism is non-negotiable. Left-wing terrorist activity is ideologically driven and can therefore be understood as a form of \textit{supreme value terrorism}. As argued by Bernholz (2004), supreme value ‘believers’ prefer these values to all else, making them far less responsive and potentially immune to any cost-benefit considerations (which are typically referred to in rational-choice models of terrorist behavior). Ethnic terrorism, by contrast, usually does not adhere to supreme values. Its goals are negotiable, so that concessions—e.g., in the form of autonomy—can be made.

The non-negotiability of left-wing terrorist demands can be expected to limit their popular appeal and support. Consequently, they are more likely to strive for external support, while—as a ‘revolutionary vanguard’—resorting to a strategy of targeted killings to incite a popular revolution (Shughart, 2006). Opposed to this, the negotiability of the demands of nationalist-separatist groups can be expected to create strong support from its ethnic target audience. Ethnic terrorism thus has fewer incentives to internationalize, with prominent international links, however, still existing (e.g., diaspora support). Ethnic terrorist groups aim

\(^2\)These countries are Austria, Belgium, Denmark, France (incl. Corsica), Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom (incl. Northern Ireland).

\(^3\)Some national liberation terrorist groups (e.g., PIRA, ETA) also adopted a (left-wing) revolutionary jargon (Sanchez-Cuenca, 2009). However, their central goal is to achieve territorial concessions. Following Sanchez-Cuenca (2009), we therefore consider such groups as nationalist-separatist.
at creating a distinct communal identity and ethnic ‘infrastructure’, i.e., they tend to create public goods (Byman, 1998). This public good provision may render nationalist-separatist terrorism even more persistent. Popular support and communal ‘anchoring’ make it possible for ethnic groups to resort to attrition warfare, while the negotiability of their goals makes truces and political talks a viable strategic option (e.g., Sanchez-Cuenca, 2007).

What this brief discussion about the differences between revolutionary and ethnic terrorism suggests is that both forms have different historic roots and pursue different goals. These factors in turn affect the size of the terrorists’ potential support, their degree of internationalization as well as their politico-military strategy. We argue that, ultimately, due to these differences left-wing and nationalist-separatist terrorism have distinct mechanisms of mobilization and radicalization—related to specific social conditions—and therefore ought to respond differently to social change and politico-economic incentives. Nevertheless, we believe it to be rather unlikely that there is no intersecting set of social conditions at all that simultaneously explains the genesis of both forms of terrorism.

Following this discussion on the potential heterogeneity in the causes of different forms of terrorism, we use a uniquely coded dataset to separately analyze the roots of revolutionary and ethnic terrorism in 17 Western European countries between 1970 and 2007. Our study builds on those few empirical studies that account for different types of political terrorism. For instance, Robison et al. (2006) distinguish between the determinants of Islamist and leftist transnational terrorism. They find that leftist (but not Islamist) terrorism is particularly stimulated by the Cold War, while Islamic (but not leftist) terrorism is influenced by the growth of secular governments and religious competition. Sanchez-Cuenca (2009) identifies a unique set of variables (past dictatorship, population size, strong communist parties) that determines the intensity of left-wing terrorism in the developed world, while Blomberg et al. (2011) find that group ideology influences the survival of terrorist groups. In short, these studies suggest that motivational causes indeed matter to the emergence and continuity of terrorism.

To preview our empirical results, we similarly find differences in the determinants of left-wing and nationalist-separatist terrorism in Western Europe. Certain politico-demographic factors matter to either form of terrorism only. For instance, while only left-wing terrorism is strongly affected by the prevalence of the Cold War, only nationalist-separatist terrorism is fueled by ethnic polarization or, interestingly, the incumbency of ‘more security-prone’ right-wing governments (that are typically thought to be the ‘natural political enemy’ of left-wing terrorists in the first place). The prevalence of democratic institutions even leads

---

4 Transnational terrorism involves citizens, groups, territory, etc. of more than one country, while domestic terrorism involves only one country. Previous empirical efforts have focused on the former type of terrorism due to data constraints, although the latter type of terrorism by far outnumbers the former (e.g., Enders et al., 2011).
4.2 Left-Wing and Nationalist-Separatist Terrorism in Western Europe

to opposing influences on the different types of terrorism. Yet, there are also some variables that sway both forms of terrorism. For example, certain socio-economic factors (e.g., unemployment, inflation) play an important and similar role in left-wing and nationalist-separatist terrorism. This may indicate that both kinds of terrorism are geared towards socio-economic change, where nationalist-separatist terrorist groups have commonly also embraced socialist agendas (e.g., ETA, IRA). Overall, our findings suggest that different types of terrorism are associated with different mobilization and radicalization mechanisms and different forms of popular and external support. Our results indicate that supreme value (left-wing) terrorism may also be alleviated through social improvements; however, ethnic terrorism seems to be more responsive to socio-economic and political incentives (e.g., economic progress, political participation). Finally, we also show that the ‘pooling’ of left-wing and nationalist-separatist terrorism affects our previous findings and may potentially mask the influence of specific variables that matter to distinct forms of terrorism only. This indicates that empirical studies should more thoroughly account for heterogeneity in terrorism—linked to motivational underpinnings—when studying its causes. It is our understanding that an inappropriate ‘pooling’ of different forms of terrorism in large-N studies may have contributed to the inconclusive evidence regarding the determinants of terrorism.

This paper is organized as follows. In Section 4.2 we give a description of the dataset and the patterns of left-wing and ethnic terrorism in Western Europe between 1970 and 2007. In Section 4.3 we establish our hypotheses, which we test in Section 4.4. Section 4.5 concludes.

4.2. Left-Wing and Nationalist-Separatist Terrorism in Western Europe

We use the Global Terrorism Database (GTD) of the National Consortium for the Study of Terrorism and Responses to Terrorism (START, 2011) to create a unique dataset that differentiates between left-wing and nationalist-separatist terrorist attacks. The GTD is a comprehensive database that includes information on both domestic and transnational terrorist events (START, 2011). There are potential shortcomings when using a public dataset such as the GTD. First, the problem of underreporting may occur due to the fact that the press is not able to report terror incidents in autocratic regimes (e.g., Drakos and Gofas, 2006). However, given that all countries in our sample during most of our observation period had a free press, we expect this underreporting bias to be negligible. Second, the GTD has been criticized for including violent incidents by actors that do not qualify as terrorists (e.g., Sanchez-Cuenca and de la Calle, 2009). For Western Europe there are some isolated reports of incidents by non-terrorist actors (e.g., youths, mobs, demonstrators, students). These attacks are excluded from our dataset. Third, Enders et al. (2011) argue that the GTD—in comparison to ITERATE, another terrorism dataset—tends to underreport terrorism for the period between 1970 and 1977, while it tends to overreport terrorism for the period between 1991 and 1997. While we use the unadjusted data as
terrorist attacks is used as the dependent variable in our statistical analysis (Section 4.4).

In order to be counted, any terrorist attack has to meet three criteria. First, the attack has to be perpetrated by a known (i.e., identifiable) terrorist group. That is, we exclude all attacks by individuals (e.g., ‘lone wolves’) and by unknown perpetrators.

Second, the attack has to be carried out by a group operating in its natural territory (cf. Sanchez-Cuenca and de la Calle, 2009). This refers to the country in which a terrorist organization is rooted and whose politico-economic system or territorial integrity it challenges (Sanchez-Cuenca and de la Calle, 2009). Hence, we exclude all attacks by non-European groups on European soil (e.g., the attack by the Palestinian Black September group on the 1972 Olympic Games in Munich) and by European groups that act outside their natural territory (e.g., attacks by the PIRA on British interests on the European mainland). However, for the creation of our dataset it does not matter whether an attack is directed against a domestic or international target. That is, our dataset includes attacks by, e.g., the German Red Army Faction (RAF) on both German and international targets, as long as these attacks were carried out in Germany (the RAF’s natural territory). As previously argued by Sanchez-Cuenca and de la Calle (2009), it is not plausible to artificially differentiate between domestic and transnational terrorism (e.g., RAF attacks against German targets vs. RAF attacks against U.S. targets), given that the terrorist actor—and thus the underlying set of social conditions motivating its activities—is identical. Through this approach our dataset provides a more consistent picture of terrorism in Western Europe than other datasets that—oftentimes for artificial reasons—cover only either domestic or transnational events.

Third, the attack has to be carried out by a group which pursues either left-wing or nationalist-separatist goals. Our main data sources for classification are the START Terrorist Organization Profiles6 and the data appendices of Schmid and Jongman (2005), Engene (2007) and Masters (2009). These sources are also used to determine a terrorist organization’s natural territory.7

For our classification efforts all terrorist organizations are coded as left-wing when they adhere to predominantly social revolutionary agendas that are directed against the existing socio-economic order. This includes anarchist, communist/socialist, anti-globalization and other leftist groups. The ultimate goal of all these groups is to destroy the capitalist and

---

6http://www.start.umd.edu/start/data_collections/tops.
7A detailed list of those left-wing and nationalist-separatist terrorist organizations we identified in our coding efforts is available as supplementary appendix.
bourgeois society and replace it with an alternative (anarchist, Marxist-Leninist etc.) system, meaning that these groups usually strive for a regime change (e.g., Sanchez-Cuenca, 2009). Prominent examples of these groups are the German RAF, the Spanish GRAPO, the French Action Directe and the Italian Informal Anarchist Federation. As shown in Figure 1, the countries that were hit the strongest by this kind of ideology terrorism between 1970 and 2007 were Italy, Spain, Greece, Germany and France.

Terrorist groups whose activities are predominantly related to territorial changes are coded as nationalist-separatist terrorist organizations. On the one hand, this includes groups with predominantly separatist agendas such as the British PIRA (unification of Northern Ireland with the Irish Republic), the Spanish ETA (establishment of an independent Basque state) and the French FLNC (creation of an independent Corse state). On the other hand, we also include armed groups that oppose these very territorial ambitions. For instance, we coded terrorist actions by the British UFF (opposed to Catholic emancipation efforts in Northern Ireland) and the Spanish GAL (opposed to the Basque independence movement) as nationalist-separatist terrorism. As shown in Figure 1, the countries that were affected the most from this type of terrorism in the period of 1970 to 2007 were the United Kingdom, Spain and France.

For our observation period (1970–2007) the GTD reports 14,404 terrorist incidents by known and unknown terrorist perpetrators in Western Europe. 1,670 (approx. 11.6 per cent) of these attacks were carried out by left-wing terrorist groups within their respective natural territory. 7,180 (approx. 49.8 per cent) terrorist attacks were carried out by terrorist groups with separatist or nationalist agendas within their respective natural territory. This means that revolutionary and ethnic terrorism accounted for over 60 per cent of all attacks during our observation period. Figure 2 illustrates the dynamics of the number of attacks per type. The number of nationalist-separatist attacks was constantly high during the 1970s and 1980s, peaking several times. The absolute number of attacks of left-wing terrorists has always been much smaller and decreasing since the end of the 1970s. There is a clear decline in both left-wing and nationalist-terrorist attacks after the mid-1990s.

Figure 2 also shows the trend in other (i.e., non-left-wing and non-nationalist-separatist) forms of terrorism. These include attacks of unknown perpetrators and individuals (approx. 25 per cent of all attacks); attacks carried out by groups operating outside their natural territory (approx. 8 per cent), e.g., attacks by the Turkish PKK in Germany; as well
as attacks by right-wing and racist terrorist organizations within their respective territory (approx. 2 per cent).\(^8\) A very small number of attacks during 1970 and 2007 were conducted by terrorist groups with religious (e.g., homegrown Islamic) and environmentalist agendas.

### 4.3. The Social Origins of Left-Wing and Nationalist-Separatist Terrorism: Literature Review and Hypotheses

In this section, we discuss several hypotheses regarding the social origins of left-wing and nationalist-separatist terrorism in Western Europe. Table 2 summarizes all hypotheses, variables and their operationalization used in the following statistical analysis (Section 4.4), where we identify the mutual and distinct social origins of revolutionary left-wing and nationalist-separatist terrorism.\(^9\)

| Table 2 here |

#### 4.3.1. Socio-economic conditions

An important strand of the literature relates the emergence of terrorism to the prevalence of unfavorable socio-economic conditions. As argued by Gurr (1970), if people perceive a mismatch between the economic benefits they subjectively think they deserve and the benefits they actually receive (relative deprivation) this might induce feelings of frustration, which lead to the use of violence. For instance, Freytag et al. (2011) argue that poor economic times coincide with lower opportunity costs of violence (e.g., because nonviolent economic opportunities are sparse) and higher perceived benefits from violence (e.g., because terrorist success may lead to a redistribution of scarce economic resources). Indeed, empirical studies by, e.g., Burgoon (2006) and Blomberg and Hess (2008) find that terrorism is more likely when poor socio-economic conditions abound. Also, the literature on civil war consistently finds poverty to be one of the main predictors for the emergence of civil war (e.g., Fearon and Laitin, 2003).

We use the level of per capita income (GDP p.c.) as an indicator of the level of socio-economic development. In line with the previous discussion, we expect terrorism to decrease

---

\(^8\)Given the small number of right-wing terrorist attacks and the fact that it is difficult to distinguish between ‘false flag terrorism’ (e.g., strategy of tension in Italy), unorganized right-wing extremism and right-wing terrorism, we exclude right-wing terrorism from our analysis. See Koopman (1996) for a discussion of right-wing and racist violence in Europe.

\(^9\)As a robustness check, we also experimented with further variables (presence of U.S. troops, urban growth, growth in tertiary education, manufacturing exports, general strikes, period dummies) that may determine revolutionary left-wing and ethnic terrorism as well. Their inclusion in our empirical models did not systematically alter the findings reported in the main text.
with an increase in economic development.\textsuperscript{10} Given that left-wing ideologies (e.g., socialism, anarcho-communism) are usually rooted in the prevalence of poor material conditions, we expect left-wing terrorism to be particularly responsive to socio-economic development. However, we have no reason to believe that the effect of a higher level of income on the opportunity costs of terrorism—where a higher level of wealth makes terrorist activities less attractive—does not also matter to the calculus of ethnic terrorists. In fact, Piazza (2011) finds that economic discrimination along ethnic lines can lead to more terrorism. Therefore, a deterioration of socio-economic conditions may be felt most strongly by the discriminated who turn to violence to improve their socio-economic position. In summary, our first hypothesis regarding the relationship between socio-economic development and terrorism is:

\textbf{H1a:} The higher the level of GDP p.c. the fewer terrorist attacks will occur.

The majority of studies on the determinants of terrorism, however, come to the conclusion that economic conditions—measured in per capita income terms—share no robust association with terrorism (e.g., Abadie, 2006; Gassebner and Luechinger, 2011; Krieger and Meierrieks, 2011). This suggests to not only controlling for the effect of structural economic conditions (GDP p.c.) on the genesis of terrorism but also for the effect of short-run economic performance. Changes in social and economic life ought to be felt more strongly through short-run economic fluctuations and alignments and therefore may foster terrorism. For instance, technical and socio-economic innovations might produce shifts in the relative importance of industries, which may induce changes in the type of labor demanded. This leads to unemployment and may subsequently create a class of “modernization losers” (e.g., Olson, 1963), which may turn to violence to change material conditions to their favor. Hence, we expect a higher unemployment rate to coincide with more terrorist activity because more unemployment ought to facilitate terrorist recruitment (due to comparatively lower terrorism opportunity costs), regardless of which form of terrorism we investigate. Our second hypothesis is:

\textbf{H1b:} The higher the level of unemployment the more terrorist attacks will occur.

As part of our robustness analysis, we also consider the influence of three other socio-economic variables on terrorism. First, we use the inflation rate as an alternative measure of short-run economic change, expecting a similar relationship with terrorism as unemployment. Second, we control for the effect of economic integration (trade openness) on terrorism. This variable may reflect changes in the domestic and global economic order, potentially creating grievances and violence among the ‘losers of globalization’ (e.g., Robison et

\textsuperscript{10}The civil war literature alternatively argues that per capita income is a proxy of state capacity, where rebel groups have higher chances to defeat a state with limited resources available for its defense (Fearon and Laitin, 2003). Following this argumentation we would also expect terrorism to be less likely in richer societies.
or creating a threat to local culture and identity. Arguably, economic integration may then matter to the patterns of left-wing and ethnic terrorism alike. Third, we consider the effect of income inequality on terrorism, which is an alternative proxy to measure relative economic deprivation. Revolutionary and nationalist-separatist groups tend to depict their armed struggle as a fight against social injustice created by capitalism and mechanisms of discrimination along ethnic lines (Sanchez-Cuenca, 2009; Piazza, 2011). Thus, we anticipate terrorism to increase with income inequality.

### 4.3.2. Domestic political factors

Given that a substantial number of empirical studies suggests politico-institutional factors to be more important for the emergence of terrorism than economic variables (e.g., Gassebner and Luechinger, 2011; Krieger and Meierrieks, 2011), we test the influence of specific political factors on the patterns of left-wing and nationalist-separatist terrorism in Western Europe. As detailed below, we focus on the roles of popular support, political representation and non-violent social protest in terrorism.\(^{11}\)

Terrorist organizations depend on popular support in the form of, e.g., financial contributions and political allegiance (e.g., Siqueira and Sandler, 2006). A high level of popular support ought to make it easier to find new recruits and access material resources, consequently allowing for a sustained terrorist campaign. Popular support for a terrorist group is expected to closely correlate with the level of support for political parties with a related political agenda. Thus, our proxy for measuring support for a specific branch of terrorism is the vote share for political parties that have far-left (e.g., communist) or nationalist (e.g., separatist) agendas. On the one hand, this vote share may be positively related to terrorist activity. A higher vote share may mean a larger pool of potential recruits willing to use violence to achieve political goals, which consequently facilitates recruitment and mobilization. On the other hand, a higher vote share may also be negatively linked to terrorism, given that it may also make it more likely that terrorist demands are implemented through (non-violent) political action. That is, the precise effect of support for political parties that pursue goals similar to those of terrorist groups depends on whether this support actually strengthens or discourages the use of force to achieve political goals. Here, the negotiability of these goals may determine which effect dominates. Ethnic terrorist groups usually have negotiable goals, so that political success (e.g., more autonomy) may reduce support for terrorism. Revolutionary groups, however, have non-negotiable goals and concessions are not likely to be granted, even with rather strong political support. Thus, our first hypothesis relating a domestic political factor to the emergence of terrorism is:

\(^{11}\)Given that almost all countries in our sample were democracies for almost all of the observation period, we do not consider the democracy-terrorism nexus here.
H2a: The larger the support for their respective ideology, the more left-wing but the fewer nationalist-separatist attacks will occur.

