UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE POLITICAL ECONOMY OF DEMILITARIZATION

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

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Norman, Oklahoma
2022

THE POLITICAL ECONOMY OF DEMILITARIZATION

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF ECONOMICS

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DEDICATION

to:

My fiancé, Annie, for your constant encouragement, belief, support, and love. No one does this alone. This accomplishment is every bit as much yours as it is mine.

My mother, Lori, for always believing in me. I would never have accomplished this without your love and support. Cheers to the greatest math teacher I have ever had.

My brother, Brody, for always being there for me when I needed you most. No matter the time or distance, a brother is the person you can always count on.

My grandparents, George and Marianne, for inspiring another generation to higher education. You are the rock our family is built on and the guiding example of the value of kindness, sincerity, and the pursuit of knowledge.

All of my family and friends for their never-ending support and encouragement.

Acknowledgements

I would like to thank Daniel Hicks and Kevin Kuruc for their invaluable mentorship throughout this project. You both showed me what it means to be a dedicated economist and how we may use our abilities to impact others in a positive way. I would also like to thank my doctoral advisor, Cynthia Rogers, for her guidance, support, and kindness in a discipline that so often lacks it. I would like to thank my committee members Joan Hamory and Mark Raymond. Your scholarship and instruction have been invaluable throughout this process and I can't thank you both enough. I would like to thank my department chair, Greg Burge, for taking a chance on me and accepting me into the PhD program. I hope I have lived up to your expectations and made a positive impact on future generations of OU graduate students. Additionally, I would like to thank Gary Hoover, Firat Demir, MJ Yeung, Jonathan McFadden, Pallab Ghosh, Tyler Ransom, Hewei Shen, Brent Norwood, seminar participants at the University of Oklahoma, Center for Naval Analyses, Department of Defense, RAND Corporation, and several anonymous referees for helpful comments, feedback, and suggestions. Finally, I would like to thank the NASA Land-Cover and Land-Use Change Program and the University of Oklahoma for their generous funding of my scholarly pursuit. All remaining errors are my own.

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Abstract

This dissertation studies the economic implications of demilitarization. My primary contributions include: (1) defining demilitarization statistically and creating a novel dataset of military transitions, (2) empirically testing the impact of demilitarization on economic growth, (3) identifying a relationship between demilitarization and international trade, and (4) providing a case study on the economic impact of militarization in contrast with my findings on demilitarization.

In chapter one, I create the novel dataset of military transitions since 1960 and measure the economic growth effect of demilitarization in countries that reduced their military capabilities and subsided aggressive or violent behavior. I estimate that on average, demilitarization is associated with a 1% higher annual GDP per capita than if the country had remained militarized. Dynamic analysis shows that on average, GDP per capita is 15-20% higher 20 years after transition.

In chapter two, I assemble a panel dataset from the last 140 years of bilateral international trade flows, formal military alliances, and military capacity, in order to study the relationship between trade and demilitarization. I uncover three stylized facts: (1) entry into formal defense agreements corresponds with reduced military capacity, (2) dyadic country pairs trade more when they are engaged in a formal military alliance, and (3) gains in trade from formal alliances are larger when country pairs reduce military capacity.

Finally, in chapter three, I estimate the economic effect of militarization. Using Pakistan's nuclear proliferation efforts beginning in 1972 as a case study, I perform a synthetic control analysis and find that Pakistan's economy was 27.8 percent smaller than expected, 25-years after the start of the nuclear program.

Chapter 1

Demilitarization and Economic Growth

Demilitarization is a movement away from a society organized for violent conflict. There are relatively few historical examples of demilitarization as governments throughout the world have assumed that peace and economic prosperity would be the product of more weapons, not fewer [Rubenstein, 2010].[1]

However, in recent decades, there is evidence to suggest that countries may be beginning to move away from this belief [Stearns, 2013]. A popular theory held by academics and policymakers to explain this movement is a realization of economic gains as a result of demilitarization. Otherwise known as the Peace Dividend.[2] Despite the importance of the decision to unwind conflict-oriented institutions, little is known about repercussions on the macroeconomy.[3]

In this paper, I estimate the effect of demilitarization on economic growth with a novel dataset of military transitions since 1960. Semiparametric difference-in-difference and instrumental variable estimates predict that on average, demilitarizations are associated with a 1% higher annual GDP per capita than if the country had remained militarized. Dynamic analysis shows that on average, GDP per capita is 15-20% higher 20 years after transition. My findings give empirical credibility to the theory of a Peace Dividend.

I begin by documenting the institutional factors that determine if a country is in a militarized or demilitarized state. Previous work has focused almost solely on the military capabilities of a country as reference for which state the country is in. Here, the literature on democratization provides some guidance. It would be too narrow to define democracy as just having elections [Papaioannou and Siourounis, 2008]. Instead, democracy is the combination of several institutions working in a representative and equitable manner for the people of a state. Much in the same way, demilitarization is a broader concept that includes multiple institutions being redirected from violent conflict to a greater concentration on a peaceful society [Naidu, 1985].