The ideological affiliation of the incumbent government may also affect the emergence of terrorism. Koch and Cranmer (2007) find that left-wing governments are more likely to be target of international terrorism than right-wing governments. They argue that right-wing governments tend to favor national security over other domestic policies, thereby making terrorism a less attractive option (e.g., due to higher opportunity costs from increased police efforts). Apart from this reasoning, Burgoon (2006) suggests that countries governed by left-wing governments are less prone to terrorism as left-wing governments tend to reduce inequality, poverty and economic insecurity through social welfare policies, in turn making violence incited by poor material conditions less likely. This implies that right-wing governments are likelier targets of terrorism. What is more, a right-wing government ought to be the ‘natural political enemy’ of left-wing and separatist terrorism because it usually pursues policies that are detrimental to their goals. For instance, a right-wing government tends to favor capitalism over socialism and territorial integrity over territorial concessions. The ‘natural’ hostility between right-wing governments and revolutionary and ethnic terrorism may increase terrorist support if non-violent means of achieving political change are constrained. Following this line of reasoning, we introduce a dummy variable that reflects whether a right-wing government is in office and we expect the following relationship between a government’s ideological affiliation and left-wing and nationalist-separatist terrorism:

H2b: The existence of a right-wing government will lead to more terrorist attacks.

Finally, we consider the impact of non-violent protest (anti-government demonstrations) on terrorism. These protests signal the existence of grievances, which in turn may contribute to the emergence of terrorism. Also, political instability may facilitate terrorist fundraising, recruitment and training since even non-violent protests usually coincide with reduced government control (e.g., Piazza, 2008). What is more, harsh government measures against non-violent protest may create a vicious circle of violence and counter-violence, which may increase terrorist mobilization, i.e., the willingness to use force to voice dissent (e.g., Byman, 1998). We expect these mechanisms to matter both to revolutionary and ethnic terrorism, so that we arrive at the following hypothesis:

H2c: The prevalence of anti-government protests will lead to more terrorist attacks.

In addition to the aforementioned variables, we also control for the effect of government size and social spending on terrorism. Both variables ought to reflect government intervention in the socio-economic sphere. As argued by Burgoon (2006) and Krieger and Meierrieks (2010), such intervention may remove socio-economic grievances (e.g., inequality) which
may otherwise lead to violence. Thus, we expect a negative effect of government size and social security spending on the emergence of terrorism in Western Europe.

### 4.3.3. Politico-historic factors

Terrorism may also be related to international political and historic factors. In particular, left-wing terrorism was not only dependent upon domestic circumstances but also international developments associated with the dynamics of the Cold War. Terrorist groups—particularly those that shared goals with the Soviet Bloc—received political and material support from the Soviet Bloc during the Cold War era, so as to instrument them in proxy wars against the U.S.-dominated Western bloc (O’Brien, 1996). Consequently, the end of the Cold War can be expected to have reduced especially revolutionary left-wing terrorism. First, the end of financial and military support by the Soviet Union reduced the clout of this kind of terrorism. Second, the end of the Soviet Bloc also meant an undermining of the ideological foundations of left-wing terrorism, which can be expected to have strongly discouraged the attractiveness of this kind of terrorism (e.g., Shughart, 2006). We include a dummy variable for the Cold War period to account for the effect of changes in the international political arena on terrorism in Western Europe. While it is true that ethnic terrorist groups in this part of the world also received some support from the Soviet Bloc during the Cold War era, we expect left-wing terrorism to be particularly sensitive to this change in the international political system. We test the following hypothesis:

**H3a:** During the *Cold War Era* more left-wing terrorist attacks occurred.

Sanchez-Cuenca (2009) points out that countries with a dictatorial past are more prone to terrorism than established democracies. This implicitly speaks to Piazza (2008) who finds that political instability is conducive to terrorism. Sanchez-Cuenca (2009) argues that a dictatorial past may indicate the presence of stronger political conflict that makes the use of more extreme measures (terrorism) more likely. He also suggests that a dictatorial past may signal the possibility of state capture by insurgents as well as the prevalence of authoritarian structures that are conducive to state repression and thus the escalation of conflict. While Sanchez-Cuenca (2009) suggests that these mechanisms matter to the emergence of lethal left-wing terrorism, they may plausibly also matter to nationalist-separatist terrorism. We may speculate that old democracies (with no recent dictatorial past) are in ethnic-social equilibrium, so that ethnic needs are met through non-violent participation. Alternatively, however, the existence of this very equilibrium may coincide with structural discrimination along ethnic lines, making the use of violence—through the eyes of would-be terrorists—necessary to overcome it. That is, it is also possible that democratic stability fuels conflict.
We measure the dependence of terrorism on a country’s political history by the—highly variable—number of years since a country can be considered as democratic. We test the following hypothesis:

\[ H_{3b}: \text{The older a democracy, the fewer terrorist attacks will occur.} \]

### 4.3.4. Demographic conditions

We also consider the impact of demographic factors. Here, we expect population size to correlate positively with left-wing and nationalist-separatist terrorism alike due to two effects. First, there is a simple scale effect as a larger population has more people in the tails of the distribution of political preferences and thus more people with radical political views (Sanchez-Cuenca, 2009). Second, policing is in general more costly in larger populations, suggesting that terrorist groups may find it easier to operate in more populous countries (e.g., Sanchez-Cuenca, 2009). In addition, the evidence from large-N studies consistently shows that population size is a strong and robust predictor of terrorism (e.g., Gassebner and Luechinger, 2011; Krieger and Meierrieks, 2011), indicating that this relationship holds for all forms of terrorism. Thus, our first hypothesis linking a demographic variable to terrorism is:

\[ H_{4a}: \text{The larger the size of the population, the more terrorist attacks will occur.} \]

Finally, we introduce a further demographic variable that ought to interact differently with left-wing and nationalist-separatist terrorism: the degree of ethnic polarization. Evidently, ethnic polarization ought to be a particular relevant motivational cause of nationalist-separatist terrorism. For instance, the political violence literature argues that ethnic polarization leads to conflicts over the allocation of scarce resources along ethnic lines (e.g., Montalvo and Reynal-Querol, 2005). Basuchoudhary and Shughart (2010) find that the degree of ethnic tensions within a country is significantly related to the genesis of terrorism. Ethnic polarization may, for instance, induce economic discrimination, which may then turn into terrorist violence by discriminated minorities. Piazza (2011) provides empirical evidence for this argumentation. In contrast, Victoroff (2005) suggests that left-wing terrorists have a less close relationship with their respective culture of origin and therefore ought to be less responsive to ethnic conflict. Thus, we arrive at the following hypothesis on the relationship between ethnic polarization and terrorism:

\[ H_{4b}: \text{The higher the degree of ethnic polarization, the more nationalist-separatist terrorist attacks will occur.} \]
4.4 Empirical Methodology and Results

In this section we test which of the hypotheses discussed above are supported by the data for a panel of 17 Western European countries between 1970 and 2007. The corresponding summary statistics are reported in Table 3.

— Table 3 here —

4.4.1. Methodology

The choice of an adequate estimation technique is influenced by several factors. First, our dependent variables are count variables (i.e., the number of terrorist attacks by left-wing and nationalist-separatist terrorist group, respectively, in a given country and year) that can only assume non-negative values. This calls for the use of a count data model. Second, the variances of the dependent variables are larger than their respective means (cf. Table 3). Thus, we need to employ a count data model where the count is expected to come from a negative binomial distribution, which is able to take this over-dispersion into account. Third, while the use of panel data allows us to better control for heterogeneity, reduce problems of collinearity and deliver more efficient econometric estimations, we also face the problem that variables of interest are likely to be correlated over time (because the dataset includes repeated values for a country over time). In fact, initial tests indicate the presence of serial correlation. This non-independence of the data calls for the use of a panel estimator that considers this temporal dependence accordingly (e.g., Zorn, 2001).

To adequately account for the data structure, we run a series of generalized estimation equation (GEE) models for negative-binomially distributed (panel) count data, where we control for an AR(1) term to factor in temporal correlation (e.g., Zorn, 2001; Robison et al., 2006). We choose the population-averaged GEE approach over a cluster-specific approach (e.g., the conditional fixed effects negative binomial regression) because the former is expected to yield parameter estimates that are much closer to the data, given that for the latter approach assumptions about the source of individual heterogeneity have to be made based on the available data. This leads to obvious difficulties to correctly specify the sources of individual heterogeneity (Zorn, 2001).\footnote{The conditional fixed effects (FE) negative binomial regression estimator also does not work as a ‘typical’ FE estimator as it usually does not eliminate the individual-specific time-invariant heterogeneity (e.g., Guimaraes, 2008). What is more, using the FE estimator we would be forced to drop all ‘always-zero’ country cases (e.g., Luxembourg), essentially losing the opportunity to compare countries that experienced terrorist activity to those that were spared. These factors additionally motivate our choice of a GEE approach over a FE negative binomial regression estimator.}
4.4 Empirical Methodology and Results

To account for heterogeneity we use (semi-robust) Huber/White/Sandwich standard errors clustered over countries. We let the control variables enter the model with $(t - 1)$ lagged values to make a more stringent causal argument, while also reducing any correlation between the explanatory variables and the error term. Finally, we take the natural logarithm of population size and per capita income to correct for skewness and avoid any outlier bias.

4.4.2. The social origins of revolutionary terrorism

The GEE estimation results for the determinants of left-wing terrorism in Western Europe are reported in Table 4.

— Table 4 here —

Considering the role of socio-economic variables in terrorism, we find that per capita income exerts no influence on left-wing terrorism, meaning that there is no support for H1a. However, a higher unemployment rate is robustly associated with more terrorist activity, supporting H1b. Additional model specifications suggest that higher inflation rates and levels of income inequality are associated with more revolutionary terrorism, while trade openness shares no substantial relationship with it. The failure to find a robust relationship between socio-economic development and terrorism speaks to the inconclusive evidence from large-N studies on this relationship (e.g., Abadie, 2006; Blomberg and Hess, 2008). While we do not find an effect of broad measures of socio-economic development (GDP p.c.) on terrorism, variables reflecting socio-economic imbalances (e.g., unemployment) tend to promote terrorism (e.g., by lowering its opportunity costs and facilitating recruitment), meaning that economic grievances may nevertheless matter to the left-wing terrorists’ calculus.

In addition, our empirical findings show that domestic politics matter to left-wing terrorism insofar as a higher vote share of radical left-wing parties leads to more terrorism (supporting H2a). This is in line with Sanchez-Cuenca (2009) who finds that support for communist parties is among the strong predictors of left-wing terrorism. Potentially, a higher vote share may mean stronger popular support and a larger pool of potential recruits, which ought to foster terrorist recruitment and mobilization. The non-negotiability of revolutionary terrorism’s goals (e.g., replacement of a capitalist with a socialist society) also makes it plausible that this mobilization effect dominates the potentially appeasing effect from voicing dissent in parliament. Indeed, among left-wing radicals there seems to have been a deep mistrust over the effectiveness of democratic institutions in fostering political change (cf. Sanchez-Cuenca, 2009).

By contrast, we find neither an effect of the existence of a right-wing government nor of anti-government demonstrations on left-wing terrorism (rejecting H2b and H2c, respectively).
Also, the size of the government and social security transfers are not substantially associated with it. This indicates that the mobilization of revolutionary terrorism may have largely come from the rejection of capitalist ideas (as reflected by the share of votes for radical leftist parties) but not from non-violent social protest and government actions. Considering the role of social protest in left-wing terrorism, our findings are in line with Della Porta and Tarrow (1986) and Della Porta (1995, pp. 83-112). Rather than arguing that increases in social protest precede the emergence of political violence, these studies suggest that terrorist groups emerge when the intensity of social movements declines in order to compensate for the loss in public support and visibility.

Furthermore, revolutionary terrorism in Western Europe between 1970 and 2007 was more likely in young democracies (supporting H3b). This corresponds to large-N study evidence (e.g., Piazza, 2008; Kis-Katos et al., 2011) arguing that instability breeds terrorism, but also to Sanchez-Cuenca (2009) who argues that especially past dictatorship has contributed to the intensity of revolutionary left-wing terrorism. Young democracies may be more vulnerable to terrorism because their institutions are comparatively weak, making it more difficult to defend themselves against terrorism. Also, many Western European countries have had fascist regimes (e.g., Germany, Italy, Spain) before democratic transformation took place. A conservation of authoritarian structures may have contributed to the escalation of social conflict and the emergence of left-wing terrorism directed against those very structures.

Left-wing terrorism was more likely during the Cold War era, too (supporting H3a). This finding is in line with earlier studies by Robison et al. (2006) and Choi (2010) focusing on global samples. Many revolutionary groups in Western Europe stressed their solidarity with non-European liberation movements (e.g., PLO, Tupamaros) and framed their armed activity as part of a global struggle between ‘capitalist imperialism’ and the ‘Third World’ (e.g., Shughart, 2006). Their ideological proximity to the Soviet Union makes it likely that these groups received political and material support from the Soviet Bloc. For instance, the GDR—a Soviet satellite—provided members of the West German RAF with shelter and assistance. The collapse of the Soviet Union consequently diminished support, while also undermining the ideological appeal of revolutionary terrorism. This is likely to have reduced the attractiveness of this kind of terrorism and greatly impeded recruitment.

Finally, our empirical findings suggest that population size is a positive predictor of terrorism, supporting H4a. This result matches the empirical mainstream. However, we do not find that ethnic polarization contributes to the emergence of left-wing terrorism. That is, the positive effect of population size on terrorism is more likely to result from a scale effect—where a large population simply coincides with more victims and more perpetrators—than to indicate that left-wing terrorism originates from demographic distress.
4.4 Empirical Methodology and Results

4.4.3. The social origins of ethnic terrorism

The GEE estimation results for the determinants of nationalist-separatist terrorism are reported in Table 5.

Table 5 here

With respect to the role of socio-economic deprivation and modernization in ethnic terrorism, we find that there is a rather robust, negative effect of per capita income on it (supporting H1a), while the unemployment rate is a very robust and positive predictor of nationalist-separatist terrorism (supporting H1b). There is also evidence that higher levels of inflation and economic inequality lead to more terrorism, whereas trade openness reduces it. Our findings tend to support Caruso and Schneider (2011) who detect a negative effect of GDP p.c. and a positive effect of youth unemployment on the emergence of terrorism in Western Europe between 1994 and 2007. Apparently, socio-economic success seems to increase the opportunity costs of violence, so that ethnic terrorism becomes less attractive. There may be a close and reinforcing relationship between socio-economic underdevelopment, modernization strain and economic discrimination along ethnic lines (cf. Piazza, 2011). The importance of socio-economic factors in ethnic terrorism—as indicated by our estimation results—may explain why a number of separatist movements (e.g., ETA, PIRA, INLA) integrated ideological positions (e.g., socialism, communism) into their agendas.

Besides economic conditions, our findings also show that domestic politics are relevant to some extent. First, an increase in vote shares for nationalist-separatist parties tends to reduce ethnic terrorism (rejecting H2a). Arguably, the increased political influence of separatist parties makes it more likely to achieve concessions, which are possible as the goals of—violent and non-violent—separatist movements are negotiable. We also find that there is a weakly robust, positive effect of a right-government incumbency on the emergence of ethnic terrorism (supporting H2b). Right-wing governments may more strongly favor hawkish policies over concessions and negotiations, potentially limiting the possibilities to achieve change non-violently and making violence more attractive. Indeed, e.g., Barros (2003) finds that the banning of political parties in the Basque country—fostered by the conservative Spanish Popular Party—contributed to an increase in terrorist activity by ETA. That is, our findings point at a substitution of violent for non-violent activity by means of political participation, where these means may be influenced by a right-wing incumbent government.

We also find that anti-government demonstrations are positively correlated with ethnic terrorism (supporting H2c). As argued by Sanchez-Cuenca and de la Calle (2009, p. 44), “because terrorist organizations need voluntary compliance, they may develop strong links
with social movements [...]”. Terrorist groups may try to use non-violent protest—which signals the existence of grievances—to facilitate recruitment and financing. Perhaps even more importantly, terrorist groups may capitalize on harsh government responses to terrorism. This speaks to the idea that terrorism benefits from cycles of protest and repression, e.g., in terms of increased sympathy towards the means of armed struggle (e.g., Byman, 1998). Indeed, for instance, White (1989) finds that participation in terrorism in the Northern Ireland conflict is strongly associated with state repression and the individual perception that peaceful protest does not work.

Considering the additional politico-institutional variables that enter our estimations as robustness checks, we find that ethnic terrorism does not respond to government size, but is negatively affected by social security transfers. The latter variable seems to better reflect government interventions in the socio-economic life. As in Krieger and Meierrieks (2010), social welfare spending seems to reduce nationalist-separatist terrorism, presumably by removing socio-economic grievances. This is also consistent with our earlier findings that stress the role of socio-economic variables in ethnic terrorism.

The Cold War era has not influenced the patterns of nationalist-separatist terrorism. This kind of terrorism is motivated by country-specific historic conflict and the wave of anti-colonial terrorism that began in the 1920s (cf. Shughart, 2006). As a matter of fact, ethnic terrorist groups were far less dependent on ideological and material support from the Soviet Bloc. Consistent with our findings, nationalist-terrorist groups were thus less likely to be responsive to a changing political climate after the end of the Cold War. Interestingly, ethnic terrorism in Western Europe becomes more likely with the persistence of a democratic regime (rejecting H3b). This finding runs counter to the global evidence which stresses that instability and regime immaturity foster terrorism (e.g., Piazza, 2008; Kis-Katos et al., 2011). It may indicate that ethnic conflict in Western Europe has a long history—e.g., the origins of the Northern Ireland conflict date back to the 1600s—and has not been sufficiently moderated by democratic institutions. In fact, due to their specific political traditions, older democracies (e.g., Great Britain) tend to favor centralism and nation-building over decentralism and ethnic plurality, while younger democracies tend to be more multicultural or consociational, so that ethnic conflict can be better managed (e.g., Smooha, 2002).

Finally, our finding that population size is a strong and positive predictor of ethnic terrorism is in line with the empirical mainstream and our expectations (H4a). Also, ethnic polarization is found to be a robust and positive determinant of this kind of terrorism (supporting H4b). Polarization may signal politico-economic conflicts over scarce resources and the prevalence of economic discrimination, where related grievances (the desire to change or conserve this very discrimination) may turn into terrorist violence (e.g., Montalvo and Reynal-Querol, 2005; Piazza, 2011). As argued by Basuchoudhary and Shughart (2010,
4.4 Empirical Methodology and Results

p. 68), “emphasizing differences and fabricating ethnic tensions cultivates the grievances of groups perceiving themselves to be disadvantaged under the status quo.” This ought to make ethnic terrorist mobilization and recruitment less costly, particularly as the opportunity costs of violence (e.g., employment) can be expected to be rather low. Indeed, for example, O’Hearn (1987) argues that one of the origins of the Northern Ireland conflict were socio-economic grievances of the catholic population, which in turn were rooted in ethnic polarization and discrimination.

4.4.4. Extension and further discussion

Our estimation results show that left-wing and nationalist-separatist terrorism share some social origins (e.g., unemployment), but differ with respect to others. At times, there are even detrimental effects of certain social conditions on the emergence of these two types of terrorism. These findings indicate that motivational causes matter. There are indeed some studies which suggest that political motivations and terrorism goals need to be taken into account, where supreme value terrorism with abstract goals (e.g., left-wing terrorism) may respond differently to social change than terrorism with discrete policy goals such as national liberation (e.g., Bernholz, 2004; Zimmermann, 2009; Freytag et al., 2011). However, as argued in the introduction, most empirical studies on the causes of terrorism ignore the implications of different types of terrorism.

What happens to our findings when we likewise disregard the motivational bonds of terrorist groups and ‘pool’ terrorism data as previous statistical efforts have done? To answer this question we use three alternative dependent variables to re-run our baseline empirical model. The first alternative dependent variable, constructed from our own dataset, is the combined number of left-wing and nationalist-separatist terrorist attacks. Our second variable is the number of domestic terrorist incidents. The data are drawn from Enders et al. (2011). This variable accounts for all domestic attacks (regardless of their types), but disregards incidents with an international dimensions, even when those attacks occurred within the natural territory of a terrorist group. The third variable is the total number of terrorist incidents, where the data are drawn from the GTD. It records domestic and transnational terrorist attacks by known and unknown groups (regardless of their types) in a given country and year. The corresponding empirical findings are reported in Table 6. For the sake of brevity, we only report the signs of the respective regression coefficients and significance levels.

— Table 6 here —
4.5 Conclusion

In summary, the empirical findings suggest that the ‘pooling’ of terrorism data may mask the true correlates of different types of terrorism. For instance, using ‘pooled’ data we find that terrorism in Western Europe was more pronounced during the Cold War era, even though a closer inspection shows that this is only true for left-wing terrorism. Using aggregated terrorism measures may also lead to suboptimal policy advice. For example, ethnic polarization does not seem to matter to terrorism—so that policies do not need to address it to reduce terrorism—when we use ‘pooled’ data, even though it is a robust correlate of ethnic terrorism.

Our findings show that there is some degree of heterogeneity in the determinants of different types of terrorism. This heterogeneity can be expected to be more severe for global samples since they also include information on religious (Islamic) terrorism. In the light of this heterogeneity, it seems questionable to apply one theoretical model—and consequently, one empirical model—to the study of terrorism. One way of accounting for the different role of certain social conditions in different types of terrorism is to consider their interaction with the motivational underpinnings and goals of terrorist organizations.

4.5. Conclusion

In this contribution we use a uniquely coded dataset to separately analyze the social origins of left-wing and nationalist-separatist terrorism in 17 Western European countries between 1970 and 2007. Our study is motivated by a lack of comparative studies on the causes of different types of political terrorism. While the differences in the historic roots, ultimate goals and their negotiability, politico-military strategies etc. of revolutionary and ethnic terrorism make it plausible that these forms of terrorism are differently affected by certain social conditions and changes, this potential heterogeneity has been largely ignored in the empirical literature.

We find that (1) revolutionary left-wing terrorism shares a unique, positive association with the Cold War era, while nationalist-separatist terrorism is uniquely motivated by ethnic polarization, poor structural socio-economic conditions (low GDP p.c., trade openness and poor social security institutions to ameliorate them) and social protest (anti-government demonstrations). Left-wing terrorism correlates positively with political support for radical leftist parties, while political success of nationalist parties seems to drain support for ethnic terrorism. Both types of terrorism also share a detrimental relationship with the prevalence of democratic institutions. While left-wing terrorism is more likely in young and potentially unstable democracies, ethnic terrorism is more common in older ones. (2) Both types of terrorism are robustly associated with larger populations and higher unemployment, with robustness checks also suggesting that higher inflation rates and economic inequality matter,
while government size plays no role in both of them. (3) Our findings suggest that different types of political terrorism are associated with different mechanisms of mobilization and radicalization, different levels of popular and external support etc., so that social conditions affect the terrorists’ calculus (partly) depending on their political motivation, while other influencing factors are universally important.

Empirical research on the determinants of terrorism should more thoroughly account for the heterogeneity in terrorism associated with differences in the terrorists’ motivations and goals. As indicated in an extension of our statistical analysis, the ‘pooling’ of terrorism data may mask the true role of some terrorism correlates in distinct types of terrorism. An analysis of the role of political motivations in terrorism on a global scale is a clear avenue of future research, which may help to establish a better understanding of the social origins of terrorism, given that large-N evidence on the origins of terrorism remains inconclusive (cf. Gassebner and Luechinger, 2011; Krieger and Meierrieks, 2011).

Counter-terrorism efforts need to take political motivations—which crucially influence terrorist goals and goal negotiability—into account when deciding between the ‘stick’ (e.g., police efforts) and the ‘carrot’ (e.g., concessions). For Western Europe our study suggests that nationalist-separatist terrorism can be effectively reduced by enabling socio-economic and political participation. While socio-economic incentives—particularly, employment—may also be helpful against left-wing terrorism, its overall responsiveness to politico-economic incentives is expected to be weaker, given the more abstract and non-negotiable goals of this kind of terrorism. The same ought to be true for a potential future threat for Western Europe, homegrown Islamic terrorism. Similar to left-wing terrorism, it adheres to supreme values and has strong international links—where it is framed as part of a global war between the Islamic and Western World—, making appeasement and concessions difficult. In line with our analysis, it seems necessary to carefully identify the social origins of homegrown Islamic terrorism. In a first comparative analysis, Ganor (2011) argues that policies that counter social exclusion and discrimination and foster employment may be helpful against this most recent wave of domestic terrorism. That is, there is hope that Islamic terrorism—like its left-wing and nationalist-separatist companions—may at least be partly rooted in very ‘this-worldly’ social conditions and thus also be responsive to their improvement.
Bibliography


4. Bibliography


Figure 1: Spatial Distribution of Different Types of Terrorism in Western Europe, 1970-2007

Figure 2: Trends of Different Types of Terrorism in Western Europe, 1970-2007
### Table 1: Attributes of Left-Wing and Nationalist-Separatist Terrorism

<table>
<thead>
<tr>
<th></th>
<th>Left-Wing Terrorism</th>
<th>Nationalist-Separatist Terrorism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic Roots</td>
<td>- Propaganda of the Deed</td>
<td>- Country-specific roots (occupation, discrimination)</td>
</tr>
<tr>
<td></td>
<td>- Internationalism</td>
<td>- Irredentism</td>
</tr>
<tr>
<td></td>
<td>- Cold War</td>
<td>- Anti-colonialism and right to self-determination</td>
</tr>
<tr>
<td></td>
<td>- Anti-colonialism</td>
<td>- Anti-imperialism</td>
</tr>
<tr>
<td></td>
<td>- Protests of 1968 and Vietnam War</td>
<td>- Incorporation of socialist/communist ideas possible</td>
</tr>
<tr>
<td></td>
<td>- Anti-capitalism and anti-globalization</td>
<td></td>
</tr>
<tr>
<td>Ultimate Goal</td>
<td>Regime change: establishment of communist/socialist/anarchist etc. society</td>
<td>Territorial change: creation of an independent state (or its prevention)</td>
</tr>
<tr>
<td>Negotiability of Goal?</td>
<td>No</td>
<td>Potentially, yes (autonomy, independence etc.)</td>
</tr>
<tr>
<td>Popular Support and Appeal</td>
<td>Limited appeal to privileged, well-educated, “modernist” avant-garde</td>
<td>Restricted to specific ethnos, but broader coalition within it possible</td>
</tr>
<tr>
<td>Provision of Public Goods?</td>
<td>No</td>
<td>Potentially, yes (identity, security etc.)</td>
</tr>
<tr>
<td>International Links</td>
<td>- Alliances with other foreign terrorist groups</td>
<td>- Alliances with other foreign terrorist groups</td>
</tr>
<tr>
<td></td>
<td>- Support from foreign countries</td>
<td>- Diaspora support</td>
</tr>
<tr>
<td></td>
<td>- International targets (mainly U.S.)</td>
<td>- Cross-border attacks possible</td>
</tr>
<tr>
<td>Strategy</td>
<td>- Urban guerrilla</td>
<td>- War of attrition</td>
</tr>
<tr>
<td></td>
<td>- Actions by ‘revolutionary vanguard’ to incite popular revolution</td>
<td>- Negotiations by political wings possible</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Variable</td>
<td>Exp. Sign</td>
</tr>
<tr>
<td>------------</td>
<td>----------</td>
<td>-----------</td>
</tr>
</tbody>
</table>
| H1a | GDP p.c. | - | Source: Penn World Tables  
Operation: Real per capita income, logged |
| H1b | Unemployment | + | Source: Comparative Political Data Set  
Operation: Unemployment rate as a percentage of civilian labor force |
| H2a | Left-wing/nationalist parties influence | +/- | Source: Comparative Political Data Set  
Operation: Share of votes for parties classified as left-wing (socialist, communist etc.) or ethnic (separatist etc.) in last general election |
| H2b | Existence of a right-wing government | +/- | Source: Comparative Political Data Set  
Operation: Dummy variable; 1 indicating government dominated by right-wing (e.g., conservative) political parties |
| H2c | Anti-government protests | + | Source: CNTS Data Archive  
Operation: Number of peaceful public gathering of at least 100 people for the primary purpose of displaying or voicing their opposition to government policies or authority |
| H3a | Cold war era | + | Source: —  
Operation: Dummy variable; 1 until 1991, 0 from 1992 onwards |
| H3b | Age of democracy | +/- | Source: POLITY IV Project  
Operation: Persistence of polity as a democracy, in number of years |
| H4a | Population size | + | Source: Penn World Tables  
Operation: Number of inhabitants, logged |
| H4b | Ethnic polarization | + | Source: Alesina et al. (2003)  
Operation: Constant index of ethnic polarization reflecting the probability that two randomly chosen individuals from a country belong to different ethnic groups |

**Data Sources:**  
Comparative Political Data Set = [http://www.ipw.unibe.ch/content/team/klaus_armingeon/comparative.political.data.sets/index_ger.html](http://www.ipw.unibe.ch/content/team/klaus_armingeon/comparative.political.data.sets/index_ger.html).  
### Table 3: Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N*T</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left-Wing Terrorist Attacks</td>
<td>684</td>
<td>2.441</td>
<td>10.166</td>
<td>0</td>
<td>166</td>
</tr>
<tr>
<td>Nationalist-Separatist Terrorist Attacks</td>
<td>684</td>
<td>10.497</td>
<td>35.693</td>
<td>0</td>
<td>279</td>
</tr>
<tr>
<td>Per Capita Income (logged)</td>
<td>684</td>
<td>10.019</td>
<td>0.344</td>
<td>8.940</td>
<td>11.262</td>
</tr>
<tr>
<td>Unemployment</td>
<td>680</td>
<td>6.133</td>
<td>4.300</td>
<td>0.002</td>
<td>24.171</td>
</tr>
<tr>
<td>Population Size (logged)</td>
<td>684</td>
<td>9.103</td>
<td>1.535</td>
<td>5.319</td>
<td>11.320</td>
</tr>
<tr>
<td>Cold War Era</td>
<td>684</td>
<td>0.579</td>
<td>0.494</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Left-Wing Parties Influence</td>
<td>668</td>
<td>7.752</td>
<td>8.359</td>
<td>0</td>
<td>41.1</td>
</tr>
<tr>
<td>Nationalist Parties Influence</td>
<td>668</td>
<td>1.043</td>
<td>3.077</td>
<td>0</td>
<td>15.7</td>
</tr>
<tr>
<td>Right-Wing Government</td>
<td>666</td>
<td>0.495</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Age of Democracy</td>
<td>684</td>
<td>67.766</td>
<td>37.639</td>
<td>0</td>
<td>138</td>
</tr>
<tr>
<td>Ethnic Polarization</td>
<td>684</td>
<td>0.326</td>
<td>0.253</td>
<td>0.020</td>
<td>0.871</td>
</tr>
<tr>
<td>Anti-Government Demonstrations</td>
<td>684</td>
<td>0.544</td>
<td>1.453</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Inflation</td>
<td>684</td>
<td>6.797</td>
<td>7.833</td>
<td>-9.629</td>
<td>84.222</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>684</td>
<td>67.664</td>
<td>47.873</td>
<td>13.989</td>
<td>301.412</td>
</tr>
<tr>
<td>Income Inequality</td>
<td>483</td>
<td>0.018</td>
<td>0.014</td>
<td>0.003</td>
<td>0.134</td>
</tr>
</tbody>
</table>

### Table 4: The Determinants of Left-Wing Terrorist Attacks

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c. (t-1)</td>
<td>-0.378</td>
<td>-0.428</td>
<td>0.096</td>
<td>-0.310</td>
<td>-0.827</td>
<td>-0.489</td>
</tr>
<tr>
<td></td>
<td>(0.866)</td>
<td>(0.890)</td>
<td>(0.781)</td>
<td>(1.186)</td>
<td>(0.736)</td>
<td>(0.861)</td>
</tr>
<tr>
<td>Unemployment (t-1)</td>
<td>0.131</td>
<td>0.134</td>
<td>0.141</td>
<td>0.133</td>
<td>0.094</td>
<td>0.111</td>
</tr>
<tr>
<td></td>
<td>(0.048)**</td>
<td>(0.046)**</td>
<td>(0.048)**</td>
<td>(0.047)**</td>
<td>(0.051)*</td>
<td>(0.046)**</td>
</tr>
<tr>
<td>Population Size (t-1)</td>
<td>0.893</td>
<td>0.857</td>
<td>0.997</td>
<td>0.871</td>
<td>0.840</td>
<td>1.079</td>
</tr>
<tr>
<td></td>
<td>(0.246)**</td>
<td>(0.225)**</td>
<td>(0.253)**</td>
<td>(0.321)**</td>
<td>(0.821)**</td>
<td>(0.271)**</td>
</tr>
<tr>
<td>Cold War Era (t-1)</td>
<td>1.103</td>
<td>1.151</td>
<td>0.902</td>
<td>1.092</td>
<td>0.966</td>
<td>1.142</td>
</tr>
<tr>
<td></td>
<td>(0.394)**</td>
<td>(0.419)**</td>
<td>(0.458)**</td>
<td>(0.493)**</td>
<td>(0.630)**</td>
<td>(0.528)**</td>
</tr>
<tr>
<td>Left-Wing Parties</td>
<td>0.064</td>
<td>0.064</td>
<td>0.054</td>
<td>0.063</td>
<td>0.073</td>
<td>0.054</td>
</tr>
<tr>
<td>Influence (t-1)</td>
<td>(0.020)**</td>
<td>(0.019)**</td>
<td>(0.019)**</td>
<td>(0.021)**</td>
<td>(0.019)**</td>
<td>(0.018)**</td>
</tr>
<tr>
<td>Right-Wing</td>
<td>0.256</td>
<td>0.231</td>
<td>0.174</td>
<td>0.261</td>
<td>0.251</td>
<td>0.122</td>
</tr>
<tr>
<td>Government (t-1)</td>
<td>(0.246)</td>
<td>(0.259)</td>
<td>(0.210)</td>
<td>(0.239)</td>
<td>(0.290)</td>
<td>(0.250)</td>
</tr>
<tr>
<td>Age of</td>
<td>-0.030</td>
<td>-0.028</td>
<td>-0.028</td>
<td>-0.030</td>
<td>-0.034</td>
<td>-0.026</td>
</tr>
<tr>
<td>Democracy (t-1)</td>
<td>(0.013)**</td>
<td>(0.015)*</td>
<td>(0.012)**</td>
<td>(0.012)**</td>
<td>(0.016)**</td>
<td>(0.012)**</td>
</tr>
<tr>
<td>Ethnic</td>
<td>-1.523</td>
<td>-1.456</td>
<td>-1.550</td>
<td>-1.468</td>
<td>-1.172</td>
<td>-1.869</td>
</tr>
<tr>
<td>Polarization (t-1)</td>
<td>(1.192)</td>
<td>(1.208)</td>
<td>(1.242)</td>
<td>(1.230)</td>
<td>(1.101)</td>
<td>(1.212)</td>
</tr>
<tr>
<td>Anti-Government</td>
<td>0.002</td>
<td>0.001</td>
<td>-0.014</td>
<td>0.001</td>
<td>-0.002</td>
<td>-0.004</td>
</tr>
<tr>
<td>Demonstrations (t-1)</td>
<td>(0.046)</td>
<td>(0.046)</td>
<td>(0.049)</td>
<td>(0.043)</td>
<td>(0.050)</td>
<td>(0.052)</td>
</tr>
<tr>
<td>Government Transfers (t-1)</td>
<td>-0.057</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size (t-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.075)</td>
</tr>
<tr>
<td>Inflation (t-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.015)**</td>
</tr>
<tr>
<td>Trade Openness (t-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.002</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Social Security</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.110</td>
</tr>
<tr>
<td>Transfers (t-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.070)</td>
</tr>
</tbody>
</table>
## 4.6 Figures and Tables

<table>
<thead>
<tr>
<th>Income</th>
<th>34.271</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inequality $t-1$</td>
<td>(10.016)***</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>18 18 18 18 18 17</td>
</tr>
<tr>
<td>N*T</td>
<td>644 644 644 644 641 466</td>
</tr>
<tr>
<td>Wald $\chi^2$</td>
<td>542.05 445.06 283.68 545.96 1104.89 365.35</td>
</tr>
<tr>
<td>Prob. &gt; $\chi^2$</td>
<td>(0.000)*** (0.000)*** (0.000)*** (0.000)*** (0.000)*** (0.000)***</td>
</tr>
</tbody>
</table>

**Notes:** Dependent variable is the number of terrorist attacks by left-wing groups within their natural territory. Robust standard errors clustered on countries reported in parentheses. All models control for an AR(1) term. Constant not reported. (*) , (**) and (***) indicate significance at 10%, 5% and 1% level, respectively.
### Table 5: The Determinants of Nationalist-Separatist Terrorist Attacks