To identify military transitions, I look at military structure and behavior in addition to capabilities for a broader interpretation. Section 2.2 presents seven key indicators used to determine the state of these institutions. Coverage includes 147 countries from 1960-2019, a significant increase over similar datasets like the Global Militarization Index. Using variation in the persistence of these indicators, I am able to find points of transition across countries. I combine this quantitative measure with qualitative findings to properly identify the point in time when a country transitions from militarized to demilitarized, as well as the intensity of that transition.[4] In total, I identify 53 cases of permanent demilitarization. 32 of these cases are categorized as 'strong' while a 19 are considered 'weak'. I also find 12 cases of permanent militarization and 5 cases of reversal.

Determining which estimation technique to apply to this question and new dataset requires thought given the challenges of identification on cross-country data. A commonly used approach is Difference-in-Differences (DiD). There are several econometric circumstances that prevent this approach from returning a reliable estimation. For example, demilitarized countries differ from militarized countries along many unobserved dimensions including institutional, historical, and cultural factors, all of which could impact income. In figure 1.2, I show the difference in GDP between countries that demilitarize and countries remaining militarized. Demilitarizing countries experience a dip in output prior to transition which is a violation of the critical parallel trends assumption (Ashenfelter Dip) in the DiD framework.[5] Furthermore, selection into demilitarization is an endogenous choice. Countries make the decision to reduce their military capacity based on observable factors, not because of randomization.

The semiparametric treatment effects framework pioneered by Abadie [2005] is ideal for these conditions. In this application of DiD, randomization of treatment is not possible. Treatment is instead selective on observable covariates. The semiparametric method models random selection into treatment by re-weighting untreated (militarized) units to have parallel trends to units undergoing treatment (demilitarization). Essentially, this produces a random treatment given that treated and untreated units are nearly identical in the pre-treatment period. I choose the semiparametric estimator proposed by Callaway and Sant'Anna, that I will refer to as CSDiD, because it specifically deals with staggered adoption. Recent work from Goodman-Bacon [2021] has shown that when treatment in a DiD framework is not adopted in the same time period for all treated units (staggered adoption), effects may be biased toward zero.[6] CSDiD groups countries into time-cohorts based on when the treatment was adopted. This method has been shown to account for time heterogeneity bias that could otherwise drive effects toward zero [Baker et al., 2021]. Serving as my baseline estimate in section 1.3, the CSDiD approach finds that on average, demilitarizations are associated with a 1% higher annual GDP per capita than if the country had remained militarized. Dynamically, GDP per capita is 15-20% higher 20 years after transition.

A major threat to the causality of my estimation is the idea that a safer global environment drives growth rather than the mechanism of demilitarization. Collier [1999] finds that countries experience growth following the end of a civil conflict as a result of increased foreign capital flows. Capital is often risk adverse to violence. No one wants to build a factory somewhere it might get blown up. As I show in figure 1.1, we live in perhaps the most peaceful time in history. To test this proposition, I conduct another CSDiD estimate but use countries choosing to remain militarized even when they have a shock to the violent threats around them as an alternative treatment status. This placebo test in section 1.4 finds no statistically significant impact on growth. Meaning, becoming safer is not driving economic growth but rather the mechanism of demilitarization.

As a final check on the robustness of my baseline estimation against endogenous selection into treatment, I use an instrumental variables (IV) approach in the causal semiparametric framework in section 1.5 [Abadie, 2003]. I find that military institutions may be evolving spatially as it relates to threats faced. In figure 1.3, I map demilitarization and militarization episodes according to intensity of the transition. Demilitarization appears to be highly spatially correlated given the prevalence of transition in South/Latin America, Sub-Saharan Africa, and Eastern Europe. Because of this, I exploit plausibly exogenous variation in the external threats faced from contiguous countries as an IV.[7] Estimates from the IV approach confirm my baseline results.

There are several potential mechanisms driving this growth, and I address these in section 1.6. One such mechanism is increased international economic cooperation as a result of demilitarization. Wisniewski and Pathan [2014] show that reduced military spending leads to increased foreign direct investment inflows (FDI). Similarly, Acemoglu and Yared [2010] find that by reducing the number of troops and money spent on the military, a country becomes a more attractive trade partner. In the 15-30 years following demilitarization, I find that countries have much higher foreign direct investment inflows and international trade volume. I also find evidence that demilitarization may be positively influencing growth through a reallocation of resources into more economically productive outlets [Loayza et al., 1999]. One theory of demilitarization is that it allows a country to increase market-oriented research and development (R&D) and improve total factor productivity (TFP) [Alptekin and Levine, 2012]. Similarly, resource reallocation allows a country to build more economically productive capital (tanks vs. tractors) and strengthen the size and capability of the labor force. In my estimation of potential mechanism, I find a large increase in welfare-relevant TFP and capital stock following demilitarization. Countries undergoing militarization see TFP and capital stock levels remain flat or even decline as a result of the transition. Perhaps most interesting, I find a dramatic decline in infant mortality rate, possibly as a result of financial reallocation in labor force health. Militarizing countries see a significant increase in the infant mortality rate following transition. This is likely because of the association with violent conflict of militarization and the movement of resources away from health and labor force related outlets.