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c. t-1</td>
<td>-5.284</td>
<td>-5.327</td>
<td>-4.249</td>
<td>-3.065</td>
<td>-5.210</td>
<td>-6.137</td>
</tr>
<tr>
<td></td>
<td>(2.503)**</td>
<td>(2.782)*</td>
<td>(2.711)</td>
<td>(2.876)</td>
<td>(1.738)***</td>
<td>(2.200)***</td>
</tr>
<tr>
<td>Unemployment t-1</td>
<td>0.162</td>
<td>0.162</td>
<td>0.199</td>
<td>0.144</td>
<td>0.271</td>
<td>0.143</td>
</tr>
<tr>
<td></td>
<td>(0.065)**</td>
<td>(0.068)**</td>
<td>(0.064)***</td>
<td>(0.066)**</td>
<td>(0.090)***</td>
<td>(0.049)***</td>
</tr>
<tr>
<td>Population Size t-1</td>
<td>2.570</td>
<td>2.585</td>
<td>2.637</td>
<td>1.738</td>
<td>2.614</td>
<td>2.311</td>
</tr>
<tr>
<td></td>
<td>(0.567)***</td>
<td>(0.529)***</td>
<td>(0.572)***</td>
<td>(0.534)***</td>
<td>(0.375)***</td>
<td>(0.387)***</td>
</tr>
<tr>
<td>Cold War Era t-1</td>
<td>0.122</td>
<td>0.120</td>
<td>0.025</td>
<td>-0.453</td>
<td>0.378</td>
<td>0.192</td>
</tr>
<tr>
<td></td>
<td>(0.845)</td>
<td>(0.844)</td>
<td>(0.873)</td>
<td>(0.795)</td>
<td>(0.600)</td>
<td>(0.597)</td>
</tr>
<tr>
<td>Nationalist Parties</td>
<td>-0.163</td>
<td>-0.161</td>
<td>-0.164</td>
<td>0.039</td>
<td>-0.104</td>
<td>-0.313</td>
</tr>
<tr>
<td></td>
<td>(0.085)*</td>
<td>(0.079)**</td>
<td>(0.087)*</td>
<td>(0.084)</td>
<td>(0.074)</td>
<td>(0.101)***</td>
</tr>
<tr>
<td>Influence t-1</td>
<td>0.232</td>
<td>0.231</td>
<td>0.240</td>
<td>0.270</td>
<td>0.270</td>
<td>0.279</td>
</tr>
<tr>
<td>Right-Wing</td>
<td>(0.132)*</td>
<td>(0.137)*</td>
<td>(0.131)*</td>
<td>(0.187)</td>
<td>(0.151)*</td>
<td>(0.248)</td>
</tr>
<tr>
<td>Government t-1</td>
<td>0.025</td>
<td>0.025</td>
<td>0.029</td>
<td>0.030</td>
<td>0.036</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>(0.014)*</td>
<td>(0.016)</td>
<td>(0.013)**</td>
<td>(0.010)***</td>
<td>(0.016)**</td>
<td>(0.016)**</td>
</tr>
<tr>
<td>Democracy t-1</td>
<td>7.713</td>
<td>7.715</td>
<td>7.863</td>
<td>7.338</td>
<td>5.956</td>
<td>8.707</td>
</tr>
<tr>
<td>Ethnic</td>
<td>(1.320)***</td>
<td>(1.287)***</td>
<td>(1.211)***</td>
<td>(1.120)***</td>
<td>(1.407)***</td>
<td>(1.451)***</td>
</tr>
<tr>
<td>Polarization t-1</td>
<td>0.094</td>
<td>0.093</td>
<td>0.088</td>
<td>0.064</td>
<td>0.109</td>
<td>0.036</td>
</tr>
<tr>
<td>Anti-Government</td>
<td>(0.013)***</td>
<td>(0.013)***</td>
<td>(0.021)***</td>
<td>(0.024)***</td>
<td>(0.014)***</td>
<td>(0.031)</td>
</tr>
<tr>
<td>Demonstrations t-1</td>
<td>-0.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government Size t-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation t-1</td>
<td>0.076</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.030)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade Openness t-1</td>
<td>-0.078</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.016)***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Security</td>
<td>-0.286</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfers t-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.097)***</td>
</tr>
<tr>
<td>Income</td>
<td>59.866</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inequality</td>
<td>$t_{-1}$</td>
<td>(31.067)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Countries</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>N*T</td>
<td>644</td>
<td>644</td>
<td>644</td>
<td>644</td>
<td>641</td>
<td>466</td>
</tr>
<tr>
<td>Wald $\chi^2$</td>
<td>2808.60</td>
<td>3464.33</td>
<td>12515.84</td>
<td>7314.36</td>
<td>43056.80</td>
<td>104866.87</td>
</tr>
<tr>
<td>Prob. $&gt; \chi^2$</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is the number of terrorist attacks by nationalist-separatist groups within their natural territory. Robust standard errors clustered on countries reported in parentheses. All models control for an AR(1) term. Constant not reported. (*), (**), and (***) indicate significance at 10%, 5% and 1% level, respectively.
Table 6: Influencing Factors of Terrorism Using Different Definitions

<table>
<thead>
<tr>
<th>Dependent Variable (No. of Attacks)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP p.c.</td>
<td>(0)</td>
<td>(-)</td>
<td>(0)</td>
<td>(0)</td>
<td>(-)</td>
</tr>
<tr>
<td>Unemployment</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>Population Size</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>Cold War Era</td>
<td>(+)</td>
<td>(0)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>Support for Ideology†</td>
<td>(+)</td>
<td>(-)</td>
<td>(-)</td>
<td>(0)</td>
<td>(-)</td>
</tr>
<tr>
<td>Right-Wing Government</td>
<td>(0)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
<tr>
<td>Age of Democracy</td>
<td>(-)</td>
<td>(+)</td>
<td>(0)</td>
<td>(-)</td>
<td>(0)</td>
</tr>
<tr>
<td>Ethnic Polarization</td>
<td>(0)</td>
<td>(+)</td>
<td>(0)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Anti-Government Demonstrations</td>
<td>(0)</td>
<td>(+)</td>
<td>(0)</td>
<td>(+)</td>
<td>(+)</td>
</tr>
</tbody>
</table>

Notes: Significant at 0.05 = bold; significant at 0.10 = italics; 0 = results insignificant. † = variable changes with model specification (combined support for left-wing and nationalist parties in specifications 3-5). Estimation method, empirical setup and variable operationalization as described in the main text (baseline model).
### Supplementary Table: List of terrorist groups in Western Europe included in GTD, per type, 1970-2007

<table>
<thead>
<tr>
<th>Country</th>
<th>Left-wing</th>
<th>Nationalist-separatist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nationalist-separatist</td>
</tr>
<tr>
<td>Belgium</td>
<td>Left-wing</td>
<td>Communist Combatant Cells (CCC), Proletarian Revolutionary Action Front (FRAP)</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td>Denmark</td>
<td>Left-wing</td>
<td>Anarchists</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>Left-wing</td>
<td>Action Directe, Autonomous Revolutionary Brigade, International Revolutionary Action Group (GARI), Gracchus Babeuf, Black War, Raul Sendic International Brigade, Armed Nucleus for Popular Autonomy, Partisan Sharpshooters, Meinhof-Puig-Antich Group, Sixth of March Group, Comite de Liberation et de Detournements d'Ordinateurs, International Revolutionary Solidarity, January 22, Coordination for Revolutionary Action (CAR), Autonomous Group for Armed Action, Revolutionary Anarchist Armed Terror Movement, Autonomous Groups</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>Breton Liberation Front (FLB), Resistenza Corsa, Armata Corsa, Gazteriak, Armata di Liberazione Nazionale (ALN), Indipendenza, Resistenza, Corsican National Liberation Front-Historic Channel, Corsican Revolutionary Brigade, Corsican National Liberation Front (FLNC), Unione di u Populu Corsu (UPC), Iparretarrak (IK), Caribbean Revolutionary Alliance (ARC), Francia, Guadeloupe Liberation Army, Fronte Paesano Corsu di Liberazione (FPCL), Basque Rectitudes, Others (Basque Separatists, Breton Separatists, Corsican Separatists, Carribean Nationalists)</td>
</tr>
<tr>
<td>Finland</td>
<td>Left-wing</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>Left-wing</td>
<td>Red Army Faction (RAF) a.k.a. Baader-Meinhof Group, Anti-Imperialist Cell (AIZ), Revolutionary People's Army, Revolutionary Cells, Red Cell, 2nd of June Movement, Socialist Patients' Collective (SPK), Other Left-Wing Groups (Autonome, Rote Zora, Other Militants, APO, Black Cells etc.)</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td>Nationalist-separatist</td>
<td>Greek Anti-Dictatorial Youth (EAN), Turks of Western Thrace, The Hawks of Thrace</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>Left-wing -</td>
<td></td>
</tr>
<tr>
<td>Nationalist-separatist</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Left-wing -</td>
<td></td>
</tr>
<tr>
<td>Nationalist-separatist</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Nationalist-separatist</td>
<td>Ein Tirol (One Tyrol), Sudtiroler Volkspartei (South Tyrol People's</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Party)</td>
<td>Tyrolean Defense League, Sardinian Autonomy Movement, Further Separatists (Tyrol, Sardinia)</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Luxembourg</strong></td>
<td>Left-wing</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td><strong>Netherlands</strong></td>
<td>Left-wing</td>
<td>Red Resistance Front, Red Revolutionary Front, Autonomy Front</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>South Moluccans</td>
</tr>
<tr>
<td><strong>Norway</strong></td>
<td>Left-wing</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td><strong>Portugal</strong></td>
<td>Left-wing</td>
<td>Popular Forces of April 25, Further Left-Wing Groups (Action Group for Communism, Anti-Capitalist Brigades, Revolutionary Autonomous Group, Communists)</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>Front For the Liberation of the Azores</td>
</tr>
<tr>
<td><strong>Spain</strong></td>
<td>Left-wing</td>
<td>First of October Antifascist Resistance Group (GRAPO), Revolutionary Patriotic Anti-Fascist Front (FRAP), Red Guerrilla, Iberian Anarchist Federation, Iberian Liberation Movement (MIL), Revolutionary Communist League (LCR), GAC, Other Left-Wing Groups (1st of May Group, Organization of Anti-Fascist Students, Armed Groups for Communism, Autonomous Anarchist Groups, Spanish International Communist Party)</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>Basque Fatherland and Freedom (ETA), Terra Lliure, Catalan Liberation Front (FAC), Free Galician People's Guerrilla Army, Guerilla Party of the Galician Poor, Red Army for the Liberation of Catalonia, Anti-terrorism ETA (ATE), Anti-terrorist Liberation Group (GAL), Spanish Basque Battalion (BBE), Catalanian Resistance, Basque Battalion, Canary Islands Independence Movement, 28 February Armed Group, Spanish National Action, Catalan Independence Group, Other Basque Groups (e.g., Haika, Jarrai, Autonomous Anti-Capitalist Commandos (CAA))</td>
</tr>
<tr>
<td><strong>Sweden</strong></td>
<td>Left-wing</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td><strong>Switzerland</strong></td>
<td>Left-Wing</td>
<td>Revolutionary Perspective</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>-</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td>Left-wing</td>
<td>Angry Brigades, Black Liberation Front</td>
</tr>
<tr>
<td></td>
<td>Nationalist-separatist</td>
<td>Irish Republican Army (IRA), Official Irish Republican Army (OIRA), Continuity Irish Republican Army (CIRA), Real Irish Republican Army (RIRA), Irish National Liberation Army (INLA), Irish People's Liberation Organization (IPLO), People's Liberation Army (Northern Ireland), Ulster Freedom Fighters (UFF), Red Hand Commandos, South Londonderry Volunteers (SLV), Loyalist Action Force, Red Hand Defenders (RHD), Ulster Volunteer Force (UVF), Other Groups in North Ireland Conflict (e.g., Catholic Reaction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Force, Extremist Protestants, Loyalist Volunteer Forces (LVF), Orange Volunteers (OV), Red Flag, Direct Action Against Drugs (DADD), Protestant Action Group, Extremist Catholics, Republican Action Force, Scottish National Liberation Army, Army for Freeing Scotland, Scottish Socialist Republican League, Meibion Glyndwr, Other Welsh Extremists</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Great Expectations and Hard Times—The (Nontrivial) Impact of Education on Domestic Terrorism

This chapter is joint work with Tim Krieger and Daniel Meierrieks and refers to the working paper available as CESifo Working Paper No. 3817, May 2012, CESifo Group Munich.

“What is it that seduces some young people to terrorism? It simplifies things. The fanatic has no questions, only answers. Education is the way to eliminate terrorism.”


“On the whole, there is little reason for optimism that [an] [...] increase in educational attainment will lead to a meaningful reduction in [...] terrorism.”

— Krueger and Maleckova (2003, p. 142)

5.1. Introduction

In the aftermath of the terrorist attacks on New York City’s World Trade Center and the Pentagon in Washington, D.C. on September 11, 2001, policymakers, intellectuals, and the general public largely agreed that education needed to be strengthened to work as an ‘antidote’ to terrorism. This spoke to the idea that education leads to less hatred and fewer socioeconomic and political grievances, thus making terrorism less likely.

While intuitive, this optimistic view on the terrorism-education nexus is, however, called into question by anecdotal and academic evidence, which tends to be more pessimistic about the relationship between education and terrorism. For instance, the highly influential paper by Krueger and Maleckova (2003) finds that education does not matter to terrorism on a cross-country level, while—on an individual level—many terrorists tend to be rather well
5.1 Introduction

educated. Other studies point at a similar relationship (Berrebi, 2007; Shafiq and Sinno, 2010; Ganor, 2011).

Why is there disagreement over the impact of educational attainment on terrorist activity? We argue that there is a country-specific dimension to the terrorism-education nexus which has been disregarded in previous empirical efforts. We argue that these very country-specific factors determine whether education—and the type of education—reduces or fuels terrorism. When country-specific conditions are favorable (e.g., sound institutions, strong economic development), education helps to reduce terrorism. However, when country-specific conditions are poor, education may fuel terrorism. In other words, those very ‘great expectations’ associated with the positive role of education in terrorism may in fact turn into ‘hard times’ when country-specific conditions are unfavorable.

We provide an in-depth assessment of the terrorism-education nexus using cross-sectional time-series data for 133 countries for the period 1984 to 2007. As a major innovation, we identify groups of countries that differ with respect to certain socio-economic, political and demographic traits (e.g., economic growth, income, politico-institutional conditions) by means of a cluster analysis and then examine whether the dynamics of the nexus are conditional upon cluster-specific circumstances. We also add to the existing evidence by considering the relationship between education and domestic terrorism. Previous studies only consider the effect of education on transnational terrorism. Domestic terrorism, however, accounts for the bulk of terrorist activity (e.g., Enders et al., 2011) and—as we will discuss below—is expected to have a closer relationship with education variables. Finally, we use several education indicators to systematically cover different levels of education, unlike earlier studies that rely on one specific education proxy only. This ought to add to the robustness of our findings and simultaneously provides new insights as to whether specific forms of education matter more strongly in certain parts of the world. For instance, for demographic and economic reasons, lower education may be more important for less developed countries, while developed countries may benefit more from higher education.

To preview our findings, we find evidence of a nontrivial effect of education on terrorism. Lower education levels tend to foster terrorism for a cluster of countries where poor conditions abound (e.g., slow growth, poor human and economic rights situation), while higher education levels tend to reduce terrorism for a cluster of countries where conditions are more favorable. These core findings are robust to a variety of sensitivity checks. They call for a more nuanced analysis of the terrorism-education nexus, given that country-specific circumstances and the choice of adequate education proxies seem to matter to empirical inferences. Our results suggest that promoting education in less developed countries may

---

Domestic terrorism involves only one country, whereas transnational terrorism involves at least two countries (e.g., when domestic groups attack international targets).
5.2 The Terrorism-Education Nexus: Literature Review and Hypotheses

actually foster terrorism when poor structural socio-economic, politico-institutional and demographic issues are not addressed at the same time. Interestingly, our framework not only helps to better understand the role of education in terrorism. It also relates to other historic incidences of political violence such as the French Revolution (Glaeser et al., 2007) or the popular uprisings during the Arab Spring (Campante and Chor, 2011), which were characterized by a combination of educational advances and poor institutional, socio-economic and demographic circumstances. Such linkages have been largely ignored in the literature. However, they may account for the inconclusive evidence on the terrorism-education nexus on cross-national level as well as the positive correlation between education and terrorism on the micro level.

This paper is organized as follows. In Section 5.2 we discuss the literature on the relationship between education and terrorism. Section 5.3 introduces the data and empirical methodology. Section 5.4 presents and discusses our main empirical findings. Section 5.5 offers several robustness checks and extensions to our empirical efforts. Section 5.6 concludes.

5.2. The Terrorism-Education Nexus: Literature Review and Hypotheses

5.2.1. Great expectations: Why education should reduce terrorism

Following the rational-choice approach, education is expected to determine the level of terrorist activity by influencing its (opportunity) costs and benefits. The optimistic view of the terrorism-education nexus suggests that education raises terrorism’s opportunity costs by fostering individual socio-economic success and political participation. For instance, higher education means higher personal human capital endowment and thus income, so that educated individuals ought to have more to lose (higher opportunity costs) when they choose to resort to terrorism. On national levels, higher levels of education are found to be positively related to economic growth and a reduction in poverty and inequality (Temple, 1999; Cohen and Soto, 2007). This may additionally affect the terrorists’ calculus by inducing higher opportunity and also higher recruitment costs, given that, e.g., the size of the pool of potential terrorist recruits ought to shrink with more favorable socio-economic conditions (e.g., Bueno de Mesquita, 2005).

Education is also found to positively correlate with political participation. For instance, Dee (2004) finds that voter participation and support for free speech increase with individual education. Barro (1999) and Glaeser et al. (2007) argue that education is among the determinants of democracy. Consequently, the positive effect of education on political participation may result in higher terrorism opportunity costs (due to the recognition and
use of nonviolent means to foster political change) and thus less terrorist activity. What is more, the favorable interaction between education, economic development and democracy may lead to positive politico-institutional outcomes, e.g., as corruption is reduced or redistribution takes place in a more welfare-enhancing way, which may reinforce the positive effect of education on economic growth (Saint-Paul and Verdier, 1993; Glaeser et al., 2007).

Finally, education may also change personal attitudes towards extremist ideologies, the use of violence and its legitimization (Victoroff, 2005). These effects may be reflected in lower (perceived) personal benefits from terrorism as well as higher recruitment costs for terrorist groups. For instance, educated individuals may evaluate the probability of terrorist success more realistically and therefore be less easy to recruit. Also, the educated may more easily see through the terrorists’ propaganda, so that terrorist mobilization is constrained and popular support remains marginal. The latter mechanism can be understood as a representation of the popular—perhaps somewhat idealistic—idea that education counters hate and ignorance, and implies higher moral constraints associated with the use of violence (cf. Victoroff, 2005).

In summary, the optimistic view of the terrorism-education nexus argues that education raises the (opportunity) costs and lowers the benefits of terrorism in such a way that the risk of terrorism is reduced. This leads to our first hypothesis (H1):

Hypothesis 1: Countries with higher levels of education will (ceteris paribus) experience lower levels of terrorism.

Some empirical studies on the causes of terrorism implicitly back this hypothesis. They find that terrorism is positively related to poor institutions such as a deficient rule of law (Choi, 2010; Walsh and Piazza, 2011), socioeconomic underdevelopment (Blomberg and Hess, 2008; Freytag et al., 2011) and inefficient means of redistribution and economic participation (Burgoon, 2006; Krieger and Meierrieks, 2010, Piazza, 2011). If education positively interacts with economic and political development, as the previous discussion suggests, then education ought to be negatively related to terrorism since it removes the economic and institutional grievances that usually fuel terrorism. Also, studies on the causes of other forms of political violence suggest that interactions—which are similar to those discussed above—between education and underdevelopment matter to these conflicts. For example, they consistently find that these conflicts are related to economic and political grievances (e.g., Fearon and Laitin, 2003). They also suggest that education is negatively related to civil wars (e.g., Thyne, 2006). If terrorism and other forms of conflict share similar roots—as suggested by Gassebner and Luechinger (2011, p. 251)—then education may have a dampening effect on terrorism.
5.2 The Terrorism-Education Nexus: Literature Review and Hypotheses

5.2.2. Education during good and hard times: An alternative view

Although the previous discussion provides some evidence that education may reduce terrorism, skeptical views prevail. While most cross-national and global (large-N) studies on the causes of terrorism do not consider the effect of education on terrorism, a review of those studies that control for the impact of education on terrorism fails to produce a consistent picture (Table 1). For example, while Bravo and Dias (2006) find that education makes terrorism less likely, Testas (2004) comes to the opposite conclusion. Even more puzzlingly, studies that analyze the relationship between individual education and participation in terrorism find that the two are positively related (Victoroff, 2005; Berrebi, 2007; Benmelech and Berrebi, 2007; Krueger, 2008). For example, in their highly influential contribution Krueger and Maleckova (2003) find that terrorist operatives who are engaged in the Arab-Israeli conflict (e.g., the Jewish underground, Hezbollah) are on average well educated.

Why may education positively correlate with terrorism? Building on the existing literature, we argue that education may fuel terrorism when country-specific conditions are unfavorable. Such poor conditions may consist of a set of socioeconomic (e.g., poor growth, economic disenfranchisement), politico-institutional (e.g., discrimination, corruption, poor governance) or demographic (e.g., population growth) factors. Due to poor country-specific circumstances, advances in education may not sufficiently increase the opportunity costs of terrorism because the relevant transmission channels (e.g., income, political participation, economic growth) do not work properly on individual and social levels, meaning that no nonviolent opportunities open up. For instance, slow economic growth and slack labor markets may cause individuals to take up jobs that do not match their qualification and thus their expected personal income. Also, institutional constraints (e.g., corruption, nepotism) may redirect the flow of educated labor into the public sector, consequently inhibiting economic growth by creating inefficiencies and constraining private economic activity (Pritchett, 2001). Likewise, when political participation is constrained (e.g., due to poor democratic institutions), education cannot be easily linked to positive political development.

Other mechanisms may even promote the genesis of terrorism. First, education may make it easier for individuals to recognize those socioeconomic and politico-institutional constraints that limit the personal and social success that is expected from education. Shafiq and Sinno (2010) argue that increases in education coupled with political disenfranchisement lead to greater support for (suicide) terrorism, potentially because education helps individuals to contextualize political problems and possibly choose violence as a means of achieving political change. Second, education may increase the (perceived) benefits from terrorism,
given that an eventual removal of existing social constraints ought to benefit the educated the most. In case of terrorist success, education may finally pay off (e.g., in terms of income, growth and political participation), particularly for the highly educated. Third, when the labor market fails to offer individuals an adequate return on their investment in education, it may become increasingly attractive for individuals to pursue a ‘career’ in terrorism. Terrorist organizations may offer their operatives wages and other incentives (e.g., reputation as a terrorist leader, martyrdom) that are closer to individual human capital endowments and associated aspirations than those offered by the regular labor market (cf. Bueno de Mesquita, 2005). Fourth, education may also lower the (perceived) costs of terrorism. Intuitively, education makes terrorist success (e.g., launching an attack, evading prosecution) likelier. Bueno de Mesquita (2005) argues that due to the positive effect of individual human capital endowment on terrorist success terrorist organizations are particularly interested in highly educated members.\(^2\)

To sum up, when poor country-specific conditions abound, education does not sufficiently translate into higher opportunity costs of terrorism. Instead, education may facilitate mobilization due to an increased attractiveness of terrorism for educated individuals, which reinforces the probability of terrorist success. This leads to the following hypothesis (H2a):

**Hypothesis 2a:** Countries with higher levels of education will (ceteris paribus) experience higher levels of terrorism when country-specific (socio-economic, political, institutional, demographic etc.) circumstances are poor.

This hypothesis is supported by a number of examples. Abeyratne (2004) argues that in Sri Lanka increases in education in combination with poor country-specific conditions (strong population growth, ethnic discrimination, socioeconomic and political exclusion) led to armed insurgencies by the communist Janatha Vimukthi Peramuna and the separatist Liberation Tigers of Tamil Eelam. Similarly, Ganor (2011) argues that the expansion of education in Palestine in the 1970s was not met by adequate demand for highly-skilled labor, but instead led to increasing frustration, humiliation and radicalization among young Palestinians who eventually filled the ranks of radical groups active during the 1987 Intifada. Ganor (2011) also suggests that the interplay between education, denied opportunities, alienation and frustration may contribute to the radicalization—and possibly, terrorist activity—among Muslim youth in Western European communities. The findings of Testas (2004), Kavanagh (2011) and Urdal (2006) also suggest that the reciprocity between advances in education and poor social conditions matters to the emergence of social conflicts.

\(^2\)Note that the preponderance of poor social conditions and the lack of nonviolent alternatives also ought to increase the pool of potential recruits from which terrorist organizations usually choose the most educated members, meaning lower recruitment costs that may also facilitate terrorist activity (Bueno de Mesquita, 2005).
5.2 The Terrorism-Education Nexus: Literature Review and Hypotheses

For instance, Urdal (2006) finds that an expansion in education that is coupled with demographic pressures makes civil conflict more likely. Finally, the recent revolutions and riots in Northern Africa and the Middle East—as well as other forms of political protest—can also be linked to the interaction between rising educational levels, which induce political activism, and socioeconomic underperformance (Campante and Chor, 2011).

Following this line of reasoning, the role of education in terrorism may be determined by the change in educational attainment relative to the change in politico-institutional and sociodemographic conditions. If the former dominates the latter at relatively low levels, terrorism becomes more likely. However, it seems reasonable to expect politico-institutional and sociodemographic factors to eventually catch up with educational quality, which ought to reverse the outcomes. Hence, as a corollary of hypothesis H2a we argue that education can be expected to exert a dampening effect on terrorism when social conditions are more favorable. Education ought to contribute to (individual and social) progress when the socioeconomic, demographic and politico-institutional barriers that govern employment, economic redistribution, political participation etc. are low or nonexistent. In turn, this is expected to make terrorism less likely by sufficiently raising its opportunity costs (as outlined above), where these effects ought to outweigh those through which education may fuel terrorism (e.g., the improved recognition of disenfranchisement). This leads to the final hypothesis (H2b):

**Hypothesis 2b:** Countries with higher levels of education will (ceteris paribus) experience lower levels of terrorism when country-specific (socio-economic, polit- ical, institutional, demographic etc.) circumstances are favorable.

This does not, however, rule out the emergence of terrorism when favorable social conditions abound. In fact, the history of domestic terrorism in Western Europe and the US after the Second World War indicates that education did not ‘immunize’ societies against terrorism. Rather, many terrorists from these countries had an academic background (Victoroff, 2005). However, domestic terrorist activity in Western countries was often perpetrated by isolated groups that failed to obtain popular support or achieve generational transition as they were not successful in recruiting younger followers (Cronin, 2006). In accordance with our previous discussion, we may speculate that the beneficial interaction between advances in education and favorable country-specific conditions—besides other factors—minimized the pool of potential terrorists and supporters in these countries and raised terrorism opportunity costs, making it practically infeasible for a sustained terrorist campaign to enjoy broad popular support.

---

3 See Glaeser et al., (2007) for further historic examples where increases in education contributed to political conflict.
5.3. Data and Methodology

We test which of the hypotheses discussed in the previous section are supported by the data for a panel of 133 countries for the period 1984 to 2007. The summary statistics are reported in Table 2. A country list is given in the appendix.

5.3.1. Dependent variable: Domestic terrorism

Our dependent variable is the number of domestic terrorist incidents in a given year and country. Previous studies have focused on the causes of transnational terrorism mainly due to data constraints (cf. Krieger and Meierrieks, 2011). However, the relationship between education and domestic terrorism is unlikely to be identical to the interaction between education and transnational terrorism as different factors may matter. For instance, transnational terrorism seems to be more strongly motivated by international political factors (e.g., foreign policy) than domestic terrorism (Pape, 2003; Savun and Phillips, 2009).

The economic mechanisms from education to reduced terrorist activity—via an amelioration of grievances (H1) or via the interaction between education and country-specific conditions that (potentially) determines the effect of education on terrorism (H2a and H2b)—are intuitively expected to matter more strongly to the genesis of domestic terrorism. The fact that domestic terrorism is far more common than transnational terrorism (e.g., Enders et al., 2011) further motivates our decision to study the effect of education on domestic terrorism. Finally, there is a lack of evidence on the causes of domestic terrorism in general (Krieger and Meierrieks, 2011), and with respect to the role of education in domestic terrorism (cf. Table 1).

The data for our dependent variable are drawn from Enders et al. (2011), who use terrorism data provided by the Global Terrorism Database (GTD). While the GTD contains data on domestic and transnational terrorism, it does not differentiate between the two. Enders et al. (2011) decompose the data series into domestic and transnational terrorist events. They also deal with some methodological problems (e.g., coding issues) in the GTD series. As a result, the domestic terrorism data provided by Enders et al. (2011) are to date the most reliable count data measuring this kind of activity.4

4As a robustness check, we experiment with different approaches towards dealing with remaining data problems that are discussed by Enders et al. (2011). For instance, they argue that the GTD tends to overreport terrorism for some time periods, which should be accounted for by adjusting the data accordingly. However, this leads to findings similar to those obtained using the unadjusted data.
5.3 Data and Methodology

5.3.2. Education variables

As argued above, the large-N studies that analyze the determinants of terrorism and incorporate measures of education (Table 1) may have failed to unveil a consistent relationship between the two for theoretical reasons (i.e., the failure to consider the moderating effect of country-specific conditions on the terrorism-education nexus). In addition, different analytical scopes (country samples, observation periods, education indicators etc.) may have contributed to empirical inconsistencies. In this study we use a uniform country sample to assess the influence of various education variables on the emergence of domestic terrorism. By doing so, we ought to examine, amongst others, whether the choice of a specific education proxy matters to statistical inferences.

We measure education by primary school enrollment per capita (primary education), secondary school enrollment per capita (secondary education), the sum of primary and secondary school enrollment, university enrollment per capita (university enrollment) and the literacy rate (i.e., the number of people aged 15 and over who are able to read or write over the total population). All education data are drawn from the Cross-National Time-Series Data Archive.

These measures ought to reflect the size and quality of a country’s human capital stock. That is, higher enrollment and literacy rates are expected to correspond to higher levels of education, where education may either reduce terrorism uniformly (H1) or affect terrorism depending on country-specific circumstances (H2a and H2b). Our education measures may also reflect public investment in education and the effectiveness of educational institutions (Thyne 2006). For instance, higher enrollment rates ought to mean more investment in education (teachers, school buildings etc.) and stronger institutions related to education (e.g., child labor laws, compulsory education). A stronger public commitment to education ought to result in higher levels of education, which in turn matter to terrorism. Finally, our education variables also reflect the ‘supply’ and ‘demand’ side of education. The ‘supply’ side of education relates to a country’s demographic structure (i.e., population structure, growth and distribution). For instance, primary and secondary school enrollment may be more important to ‘young’ societies (less developed countries), while tertiary education matters more to ‘older’ societies (developed countries). The ‘demand’ side of education relates to, e.g., the global division of labor, national economic structures and labor markets demands. For example, primary and secondary education may be more important in countries that do not rely on human-capital-intensive production (less developed countries), whereas in other

5We also experimented with alternative measures of education as used by Thyne (2006). He employs data on primary, secondary and postsecondary enrollment and on literacy and government education spending, drawing on data from the World Development Indicators. While the results are not directly comparable due to data limitations (only the period 1994 to 2007 is available), the findings tend to support our main results.
countries tertiary education may more prominently determine personal and social success due to corresponding production and employment demands (developed countries).

In short, we have good reason to believe that our education proxies correlate with education ‘inputs’ (public investment, quality of educational institutions) and ‘outputs’ (size and quality of an economy’s human capital stock). Our explanatory variables are expected to indicate whether education truly matters to terrorism via the transmission channels discussed in Section 5.2. However, we can also expect that specific education variables matter more strongly to specific country groups, depending on factors such as governance, demographic structure and economic demands. For these reasons, we expect primary education to be the most adequate proxy of education in the less developed world, whereas tertiary education is expected to be most important in developed economies.

5.3.3. Controls

We include a number of controls to avoid detecting only spurious correlations between education and terrorism. We control for variables that determine education and terrorism at the same time (to ensure that the ceteris paribus condition of our hypotheses holds) or which need to be included for statistical reasons. Wherever possible, we exclude variables that reflect a potential transmission channel from education to terrorism, so as to better isolate and identify the aggregate impact of education on terrorism. For instance, we do not control for economic growth, given that we expect education to influence terrorist activity—amongst other effects—via its beneficial impact on economic activity.\(^6\) Additional information on all control variables is given in the appendix.

First, we consider the effect of population size. Larger populations may signal higher demographic stress that fuels conflict. Alternatively, the positive correlation between population size and terrorism may stem from the fact that more populous countries provide more targets, victims and terrorists. In any case, population size is consistently found to be a strong, positive predictor of terrorism (Krieger and Meierrieks, 2011; Gassebner and Luechinger, 2011). At the same time, larger populations lead to increased demand for investment in education and may affect enrollment (Busemeyer, 2007).

Second, we control for the effect of per capita military spending on terrorism. Gassebner and Luechinger (2011) argue that military spending constrains the opportunities for open

---

\(^6\)Other potential determinants of terrorism that we do not include for this reason are, e.g., per capita income, the rule of law, measures of poverty and inequality, and the economic and human rights situation in a country. However, we control for these intervening variables in additional model specifications as part of our robustness analysis. As expected, their inclusion tends to reduce the overall effect of education on terrorism. Yet the general results of this study are robust to the inclusion of these variables. Also, note that we use several of these variables as conditioning variables when we create country groups by means of a cluster analysis (Section 5.4).
rebellion and therefore leads to terrorism (as an alternative form of insurgency). Simultaneously, budget decisions in favor of more military spending may imply comparatively lower public spending on education and thus a lower level of education.

Third, we control for the influence of various forms of political instability. Specifically, we account for the impact of general strikes, state failure and religious tensions. Instability is expected to positively correlate with terrorism, given that instability, e.g., could exacerbate existing grievances and provide terrorists with opportunities to network, recruit and train, while undermining the ability of governments to counter terrorism effectively (Piazza, 2008; Gassebner and Luechinger, 2011). At the same time, these forms of instability may also affect education.

It is also necessary to control for the effect of democracy. Given that education may impact terrorism through its effect on political openness, the inclusion of a regime type variable may mask this effect. However, as found by Drakos and Gofas (2006a), democracies are systematically more likely to report terrorism (given that the press is less restricted) than autocratic regimes. The existence of an underreporting bias in terrorism therefore calls for the inclusion of a control that reflects this bias. What is more, we also expect an effect of democracy on the patterns of education, given that democratic institutions usually positively correlate with public education efforts (Burgoon, 2006).

We furthermore consider the effect of trade openness. As argued by Mirza and Verdier (2008), there are a number of channels through which economic integration may affect terrorism. For instance, integration may facilitate economic disruption through terrorism (e.g., as supply chains are more vulnerable) or increase media attention. While such effects make terrorism more likely by increasing its benefits, alternatively openness may make violence comparatively less attractive when it predominantly produces economic gains (Mirza and Verdier, 2008). At the same time, economic integration is also expected to affect education. For instance, trade carries risks against which the government needs to provide insurance, which may come at the expense of public education policies and efforts, thereby negatively affecting education (Burgoon, 2006).

Finally, we control for the effect of external conflict on terrorism. On the one hand, external instability may make terrorism more likely by tying resources to this conflict, consequently reducing the capacity of a state to control its territory and effectively counter internal problems (Lai, 2007). On the other hand, this very tying of government resources can also be expected to compromise education, potentially leading to lower educational outcomes.

We try to minimize the influence of this variable by using a very rough measure of democracy. As discussed below, we also run zero-inflated negative binomial models as a statistical method for dealing with the existence of an underreporting bias.
5.3.4. Empirical methodology

The dependent variable of our empirical model is a count variable (the number of domestic terrorist attacks) which only covers discrete and nonnegative values. Its variance is larger than its mean (Table 2). Therefore, we employ a negative binomial model for (pooled) count data. This model is the standard econometric method used in the study of the determinants of terrorism (Krieger and Meierrieks, 2011; Gassebner and Luechinger, 2011).

For all model specifications we let the independent (education) and control variables enter the model with (t-1) lagged values. This reflects the idea that any changes in these parameters should affect terrorism only after some time. Simultaneously, we avoid potential reverse causation and endogeneity problems, given that lagging all explanatory variables ought to reduce the correlation between these variables and the error term (Lai, 2007). We include year dummies in all specifications to factor in time and trending effects (Burgoon, 2006). Regional dummies (for the West, the Middle East, Sub-Saharan Africa, and Latin America) are included to account for effects that matter to certain parts of the world. For all estimations we rely on standard errors that are clustered over cross-sections to account for heteroskedasticity.

5.4. Empirical Results

5.4.1. Full sample findings

Our estimation results for the complete sample of 133 countries are reported in Table 3. The findings reject H1. We do not find that higher levels of education coincide with a reduction in domestic terrorism. Rather, the findings suggest that education tends to positively correlate with terrorist activity. In particular, there is a statistically significant association between lower levels of education (literacy rates, primary education) and domestic terrorism, while there is no correlation with higher education (university enrollment). These findings are more in line with H2a and the empirical mainstream.

Table 3 also indicates that other factors influence terrorism. As expected, more populous countries are more prone to domestic terrorism. Internal political instability (strikes, incidents of state failure and religious tensions) and external threats (international conflict) make domestic terrorism more likely. These findings mirror the empirical mainstream and suggest that instability lowers the operating costs of terrorism (e.g., by diverting government
resources to other threats and creating political vacuums) and its opportunity costs by constraining nonviolent activities (Lai, 2007; Piazza, 2008). Also, we find that democracies are more prone to domestic terrorism. As argued before, this positive correlation may indicate the presence of an underreporting bias. Finally, trade openness and military spending do not robustly influence terrorist activity.

### 5.4.2. Cluster analysis

The purpose of this subsection is to create groups of countries that differ with respect to certain socioeconomic, political and demographic variables. By differentiating between countries with ‘good’ (favorable) and ‘bad’ (unfavorable) conditions we expect to better assess the validity of our hypotheses H2a and H2b.

We employ a *cluster analysis* to identify natural groupings within our dataset that would otherwise not be apparent. For the cluster analysis we collect data on socioeconomic development and performance (GDP per capita, inflation, economic growth), politico-institutional variables (rule of law, corruption, government size, human rights situation, economic freedom, female labor participation) and demographic factors (population density, population growth, urbanization).  

We then average each variable over the respective available observation period and run a two-step cluster analysis (Chiu et al., 2001). One advantage of this procedure is that it automatically chooses the optimal number of clusters. The results of the cluster analysis are reported in Table 4.

| — Table 4 here — |

Our analysis identifies two clusters. In comparison to Cluster 2, Cluster 1 exhibits ‘poorer’ conditions with a weaker rule of law, poorer protection of human and property rights, slower economic growth, and lower per capita income, female labor participation, urbanization and population density, but higher levels of corruption, population growth, inflation, and larger governments. According to the exact breakdown of the sample (cf. the country list in the appendix), Cluster 2 includes all OECD economies, some rich oil economies and some emerging markets (‘developed countries’ cluster), while Cluster 1 includes all Sub-Saharan African countries and most countries in Latin America, Asia and the Middle East (‘less developed countries’ cluster).

---

8See the appendix for a description of the data and variables used in the principal component analysis.
9Other potential conditioning variables are not included due to a lack of data. For instance, we are not able to include data on youth burdens. However, we are confident that the two country groups are also similarly different with respect to these omitted variables. For instance, Cluster 1 ought to experience much stronger demographic pressure from youth burdens than Cluster 2. We also experimented with other cluster specifications and re-ran our estimations. Our results were usually in line with those reported in the main text.
5.4 Empirical Results

For the less developed countries we anticipate to find evidence in support of H2a. Here, increases in education are not expected to pay off because socioeconomic (e.g., high inflation, slow economic growth), politico-institutional (e.g., high levels of corruption and repression) and demographic (e.g., high population growth) conditions are unfavorable. Instead, education may fuel domestic terrorism, as outlined above. Given the demographic and economic structures in the less developed world, this relationship ought to be more pronounced for variables reflecting lower education. By contrast, for the developed countries we expect to find evidence supporting H2b. Education ought to reduce terrorism by interacting favorably with good country-specific conditions. Variables indicating higher education ought to matter most to this relationship.

5.4.3. Results for a subsample of less developed countries

Table 5 reports the estimation results for a subsample of less developed countries (Cluster 1). In short, the findings with respect to the effect of education on domestic terrorism strongly mirror those reported for the full sample. That is, we find that variables reflecting lower education (primary education, literacy rate) are positively associated with terrorism, while higher education (university enrollment) does not play a role.

These findings support hypothesis H2a. Conditional upon the presence of poor country-specific conditions, education makes terrorism more likely. Presumably, education does not increase terrorism’s opportunity costs. The beneficial individual and social effects of education (e.g., socioeconomic success, political participation, institutional improvements) do not seem to materialize due to the structural socioeconomic, political and demographic constraints that are endemic in these countries. Rather, education is positively correlated with terrorism as it may, e.g., facilitate mobilization because terrorism appears more attractive to educated individuals. In turn, this relationship reinforces the probability of terrorist success. The findings with respect to controls are in line with those reported in Table 3.

5.4.4. Results for a subsample of developed countries

We analyze the effect of education on domestic terrorism for the smaller sample of developed economies (Cluster 2). The findings are reported in Table 6.

— Table 6 here —
5.5 Robustness and Extensions

In contrast to the findings for the complete country sample (Table 3) and the subsample of less developed countries (Table 5), the results for the subsample of developed countries reveal a different relationship between education and domestic terrorism. There is no positive association between lower education and terrorism. Instead, we find a negative and statistically significant effect of higher education (university enrollment) on domestic terrorism, which supports H2b. That is, in a favorable environment—characterized by, e.g., sufficient means of socioeconomic and political participation—education seems to exert a dampening influence on terrorism. On the one hand, there is good reason to believe that education can markedly improve personal and social living conditions (e.g., higher incomes, stronger economic growth, democratization, institutional advances) when the barriers for socioeconomic and political participation are rather low. This ought to mean higher opportunity costs for terrorism and thus less terrorism. On the other hand, the availability of nonviolent opportunities and the lack of (apparent) disenfranchisement ought to undermine efforts by terrorist groups to mobilize and rally popular support. This is equivalent to higher operating costs of terrorist organizations which ought to generate less terrorism.

As argued before, this does not mean that the beneficial interaction between education and politico-economic development ‘immunizes’ against the terrorist threat. There may still be reasons to rebel. However, terrorist movements in the developed world have rarely become mass movements; rather, they have remained isolated groups within society. One contributing factor seems to be the appeasing effect of (advances in higher) education.

The findings with respect to controls mirror the previous ones with two exceptions. First, we find a weakly significant, negative effect of military spending on terrorism. Higher spending may indicate increased security and counterterrorism efforts that raise the operating costs of terrorism, thus making it less likely (Lai, 2007).10 Second, we also find that democracies are less likely to see terrorism. While this may be a mere consequence of our country sample and model specification—as suggested by Gassebner and Luechinger (2011)—it may also indicate that political participation, in particular when coupled with a sound institutional framework and relatively high levels of education, makes terrorism less likely by offering nonviolent means of voicing dissent and achieving political change.

5.5. Robustness and Extensions

This section scrutinizes the robustness of the findings presented in the previous section and briefly discusses some extensions to these efforts. The corresponding tables are reported in

---

10 The marginally positive effect of military spending on terrorism in Tables 3 and 5 can be interpreted as in Gassebner and Luechinger (2011), who argue that a positive correlation between spending and terrorism reflects the asymmetric nature of terrorist conflicts.
5.5 Robustness and Extensions

the supplementary material.

5.5.1. Reverse causality and endogeneity

To the best of our knowledge, there is no empirical evidence regarding a causal effect of terrorism on education. Also, the socioeconomic consequences of terrorism tend to be small and short-lived, suggesting no strong adverse impact of terrorism on factors such as education (cf. Tavares, 2004). However, it seems possible that terrorism impairs education by, e.g., diverting resources away from public spending on education and damaging the educational infrastructure. The civil war literature similarly suggests that conflict may compromise education (Thyne, 2006). Furthermore, Dreher et al. (2011) find that terrorist activity causes emigration of the most talented due to the high opportunity costs of losing their human capital investment. Arguably, in terrorized economies there may be a lower demand for education for the same reasons.

We therefore run a series of regressions of various education measures on past terrorist activity to examine whether reverse causation is present, while also controlling for a number of important covariates. While preliminary, we find no evidence of a systematic effect of terrorism on education, implying that reverse causation is not a problem. Also, the Durbin-Wu-Hausman tests do not indicate that education is endogenous to terrorism. Finally, as in Azam and Thelen (2010), we control for endogeneity using a two-step Hausman-type test. In its first stage, we regress our respective education variables on a set of exogenous controls (e.g., external conflict, democracy, economic and institutional development) and store the resulting residuals from these regressions. In the second test stage, the residuals are included in the respective count data models outlined above. Here, any significant residual indicates that endogeneity is present and biases our estimates. However, for various model specifications this is not the case. That is, this method, too, indicates that education is not endogenous to terrorism.

5.5.2. Alternative dependent variables

We employ alternative measures of terrorist activity to examine the robustness of our findings to changes in the dependent variable. Importantly, we analyze the relationship between education and total terrorist activity. Here, transnational terrorist incidents together with domestic terrorism and attacks by unknown perpetrators sum up for total terrorist activity, with data drawn from the GTD.\footnote{We also experiment with a different definition of domestic terrorism, where we code an attack as domestic when the attacking terrorist group is located in the country of the attack. The findings for this coding effort mirror those reported above. We also use the number of transnational terrorist incidents as an alternative dependent variable, employing the data provided by Enders et al. (2011). Here, our findings}
5.5 Robustness and Extensions

We run a series of estimations using the same empirical setup as described before. In summary, we find that our previously reported results hold when we focus on total instead of domestic terrorism. In particular, while lower education increases the likelihood of total terrorism in the less developed world, higher education correlates negatively with these indicators in developed economies. This supports H2a and H2b in that education interacts beneficially (detrimentally) with a favorable (unfavorable) environment. The fact that the results for the controls are very much in line with our previously reported findings in Tables 3, 5 and 6 adds to the value of our findings.

5.5.3. Alternative estimation techniques

Next, we consider whether our findings are robust to alternative estimation methods. First, we run a series of zero-inflated negative binomial regressions, which is a method that accounts for the previously discussed reporting bias in terrorism. Drakos and Gofas (2006b) argue that autocracies tend to systematically underreport terrorism, so that the occurrence of excessive zeros is determined by a country’s regime type. The zero-inflated estimations are modeled accordingly, where the control variable democracy is chosen as the variable governing the zero-always outcome which may result from an underreporting bias. Second, we estimate a series of population-averaged negative binomial models for panel data (or generalized estimation equation models). This statistical approach allows us to fully consider the panel structure of our dataset, while using heterogeneity- and autocorrelation-consistent standard errors and controlling for an AR(1) term. Amongst others, Choi (2010) uses this empirical approach. In short, our results indicate that the zero-inflated estimation results closely mirror those presented beforehand. The findings from the population-averaged model also tend to support the findings of this study.

5.5.4. Long-run effects of education on terrorism

Education changes slowly and therefore potentially needs some time to generate positive outcomes that in turn ‘morph’ into higher terrorism (opportunity) costs and less terrorist activity. Therefore, we take 6-year averages of our dependent, education and control variables and then regress terrorism on contemporary values of the controls and on past values of the education proxy. This ought to reflect a long-run effect of education on terrorism. We find that previous innovations in primary education positively sway terrorist activity for the full sample and for the subsample of less developed economies. We also find that past changes in university enrollment negatively correlate with present levels of terrorism in the developed world. That is, there indeed seems to be a causal effect of education on terrorism.

---

are once again in line with those reported in the main text.
terrorism that depends on country-specific circumstances and emerges through the influence of education on the cost-benefit matrices of terrorists.

5.5.5. Education expansion and terrorism

Next, we consider the effect of changes in education on terrorism, given that some studies analyze the effect of changes in education (instead of level data) on socioeconomic and political variables (Temple, 1999). An expansion in education may reflect, e.g., an increasing inflow of resources into the education system (e.g., public investment) and growth in a country’s human capital, but also increasing demographic, economic and political pressures when the growth in education is not accompanied—due to poor structural conditions and related constraints—by sufficient means of socioeconomic and political participation.

In short, we find that an expansion in education tends to positively correlate with the emergence of terrorism in less developed countries, while it tends to reduce domestic terrorism in the developed world. Once more, these findings support H2a and H2b.

5.5.6. Transmission channels

Finally, we attempt to identify the transmission channels through which education influences terrorism. Here, auxiliary regressions indicate that, as argued above, education positively correlates with economic growth, higher income levels, more political openness and a better human and economic rights situation. As one would expect, these correlations are more robust for the subsample of developed economies. While these findings come from ad hoc estimations and surely need further scrutiny, they are nevertheless in line with previous theoretical and empirical findings and suggest that respective transmission channels from education to terrorism are indeed present.

5.6. Conclusion

What is the relationship between education and terrorism? The optimistic—perhaps somewhat euro-americentric—view argues that education makes terrorism less likely by inducing socioeconomic and political progress, thereby raising terrorism’s opportunity costs. From this perspective education also reduces the risk of terrorism by raising its (perceived) costs and lowering its (perceived) benefits as, e.g., the well-educated are expected to be ‘immune’ to terrorist propaganda, to disapprove of hate, ignorance and the use of violence, and to be more realistic about the probability of terrorist success. In contrast to this, more skeptical and pessimistic voices argue that education tends to work in the opposite direction.
We propose a more nuanced perspective that takes both views into consideration. We argue that the true impact of education on terrorism is conditional upon socioeconomic, politico-institutional and demographic circumstances. When these circumstances are unfavorable, education may incite terrorism because advances in education do not sufficiently translate into higher opportunity costs of terrorism. Instead, education may amplify feelings of frustration, humiliation and disenfranchisement (as argued by the proponents of the pessimistic view). What is more, education may increase the attractiveness of terrorism as an ‘occupation’, given that it may offer career paths that match one’s expectations more closely than regular employment. Finally, education may increase the perceived benefits of terrorism (mental and material rewards from eventual terrorist success), while lowering its perceived costs and increasing the probability of terrorist success (i.e., the ‘productivity’ of terrorism), which turns the educated into the preferred recruits for terrorist groups. Education can only be expected to have a terrorism-reducing effect when country-specific conditions are favorable.

We analyze the effect of education on terrorism data for 133 countries between 1984 and 2007. We find no evidence that education reduces terrorism across the board. Rather, we find that education at lower levels (primary education) leads to more terrorism for a cluster of countries where poor conditions abound, while high-level education (university education) reduces domestic terrorism for a cluster of countries where conditions are more favorable. These core findings are robust to a variety of methodological and data changes. They also match recent and historic events where educational advances promoted instability in the face of poor structural conditions such as the French Revolution of 1789, as argued by Glaeser et al. (2007), the Middle Eastern experience with terrorism on which Krueger and Maleckova (2003) build their argument, and the recent series of popular uprisings during the Arab Spring (Campante and Chor, 2011).

What are the implications of this study? From a research perspective, scholars should more thoroughly take into account the potentially heterogeneous (i.e., country-specific) relationship between education and terrorism, accounting for conditional and interacting effects and testing their hypotheses using various education proxies, given that the careful identification of the terrorism-education nexus seems to crucially depend on these factors. Future research may benefit from the eventual advent of more consistent education data that may help to better understand the role of education content, quality and public spending in the terrorism-education nexus (cf. Cohen and Soto, 2007). Although we already touch on these issues, future research may also more thoroughly consider the exact mechanisms that influence the interaction between education, development and terrorism and that correlate with country-specific conditions. Finally, future research may investigate the role of education in religious (Islamist) terrorism. For instance, education seems to play a role in the recent terrorist insurgency by the group Boko Haram (which roughly translates as Western
or non-Islamic education is a sin) in Nigeria, where terrorist activity seems to have emerged partly as a response to Western influence making itself felt through education.

From a policy perspective, our findings indicate that advances in education produce great expectations and may result in hard times when those expectations are not met. That is, a sole strengthening of education in less developed countries—e.g., through foreign aid (Azam and Thelen, 2008, 2010)—may not help in the war on terror. Rather, the promotion of education should be accompanied by domestic and international efforts to ameliorate poor structural socioeconomic, politico-institutional and demographic conditions.
Bibliography


5. Bibliography


5. Bibliography


Table 1: Large-N Studies Controlling for the Effect of Education on Terrorism

<table>
<thead>
<tr>
<th>Study</th>
<th>Scope</th>
<th>Terrorism Variable</th>
<th>Education Proxy</th>
<th>Effect on Terrorism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azam and Thelen (2008)</td>
<td>176 countries</td>
<td>transnational terrorism</td>
<td>(gross) secondary school enrollment</td>
<td>(-)/significant</td>
</tr>
<tr>
<td></td>
<td>1990-2004†</td>
<td>(origin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azam and Thelen (2010)</td>
<td>132 countries</td>
<td>transnational terrorism (origin)</td>
<td>(gross) secondary school enrollment</td>
<td>(-)/significant</td>
</tr>
<tr>
<td></td>
<td>1990-2004†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bravo and Dias (2006)</td>
<td>60-85 countries</td>
<td>domestic and transnational terrorism (location)</td>
<td>literacy rate of adult population</td>
<td>(-)/significant</td>
</tr>
<tr>
<td></td>
<td>1997-2004†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drakos and Gofas (2006b)</td>
<td>139 countries</td>
<td>transnational terrorism</td>
<td>secondary school enrollment index</td>
<td>(+)/not significant</td>
</tr>
<tr>
<td></td>
<td>1985-1999</td>
<td>(location)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Krueger and Maleckova (2003)</td>
<td>148 countries</td>
<td>transnational terrorism (origin)</td>
<td>illiteracy rate</td>
<td>(-)/not significant</td>
</tr>
<tr>
<td></td>
<td>1997-2002†</td>
<td>(location)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurrild-Klitgaard et al. (2006)</td>
<td>97-121 countries</td>
<td>transnational terrorism (location)</td>
<td>UNDP education index</td>
<td>largely (+)/not significant</td>
</tr>
<tr>
<td></td>
<td>1996-2002†</td>
<td>and origin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tavares (2004)</td>
<td>sample not reported</td>
<td>transnational terrorism</td>
<td>illiteracy of adult males</td>
<td>(-)/significant</td>
</tr>
<tr>
<td></td>
<td>1987-2001</td>
<td>(location)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testas (2004)</td>
<td>37 Muslim countries</td>
<td>transnational terrorism</td>
<td>university enrollment</td>
<td>(+)/significant</td>
</tr>
<tr>
<td></td>
<td>1968-1991†</td>
<td>(location)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urdal (2006)</td>
<td>99-158 countries</td>
<td>domestic and transnational terrorism (location)</td>
<td>tertiary education growth</td>
<td>(+)/significant</td>
</tr>
<tr>
<td></td>
<td>1984-1995</td>
<td></td>
<td>interacted with youth burden</td>
<td></td>
</tr>
</tbody>
</table>

Note: (†) indicates that the study is a pure cross-sectional analysis.
<table>
<thead>
<tr>
<th>Variable</th>
<th>N*T</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Terrorist Attacks</td>
<td>3082</td>
<td>11.049</td>
<td>42.103</td>
<td>0</td>
<td>673</td>
</tr>
<tr>
<td>Total Terrorist Attacks</td>
<td>3076</td>
<td>18.737</td>
<td>64.190</td>
<td>0</td>
<td>1041</td>
</tr>
<tr>
<td>Primary Enrollment</td>
<td>3053</td>
<td>12.146</td>
<td>4.943</td>
<td>2.94</td>
<td>35.71</td>
</tr>
<tr>
<td>Secondary Enrollment</td>
<td>3053</td>
<td>6.667</td>
<td>3.255</td>
<td>0.33</td>
<td>16.6</td>
</tr>
<tr>
<td>Prim. + Sec. Enrollment</td>
<td>3053</td>
<td>18.81</td>
<td>5.281</td>
<td>3.63</td>
<td>38.91</td>
</tr>
<tr>
<td>University Enrollment</td>
<td>3078</td>
<td>0.620</td>
<td>1.705</td>
<td>0</td>
<td>20.454</td>
</tr>
<tr>
<td>Literacy Rate</td>
<td>3045</td>
<td>77.840</td>
<td>23.307</td>
<td>8.4</td>
<td>99.9</td>
</tr>
<tr>
<td>Population Size</td>
<td>3192</td>
<td>9.239</td>
<td>1.563</td>
<td>5.437</td>
<td>14.086</td>
</tr>
<tr>
<td>Military Spending</td>
<td>2973</td>
<td>4.087</td>
<td>1.680</td>
<td>0.032</td>
<td>9.923</td>
</tr>
<tr>
<td>Strikes</td>
<td>3070</td>
<td>0.159</td>
<td>0.570</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>State Failure</td>
<td>3078</td>
<td>0.604</td>
<td>1.649</td>
<td>0</td>
<td>13.5</td>
</tr>
<tr>
<td>Religious Tensions</td>
<td>2967</td>
<td>0.244</td>
<td>0.228</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Democracy</td>
<td>3041</td>
<td>6.442</td>
<td>3.536</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Trade Openness</td>
<td>3072</td>
<td>73.593</td>
<td>47.777</td>
<td>1.035</td>
<td>441.224</td>
</tr>
<tr>
<td>External Conflict</td>
<td>2967</td>
<td>0.201</td>
<td>0.197</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 3: Education and Domestic Terrorism Activity [Full Sample]

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Education t-1</td>
<td>0.063</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>(2.85)***</td>
<td></td>
<td></td>
<td></td>
<td>(2.94)***</td>
<td></td>
</tr>
<tr>
<td>Secondary Education t-1</td>
<td>0.026</td>
<td></td>
<td></td>
<td></td>
<td>0.030</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td></td>
<td></td>
<td></td>
<td>(0.83)</td>
<td></td>
</tr>
<tr>
<td>Prim. + Sec. Education t-1</td>
<td>0.052</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2.95)***</td>
</tr>
<tr>
<td>University Enrollment t-1</td>
<td></td>
<td>-0.812</td>
<td></td>
<td></td>
<td>-0.085</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.34)</td>
<td></td>
<td></td>
<td>(1.08)</td>
<td></td>
</tr>
<tr>
<td>Literacy Rate t-1</td>
<td></td>
<td>0.016</td>
<td></td>
<td></td>
<td></td>
<td>(2.55)**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Size t-1</td>
<td>0.727</td>
<td>0.721</td>
<td>0.723</td>
<td>0.782</td>
<td>0.715</td>
<td>0.780</td>
</tr>
<tr>
<td></td>
<td>(7.40)***</td>
<td>(7.26)***</td>
<td>(7.37)***</td>
<td>(7.43)***</td>
<td>(7.27)***</td>
<td>(7.29)***</td>
</tr>
<tr>
<td>Military Spending p.c. t-1</td>
<td>0.164</td>
<td>0.113</td>
<td>0.127</td>
<td>0.160</td>
<td>0.007</td>
<td>0.176</td>
</tr>
<tr>
<td></td>
<td>(1.82)†</td>
<td>(1.19)</td>
<td>(1.44)</td>
<td>(1.75)†</td>
<td>(0.07)</td>
<td>(1.75)†</td>
</tr>
<tr>
<td>General Strikes t-1</td>
<td>0.330</td>
<td>0.352</td>
<td>0.346</td>
<td>0.336</td>
<td>0.367</td>
<td>0.321</td>
</tr>
<tr>
<td></td>
<td>(3.00)***</td>
<td>(3.19)***</td>
<td>(3.15)***</td>
<td>(2.93)***</td>
<td>(3.46)***</td>
<td>(2.92)***</td>
</tr>
<tr>
<td>State Failure t-1</td>
<td>0.500</td>
<td>0.499</td>
<td>0.491</td>
<td>0.483</td>
<td>0.486</td>
<td>0.489</td>
</tr>
<tr>
<td></td>
<td>(4.62)***</td>
<td>(4.55)***</td>
<td>(4.72)***</td>
<td>(4.41)***</td>
<td>(4.72)***</td>
<td>(4.68)***</td>
</tr>
<tr>
<td>Religious Tensions t-1</td>
<td>2.120</td>
<td>2.010</td>
<td>2.011</td>
<td>2.045</td>
<td>2.126</td>
<td>2.042</td>
</tr>
<tr>
<td></td>
<td>(4.13)***</td>
<td>(3.73)***</td>
<td>(3.86)***</td>
<td>(3.90)***</td>
<td>(4.07)***</td>
<td>(3.87)***</td>
</tr>
<tr>
<td>Democracy t-1</td>
<td>0.124</td>
<td>0.121</td>
<td>0.118</td>
<td>0.124</td>
<td>0.109</td>
<td>0.121</td>
</tr>
<tr>
<td></td>
<td>(3.24)***</td>
<td>(3.12)***</td>
<td>(3.06)***</td>
<td>(3.18)***</td>
<td>(2.65)***</td>
<td>(3.17)***</td>
</tr>
<tr>
<td>Trade Openness t-1</td>
<td>-0.003</td>
<td>-0.003</td>
<td>-0.003</td>
<td>-0.003</td>
<td>-0.003</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td>(0.96)</td>
<td>(1.06)</td>
<td>(0.81)</td>
<td>(1.01)</td>
<td>(0.96)</td>
</tr>
<tr>
<td>External Conflict t-1</td>
<td>1.716</td>
<td>1.726</td>
<td>1.848</td>
<td>1.744</td>
<td>1.969</td>
<td>1.898</td>
</tr>
<tr>
<td></td>
<td>(3.62)***</td>
<td>(3.75)***</td>
<td>(3.88)***</td>
<td>(3.79)***</td>
<td>(4.59)***</td>
<td>(3.96)***</td>
</tr>
<tr>
<td>Log Pseudolikelihood</td>
<td>-5463.60</td>
<td>-5477.71</td>
<td>-5464.66</td>
<td>-5496.28</td>
<td>-5472.10</td>
<td>-5459.24</td>
</tr>
<tr>
<td>N*T</td>
<td>2692</td>
<td>2692</td>
<td>2692</td>
<td>2702</td>
<td>2686</td>
<td>2692</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is the number of domestic terrorist incidents. Robust absolute z-values clustered on countries reported in parentheses. Constant not reported. All models include time and regional dummies (not reported). (*), (**) and (***)) indicate significance at the 10%, 5% and 1% levels, respectively.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law and Order</td>
<td>-0.579</td>
<td>0.993</td>
<td>0.668</td>
<td>0.620</td>
</tr>
<tr>
<td>Corruption</td>
<td>0.507</td>
<td>-0.869</td>
<td>0.579</td>
<td>0.974</td>
</tr>
<tr>
<td>Government Size</td>
<td>0.050</td>
<td>-0.085</td>
<td>1.164</td>
<td>0.628</td>
</tr>
<tr>
<td>Physical Integrity</td>
<td>-0.544</td>
<td>0.932</td>
<td>0.773</td>
<td>0.558</td>
</tr>
<tr>
<td>Population Density</td>
<td>-0.127</td>
<td>0.218</td>
<td>0.217</td>
<td>1.610</td>
</tr>
<tr>
<td>Population Growth</td>
<td>0.288</td>
<td>-0.493</td>
<td>0.826</td>
<td>1.085</td>
</tr>
<tr>
<td>Urbanization</td>
<td>-0.474</td>
<td>0.813</td>
<td>0.876</td>
<td>0.596</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.586</td>
<td>0.813</td>
<td>0.277</td>
<td>0.992</td>
</tr>
<tr>
<td>Economic Growth</td>
<td>-0.229</td>
<td>0.393</td>
<td>1.115</td>
<td>0.593</td>
</tr>
<tr>
<td>Property Rights Protection</td>
<td>-0.588</td>
<td>1.008</td>
<td>0.714</td>
<td>0.475</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.160</td>
<td>-0.275</td>
<td>1.229</td>
<td>0.134</td>
</tr>
<tr>
<td>Female Labor Participation</td>
<td>-0.038</td>
<td>0.064</td>
<td>0.985</td>
<td>1.033</td>
</tr>
<tr>
<td>Cluster Distribution</td>
<td>N=84 (63.2%)</td>
<td>N=49 (36.8%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Results of the two-step cluster analysis. Optimal number of clusters automatically chosen based on Schwarz’s Bayesian Criterion. Variables were averaged over respective period of observation and standardized before analysis. See text for a discussion of variables.
### Table 5: Education and Domestic Terrorism [Subsample of Less Developed Countries]

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Education $t_{-1}$</td>
<td>0.068</td>
<td>0.069</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.88)***</td>
<td>(2.86)***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary Education $t_{-1}$</td>
<td>0.039</td>
<td>0.047</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td>(1.31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prim. + Sec. Education $t_{-1}$</td>
<td>0.065</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.37)***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University Enrollment $t_{-1}$</td>
<td></td>
<td>-0.095</td>
<td>-0.020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.72)</td>
<td>(0.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literacy Rate $t_{-1}$</td>
<td></td>
<td>0.011</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.81)†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population Size $t_{-1}$</td>
<td>0.585</td>
<td>0.552</td>
<td>0.573</td>
<td>0.624</td>
<td>0.546</td>
<td>0.589</td>
</tr>
<tr>
<td></td>
<td>(5.05)***</td>
<td>(4.90)***</td>
<td>(5.19)***</td>
<td>(5.53)***</td>
<td>(4.75)***</td>
<td>(5.10)***</td>
</tr>
<tr>
<td>Military Spending p.c. $t_{-1}$</td>
<td>0.167</td>
<td>0.108</td>
<td>0.103</td>
<td>0.188</td>
<td>0.067</td>
<td>0.130</td>
</tr>
<tr>
<td></td>
<td>(1.64)†</td>
<td>(1.05)</td>
<td>(1.00)</td>
<td>(1.59)</td>
<td>(0.60)</td>
<td>(1.01)</td>
</tr>
<tr>
<td>General Strikes $t_{-1}$</td>
<td>0.211</td>
<td>0.247</td>
<td>0.217</td>
<td>0.235</td>
<td>0.276</td>
<td>0.212</td>
</tr>
<tr>
<td></td>
<td>(1.99)**</td>
<td>(2.40)**</td>
<td>(2.15)**</td>
<td>(2.11)**</td>
<td>(2.68)**</td>
<td>(2.00)**</td>
</tr>
<tr>
<td>State Failure $t_{-1}$</td>
<td>0.521</td>
<td>0.521</td>
<td>0.514</td>
<td>0.504</td>
<td>0.501</td>
<td>0.514</td>
</tr>
<tr>
<td></td>
<td>(4.67)***</td>
<td>(4.58)***</td>
<td>(4.94)***</td>
<td>(4.33)***</td>
<td>(4.55)***</td>
<td>(4.85)***</td>
</tr>
<tr>
<td>Religious Tensions $t_{-1}$</td>
<td>1.917</td>
<td>1.726</td>
<td>1.810</td>
<td>1.734</td>
<td>1.898</td>
<td>1.838</td>
</tr>
<tr>
<td></td>
<td>(3.62)***</td>
<td>(3.16)***</td>
<td>(3.38)***</td>
<td>(3.26)***</td>
<td>(3.42)***</td>
<td>(3.43)***</td>
</tr>
<tr>
<td>Democracy $t_{-1}$</td>
<td>0.209</td>
<td>0.207</td>
<td>0.212</td>
<td>0.204</td>
<td>0.196</td>
<td>0.211</td>
</tr>
<tr>
<td></td>
<td>(6.44)***</td>
<td>(5.84)***</td>
<td>(6.55)***</td>
<td>(5.85)***</td>
<td>(5.29)***</td>
<td>(6.52)***</td>
</tr>
<tr>
<td>Trade Openness $t_{-1}$</td>
<td>-0.005</td>
<td>-0.006</td>
<td>-0.006</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(1.46)</td>
<td>(1.50)</td>
<td>(1.70)†</td>
<td>(1.30)</td>
<td>(1.47)</td>
<td>(1.57)</td>
</tr>
<tr>
<td>External Conflict $t_{-1}$</td>
<td>2.155</td>
<td>2.124</td>
<td>2.377</td>
<td>1.987</td>
<td>2.199</td>
<td>2.329</td>
</tr>
<tr>
<td></td>
<td>(4.58)***</td>
<td>(4.66)***</td>
<td>(4.85)***</td>
<td>(4.47)***</td>
<td>(4.78)***</td>
<td>(4.80)***</td>
</tr>
<tr>
<td>Log Pseudolikelihood</td>
<td>-3672.92</td>
<td>-3686.66</td>
<td>-3670.66</td>
<td>-3707.86</td>
<td>-3700.90</td>
<td>-3670.22</td>
</tr>
<tr>
<td>N*T</td>
<td>1700</td>
<td>1700</td>
<td>1700</td>
<td>1710</td>
<td>1703</td>
<td>1700</td>
</tr>
</tbody>
</table>

**Notes:** Dependent variable is the number of domestic terrorist incidents. Robust absolute z-values clustered on countries reported in parentheses. Constant not reported. All models include time and regional dummies (not reported). (*), (**) and (***)) indicate significance at the 10%, 5% and 1% levels, respectively.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Education $t_{-1}$</td>
<td>0.061</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.11)</td>
</tr>
<tr>
<td>Secondary Education $t_{-1}$</td>
<td>-0.107</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.091</td>
</tr>
<tr>
<td></td>
<td>(1.17)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.94)</td>
</tr>
<tr>
<td>Prim. + Sec. Education $t_{-1}$</td>
<td>-0.003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University Enrollment $t_{-1}$</td>
<td></td>
<td>-0.132</td>
<td></td>
<td></td>
<td>-0.183</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.37)&quot;</td>
<td></td>
<td></td>
<td>(3.02)&quot;***</td>
<td></td>
</tr>
<tr>
<td>Literacy Rate $t_{-1}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.041</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.13)</td>
<td></td>
</tr>
<tr>
<td>Population Size $t_{-1}$</td>
<td>0.940</td>
<td>0.921</td>
<td>0.927</td>
<td>1.062</td>
<td>0.877</td>
<td>1.108</td>
</tr>
<tr>
<td></td>
<td>(4.30)***</td>
<td>(4.42)***</td>
<td>(4.32)***</td>
<td>(4.66)***</td>
<td>(4.21)***</td>
<td>(5.07)***</td>
</tr>
<tr>
<td>Military Spending p.c. $t_{-1}$</td>
<td>-0.442</td>
<td>-0.472</td>
<td>-0.484</td>
<td>-0.461</td>
<td>-0.487</td>
<td>-0.401</td>
</tr>
<tr>
<td></td>
<td>(1.77)*</td>
<td>(1.87)*</td>
<td>(1.95)*</td>
<td>(1.92)*</td>
<td>(1.98)**</td>
<td>(1.65)*</td>
</tr>
<tr>
<td>General Strikes $t_{-1}$</td>
<td>0.404</td>
<td>0.396</td>
<td>0.423</td>
<td>0.397</td>
<td>0.377</td>
<td>0.349</td>
</tr>
<tr>
<td></td>
<td>(2.29)&quot;**</td>
<td>(2.22)&quot;**</td>
<td>(2.17)&quot;**</td>
<td>(2.04)&quot;**</td>
<td>(2.14)&quot;**</td>
<td>(2.18)&quot;**</td>
</tr>
<tr>
<td>State Failure $t_{-1}$</td>
<td>1.397</td>
<td>1.517</td>
<td>1.420</td>
<td>1.361</td>
<td>1.363</td>
<td>1.406</td>
</tr>
<tr>
<td></td>
<td>(5.08)***</td>
<td>(5.58)***</td>
<td>(5.26)***</td>
<td>(4.91)***</td>
<td>(5.11)***</td>
<td>(5.20)***</td>
</tr>
<tr>
<td>Religious Tensions $t_{-1}$</td>
<td>2.302</td>
<td>2.731</td>
<td>2.420</td>
<td>2.525</td>
<td>2.446</td>
<td>2.694</td>
</tr>
<tr>
<td></td>
<td>(1.80)*</td>
<td>(2.07)&quot;*</td>
<td>(1.85)*</td>
<td>(1.98)&quot;*</td>
<td>(2.06)&quot;*</td>
<td>(1.93)*</td>
</tr>
<tr>
<td>Democracy $t_{-1}$</td>
<td>-0.127</td>
<td>-0.137</td>
<td>-0.140</td>
<td>-0.144</td>
<td>-0.189</td>
<td>-0.127</td>
</tr>
<tr>
<td></td>
<td>(1.97)&quot;**</td>
<td>(2.05)&quot;**</td>
<td>(2.13)&quot;**</td>
<td>(2.13)&quot;**</td>
<td>(3.09)&quot;***</td>
<td>(1.86)*</td>
</tr>
<tr>
<td>Trade Openness $t_{-1}$</td>
<td>-0.003</td>
<td>-0.004</td>
<td>-0.004</td>
<td>-0.003</td>
<td>-0.004</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.73)</td>
<td>(1.03)</td>
<td>(0.88)</td>
<td>(0.74)</td>
<td>(0.99)</td>
<td>(0.57)</td>
</tr>
<tr>
<td>External Conflict $t_{-1}$</td>
<td>2.526</td>
<td>2.333</td>
<td>2.789</td>
<td>3.178</td>
<td>3.250</td>
<td>2.590</td>
</tr>
<tr>
<td></td>
<td>(2.35)&quot;**</td>
<td>(2.16)&quot;**</td>
<td>(2.75)***</td>
<td>(3.17)***</td>
<td>(3.16)***</td>
<td>(2.42)&quot;*</td>
</tr>
<tr>
<td>Log Pseudolikelihood</td>
<td>-1734.53</td>
<td>-1733.23</td>
<td>-1736.75</td>
<td>-1731.52</td>
<td>-1721.00</td>
<td>-1724.02</td>
</tr>
<tr>
<td>N*T</td>
<td>992</td>
<td>992</td>
<td>992</td>
<td>992</td>
<td>983</td>
<td>992</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is the number of domestic terrorist incidents. Robust absolute z-values clustered on countries reported in parentheses. Constant not reported. All models include time and regional dummies (not reported). (*), (**) and (***) indicate significance at the 10%, 5% and 1% levels, respectively.
### Appendix A. List of Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Country</th>
<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>Egypt</td>
<td>Lebanon</td>
<td>Saudi Arabia†</td>
</tr>
<tr>
<td>Algeria</td>
<td>El Salvador</td>
<td>Liberia</td>
<td>Senegal</td>
</tr>
<tr>
<td>Angola</td>
<td>Estonia†</td>
<td>Libya</td>
<td>Sierra Leone</td>
</tr>
<tr>
<td>Argentina</td>
<td>Ethiopia</td>
<td>Lithuania†</td>
<td>Singapore†</td>
</tr>
<tr>
<td>Armenia</td>
<td>Finland†</td>
<td>Luxembourg†</td>
<td>Slovak Republic†</td>
</tr>
<tr>
<td>Australia†</td>
<td>France†</td>
<td>Madagascar</td>
<td>Slovenia†</td>
</tr>
<tr>
<td>Austria†</td>
<td>Gabon</td>
<td>Malawi</td>
<td>Somalia</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>Gambia</td>
<td>Malaysia</td>
<td>South Africa</td>
</tr>
<tr>
<td>Bahamas†</td>
<td>Germany†</td>
<td>Mali</td>
<td>Spain†</td>
</tr>
<tr>
<td>Bahrain†</td>
<td>Ghana</td>
<td>Malta†</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Greece†</td>
<td>Mexico</td>
<td>Sudan</td>
</tr>
<tr>
<td>Belarus</td>
<td>Guatemala</td>
<td>Moldova</td>
<td>Sweden†</td>
</tr>
<tr>
<td>Belgium†</td>
<td>Guinea</td>
<td>Mongolia</td>
<td>Switzerland†</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Guinea-Bissau</td>
<td>Morocco</td>
<td>Syria</td>
</tr>
<tr>
<td>Botswana†</td>
<td>Guyana</td>
<td>Mozambique</td>
<td>Tanzania</td>
</tr>
<tr>
<td>Brazil</td>
<td>Haiti</td>
<td>Namibia</td>
<td>Thailand</td>
</tr>
<tr>
<td>Bulgaria†</td>
<td>Honduras</td>
<td>Netherlands†</td>
<td>Togo</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>Hungary†</td>
<td>New Zealand†</td>
<td>Trinidad &amp; Tobago</td>
</tr>
<tr>
<td>Cameroon</td>
<td>Iceland†</td>
<td>Nicaragua</td>
<td>Tunisia</td>
</tr>
<tr>
<td>Canada†</td>
<td>India</td>
<td>Niger</td>
<td>Turkey</td>
</tr>
<tr>
<td>Chile†</td>
<td>Indonesia</td>
<td>Nigeria</td>
<td>Uganda</td>
</tr>
<tr>
<td>China</td>
<td>Iran</td>
<td>Norway†</td>
<td>Ukraine</td>
</tr>
<tr>
<td>Colombia</td>
<td>Iraq</td>
<td>Oman†</td>
<td>United Arab Emirates†</td>
</tr>
<tr>
<td>Congo (Republic)</td>
<td>Ireland†</td>
<td>Pakistan</td>
<td>United Kingdom†</td>
</tr>
<tr>
<td>Congo (Zaire)</td>
<td>Israel†</td>
<td>Panama</td>
<td>United States†</td>
</tr>
<tr>
<td>Costa Rica†</td>
<td>Italy†</td>
<td>Papua New Guinea</td>
<td>Uruguay†</td>
</tr>
<tr>
<td>Cote d’Ivoire</td>
<td>Jamaica</td>
<td>Paraguay</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Croatia†</td>
<td>Japan†</td>
<td>Peru</td>
<td>Vietnam</td>
</tr>
<tr>
<td>Cuba</td>
<td>Jordan</td>
<td>Philippines</td>
<td>Yemen</td>
</tr>
<tr>
<td>Cyprus†</td>
<td>Kazakhstan</td>
<td>Poland†</td>
<td>Zambia</td>
</tr>
<tr>
<td>Czech Republic†</td>
<td>Kenya</td>
<td>Portugal†</td>
<td>Zimbabwe</td>
</tr>
<tr>
<td>Denmark†</td>
<td>Korea (South)†</td>
<td>Qatar†</td>
<td></td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Kuwait†</td>
<td>Romania</td>
<td></td>
</tr>
<tr>
<td>Ecuador</td>
<td>Latvia†</td>
<td>Russia</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** (†) indicates that the country is included in the subsample of developed countries. The others are included in the subsample of less developed countries. See text for a further discussion.
Appendix B. Control and Cluster Analysis Variables


General Strikes – Source: Cross-National Time-Series Data Archive (http://www.databanksinternational.com). Definition: Any strike of 1,000 or more industrial or service workers that involves more than one employer and that is aimed at national government policies or authority. Unit: Number.


Religious Tensions – Source: International Country Risk Guide (http://www.prsgroup.com/ICRG.aspx). Definition: Assessment of the degree of tension within a country attributable to religious divisions. Unit: Score, rescaled to values in [0,1], with higher values indicating stronger tensions.

Democracy – Source: PolityIV Project (http://www.systemicpeace.org/polity/polity4.htm). Definition: Combined polity score of institutionalized democracy score minus institutionalized autocracy score with converted instances of ‘standardized authority scores’ to conventional polity scores. Unit: Score, rescaled to values in [0,10], with higher values indicating higher levels of democracy.

Trade Openness – Source: Penn World. Definition: Exports plus imports to real GDP per capita, i.e., total trade as percentage of GDP. Unit: Ratio.

External Conflict – Source: International Country Risk Guide. Definition: An assessment of the risk to the incumbent government from foreign action, ranging from non-violent external pressure (diplomatic pressures, territorial disputes, sanctions, etc) to violent external pressure (cross-border conflicts to all-out war). Unit: Score, rescaled to values in [0,1], with higher values indicating higher risk of external conflict.

Law and Order – Source: International Country Risk Guide. Definition: An assessment of the strength and impartiality of the legal system and of the popular observance of the law. Unit: Score, rescaled to values in [0,1], with higher values meaning a stronger rule of law.

Corruption – Source: International Country Risk Guide. Definition: Measures actual or potential corruption in the form of excessive patronage, nepotism, job reservations, ‘favor-for-favors’, secret party funding, and close ties between politics and business. Unit: Score, rescaled to values in [0,1], with higher values indicating more corruption.
5.7 Tables, Appendices and Supplements

\textit{Government Size} – Source: Penn World Table. Definition: Share of government consumption to real GDP. Unit: Ratio.

\textit{Physical Integrity Index} – Source: CIRI Human Rights Data Project (http://ciri.binghamton.edu). Definition: Additive index summarizing government respect for disappearance, extrajudicial killing, political imprisonment, and torture. Unit: Ratio, with higher values indicating a better human rights situation.


\textit{Economic Growth} – Source: Penn World Table. Definition: Growth rate of real GDP per capita in constant prices. Unit: Growth rate.

\textit{Economic Rights} – Source: International Country Risk Guide. Definition: An assessment of factors affecting the risk to investment that are not covered by other political, economic and financial risk components. Risk rating assigned as the sum of three subcomponents (contract viability/expropriation, profits repatriation, payment delays). Unit: Score, rescaled to values in [0,1], with higher values indicating better property rights protection.

\textit{Inflation} – Source: World Development Indicators. Definition: Inflation measured by the annual growth rate of the GDP implicit deflator, showing the rate of price change in the economy as a whole. Unit: Growth rate.

\textit{Female Labor Participation} – Source: World Development Indicators. Definition: Shows the extent to which women are active in the labor force. Unit: Percentage of the total labor force.
Supplementary Tables

Table S1: Education and Total Terrorist Activity

<table>
<thead>
<tr>
<th>Model</th>
<th>Education Variable(s)</th>
<th>Full Sample</th>
<th>Developed Countries</th>
<th>Less Developed Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Primary Education_{t-1}</td>
<td>0.058</td>
<td>0.024</td>
<td>0.067</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.74)***</td>
<td>(0.40)</td>
<td>(3.00)***</td>
</tr>
<tr>
<td>(2)</td>
<td>Secondary Education_{t-1}</td>
<td>0.018</td>
<td>-0.049</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.51)</td>
<td>(0.59)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>(3)</td>
<td>Prim. + Sec. Education_{t-1}</td>
<td>0.045</td>
<td>-0.009</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.60)***</td>
<td>(0.16)</td>
<td>(3.08)***</td>
</tr>
<tr>
<td>(4)</td>
<td>University Enrollment_{t-1}</td>
<td>-0.095</td>
<td>-0.144</td>
<td>-0.088</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.66)*</td>
<td>(3.15)***</td>
<td>(0.72)</td>
</tr>
<tr>
<td>(5)</td>
<td>Literacy Rate_{t-1}</td>
<td>0.014</td>
<td>0.037</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.35)**</td>
<td>(1.15)</td>
<td>(1.78)*</td>
</tr>
<tr>
<td>(6)</td>
<td>Primary Education_{t-1}</td>
<td>0.058</td>
<td>0.045</td>
<td>0.067</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.78)***</td>
<td>(0.81)</td>
<td>(2.93)***</td>
</tr>
<tr>
<td></td>
<td>Secondary Education_{t-1}</td>
<td>0.018</td>
<td>-0.045</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.52)</td>
<td>(0.53)</td>
<td>(0.53)</td>
</tr>
<tr>
<td></td>
<td>University Enrollment_{t-1}</td>
<td>-0.099</td>
<td>-0.175</td>
<td>-0.024</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.36)</td>
<td>(3.33)***</td>
<td>(0.17)</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is the total (i.e., domestic and transnational) number of terrorist incidents. Table reports only coefficient for respective education proxy from a pooled NB regression of total terrorism on lagged values of the controls and on the respective education variable. Other model specifications (inclusion of regional and time dummies, control variables) as in Table 3. Robust absolute z-values clustered on countries reported in parentheses. (*), (**) and (***)) indicate significance at the 10%, 5% and 1% levels, respectively.
Table S2: Results from Alternative Estimation Techniques

<table>
<thead>
<tr>
<th>Model</th>
<th>Education Variable(s)</th>
<th>Full Sample</th>
<th>Developed Countries</th>
<th>Less Developed Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Zero-Inflated Negative Binomial Regression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>Primary Education t-1</td>
<td>0.064</td>
<td>0.010</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.89)***</td>
<td>(0.14)</td>
<td>(3.06)***</td>
</tr>
<tr>
<td>(2)</td>
<td>Secondary Education t-1</td>
<td>0.029</td>
<td>-0.129</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.77)</td>
<td>(1.30)</td>
<td>(1.09)</td>
</tr>
<tr>
<td>(3)</td>
<td>Prim. + Sec. Education t-1</td>
<td>0.054</td>
<td>-0.057</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.12)***</td>
<td>(0.95)</td>
<td>(3.66)***</td>
</tr>
<tr>
<td>(4)</td>
<td>University Enrollment t-1</td>
<td>-0.092</td>
<td>-0.168</td>
<td>-0.111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.58)</td>
<td>(3.10)***</td>
<td>(0.81)</td>
</tr>
<tr>
<td>(5)</td>
<td>Literacy Rate t-1</td>
<td>0.015</td>
<td>-0.013</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.39)**</td>
<td>(0.22)</td>
<td>(1.73)*</td>
</tr>
<tr>
<td>(6)</td>
<td>Primary Education t-1</td>
<td>0.066</td>
<td>0.016</td>
<td>0.073</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.05)***</td>
<td>(0.26)</td>
<td>(3.02)***</td>
</tr>
<tr>
<td></td>
<td>Secondary Education t-1</td>
<td>0.031</td>
<td>-0.147</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.85)</td>
<td>(1.48)</td>
<td>(1.31)</td>
</tr>
<tr>
<td></td>
<td>University Enrollment t-1</td>
<td>-0.099</td>
<td>-0.197</td>
<td>-0.034</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.34)</td>
<td>(3.49)***</td>
<td>(0.21)</td>
</tr>
<tr>
<td><strong>Panel B: Generalized Estimation Equation Regression with AR(1) term</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>Primary Education t-1</td>
<td>0.050</td>
<td>0.109</td>
<td>0.054</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.65)***</td>
<td>(1.22)</td>
<td>(2.69)***</td>
</tr>
<tr>
<td>(2)</td>
<td>Secondary Education t-1</td>
<td>0.041</td>
<td>-0.012</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.07)</td>
<td>(0.18)</td>
<td>(0.90)</td>
</tr>
<tr>
<td>(3)</td>
<td>Prim. + Sec. Education t-1</td>
<td>0.044</td>
<td>0.023</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.50)**</td>
<td>(0.26)</td>
<td>(2.99)***</td>
</tr>
<tr>
<td>(4)</td>
<td>University Enrollment t-1</td>
<td>-0.097</td>
<td>-0.081</td>
<td>-0.137</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.39)**</td>
<td>(1.49)</td>
<td>(1.68)*</td>
</tr>
<tr>
<td>(5)</td>
<td>Literacy Rate t-1</td>
<td>0.012</td>
<td>0.054</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.95)*</td>
<td>(2.12)**</td>
<td>(1.77)*</td>
</tr>
<tr>
<td>(6)</td>
<td>Primary Education t-1</td>
<td>0.052</td>
<td>0.138</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.64)***</td>
<td>(1.42)</td>
<td>(2.55)**</td>
</tr>
<tr>
<td></td>
<td>Secondary Education t-1</td>
<td>0.040</td>
<td>0.016</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.12)</td>
<td>(0.23)</td>
<td>(1.04)</td>
</tr>
<tr>
<td></td>
<td>University Enrollment t-1</td>
<td>-0.098</td>
<td>-0.152</td>
<td>-0.092</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.17)**</td>
<td>(1.99)**</td>
<td>(1.05)</td>
</tr>
</tbody>
</table>

Notes: Dependent variable is the number of domestic terrorist incidents. Table reports only coefficient for respective education proxy from a pooled zero-inflated NB regression (Panel A) and a panel generalized estimation equation model (Panel B). Inflation variable in Panel A is democracy. In Panel B it is controlled for an AR(1) term. Other model specifications (inclusion of regional and time dummies, control variables) as in Table 3. Robust absolute z-values clustered on countries reported in parentheses. (*), (**) and (***)) indicate significance at the 10%, 5% and 1% levels, respectively.
Table S3: Long-Run Effect of Education on Domestic Terrorism

<table>
<thead>
<tr>
<th>Model</th>
<th>Education Variable(s)</th>
<th>Full Sample</th>
<th>Developed Countries</th>
<th>Less Developed Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Primary Education (t_{-1})</td>
<td>0.052</td>
<td>0.006</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.41)&quot;</td>
<td>(0.08) (2.49)&quot;</td>
</tr>
<tr>
<td>(2)</td>
<td>Secondary Education (t_{-1})</td>
<td>0.019</td>
<td>-0.028</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.47)</td>
<td>(0.30) (0.02)</td>
</tr>
<tr>
<td>(3)</td>
<td>Prim.+Sec. Education (t_{-1})</td>
<td>0.044</td>
<td>-0.019</td>
<td>0.044</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.46)&quot;</td>
<td>(0.27) (2.32)&quot;</td>
</tr>
<tr>
<td>(4)</td>
<td>University Enrollment (t_{-1})</td>
<td>-0.076</td>
<td>-0.168</td>
<td>-0.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.06)</td>
<td>(1.98)&quot; (0.19)</td>
</tr>
<tr>
<td>(5)</td>
<td>Literacy Rate (t_{-1})</td>
<td>0.014</td>
<td>0.063</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.97)&quot;</td>
<td>(1.19) (1.29)</td>
</tr>
<tr>
<td>(6)</td>
<td>Primary Education (t_{-1})</td>
<td>0.053</td>
<td>0.034</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.50)&quot;</td>
<td>(0.43) (2.38)&quot;</td>
</tr>
<tr>
<td></td>
<td>Secondary Education (t_{-1})</td>
<td>0.021</td>
<td>-0.024</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.54)</td>
<td>(0.232) (0.13)</td>
</tr>
<tr>
<td></td>
<td>University Enrollment (t_{-1})</td>
<td>-0.084</td>
<td>-0.188</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.94)</td>
<td>(2.12)&quot; (0.08)</td>
</tr>
</tbody>
</table>

Notes: Table reports only coefficient for respective education proxy from a pooled NB regression of six-year averages of terrorism on contemporaneous values of the controls and on lagged values (i.e., average values of education in the previous six-year period) of the respective education variable. Other model specifications (dependent variable, inclusion of regional and time dummies, control variables) as in Table 3. Robust absolute z-values clustered on countries reported in parentheses. (**) indicates significance at 5%.
### Table S4: Changes in Education and Domestic Terrorism

<table>
<thead>
<tr>
<th>Model</th>
<th>Education Variable(s)</th>
<th>Full Sample</th>
<th>Developed Countries</th>
<th>Less Developed Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Δ Primary Education</td>
<td>0.303</td>
<td>-0.600</td>
<td>0.464</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.59)</td>
<td>(1.83)*</td>
<td>(2.33)**</td>
</tr>
<tr>
<td>(2)</td>
<td>Δ Secondary Education</td>
<td>0.089</td>
<td>-0.373</td>
<td>0.341</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.47)</td>
<td>(1.67)*</td>
<td>(1.57)</td>
</tr>
<tr>
<td>(3)</td>
<td>Δ Prim. + Sec. Education</td>
<td>0.113</td>
<td>-0.113</td>
<td>0.328</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.51)</td>
<td>(1.54)</td>
<td>(2.41)**</td>
</tr>
<tr>
<td>(4)</td>
<td>Δ University Enrollment</td>
<td>-1.081</td>
<td>-2.239</td>
<td>-1.058</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.26)</td>
<td>(2.16)**</td>
<td>(1.62)</td>
</tr>
<tr>
<td>(5)</td>
<td>Δ Literacy Rate</td>
<td>-0.224</td>
<td>-0.665</td>
<td>-0.149</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.42)**</td>
<td>(1.81)*</td>
<td>(1.81)*</td>
</tr>
<tr>
<td>(6)</td>
<td>Δ Primary Education</td>
<td>0.292</td>
<td>-0.831</td>
<td>0.439</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.51)</td>
<td>(2.33)**</td>
<td>(2.22)**</td>
</tr>
<tr>
<td></td>
<td>Δ Secondary Education</td>
<td>0.083</td>
<td>-0.402</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.47)</td>
<td>(1.81)*</td>
<td>(1.37)</td>
</tr>
<tr>
<td></td>
<td>Δ University Enrollment</td>
<td>-0.940</td>
<td>-2.003</td>
<td>-0.692</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.02)</td>
<td>(1.89)*</td>
<td>(0.82)</td>
</tr>
</tbody>
</table>

**Notes:** Table reports only coefficient for respective education proxy from a pooled NB regression of domestic terrorism on lagged values of the controls and on changes in the respective education variable. Change (Δ) is defined as the difference between two periods. Other model specifications (inclusion of regional and time dummies, control variables) as in Table 3. Robust absolute z-values clustered on countries reported in parentheses. (*), (**) and (***) indicate significance at the 10%, 5% and 1% levels, respectively.