1.1 Existing Literature

Existing economic research has no shortage of literature covering various aspects of military policy and the relation to economic outcomes. However, there does not appear to be a definitive answer on the empirical effect of demilitarization. This is due in part to a lack of a statistically measurable definition for what it means to be demilitarized. Rather, previous studies tend to analyze individual aspects of what might collectively be known as demilitarization.

But how does the demilitarization of institutions impact economic growth? Most of the existing empirical work comes from cross-country regression analyses of military expenditure. Alptekin and Levine [2012] summarize the literature on military expenditure and growth in a meta-analysis. Their results state that military expenditure has a non-linear relationship with growth. This translates to an economic benefit for larger, developed countries when they spend more on the military (militarization) and inconclusive results for smaller, less developed countries. Dunne and Tian [2020] argue that greater data availability since the end of the Cold War actually shows that a reduction in military expenditure (demilitarization) has created net economic gains for countries around the world. Studies specifically discussing a Peace Dividend have also focused on the relationship between military expenditure and growth (Knight et al. [1996], Mintz and Stevenson [1995], Mintz and Huang [1990], and Gleditsch et al. [1996]).

There are no studies to my knowledge that look at the broader behavior of institutions with respect to their level of militarization. To find similar literature, I need to look at research regarding other political institutions. Here, democracy has a particularly rich catalog of papers. Determining if a country is a democracy or not is about more than if the country has elections. Democracy is instead a broad collection of institutions working in unison to create a fair and equitable society. Recent work by Papaioannou and Siourounis [2008], Giavazzi and Tabellini [2005], Persson and Tabellini [2006], and Acemoglu et al. [2019] have moved economic literature away from the continuous specifications of democracy and have instead focused on transitions. In this study, I take the existing literature of institutions and military factors, such as spending and conscription, and create a dichotomous definition for the broader state of a country's military capacity.

Military institutions began to transition globally, for nearly all countries, with the end of the Cold War. Since the mid- to late-1980s, the world has seen a dramatic decline in military spending, a reduction in the pervasiveness of conscription, the ousting of several military dictators, and the dismantling of more than 80% of the global nuclear stockpile (Cheibub et al. [2010]; Roser and Nagdy [2013]; Toronto [2007]). At the same time, significant economic development has taken place. Academics and politicians alike have attributed changes in military capacity to a corresponding growth of global economies and the potential for lasting peace.[8]

The belief in a Peace Dividend is not universally held. There has been skepticism on the part of those who believe that militarization promotes economic growth through positive security related effects and supply-side spillovers.[9] In Federalist #11, Alexander Hamilton espoused his view on the economic benefits of a strong and robust Navy to project military might [Hamilton et al., 2009]. Hamilton believed that naval power would allow the burgeoning nation to establish itself as a major player in international trade. Hamilton also discussed his belief that a united Navy would bring states together through the joint construction of ships. He said "When the staple of one fails from a bad harvest or unproductive crop, it can call to its aid the staple of another. The variety, not less than the value, of products for exportation contributes to the activity of foreign commerce" [Hamilton et al., 2009]. With southern and middle states providing the raw materials and the sailors of the North captaining the vessels, Hamilton saw the militarization of the seas for the United States as a potential economic windfall.

1.2 Data and Descriptive Statistics

In this section, I explain the challenge of identifying military transitions. I then create an algorithm for identification and describe a newly created data set of demilitarization and militarization episodes. To the best of my knowledge, this is the first attempt at classification for country-level military transitions. Transitions are identified and describe in detail in table 1.1.

1.2.1 Identifying Demilitarization

The primary challenge in the identification of military capacity is coming up with a statistically measurable definition.[10] It is easy to think of this as the number of weapons or soldiers a country has. However, this view might be too narrow. The economic literature on democracy offers some guidance here. Democracy is about much more than just the right to vote. Democracy is a set of institutions working in coordination to promote a fair and equal society. Similarly, militarization is a collection of institutions that work in unison to organize a society for violent conflict. To capture this definition empirically, I need to take into consideration a broader range of military institutions. I focus on seven military institutions described by Naidu [1985]. These are: resources, personnel, politics, heavy weapons, power projection, military industrial complex, and military action. I start by creating a data set that contains each of the seven institutions for 147 countries from 1960-2019, in order to identify military transitions. In total, I identify 53 cases of permanent demilitarization. 32 of these cases are categorized as 'strong' while a 19 are considered 'weak'. I also find 12 cases of permanent militarization and 5 cases of reversal.

Resources: Military Spending

Military spending is useful in explaining how a country values its resources. Previous studies have tended to use expenditure data on a yearly basis in a common currency, especially for cross-country analysis [Dunne and Perlo-Freeman, 2003]. However, a more relevant measure in terms of opportunity cost is the percentage of GDP per capita [Abu-Qarn and Abu-Bader, 2008]. The percentage of GDP offers a clear picture of how a country values its military in comparison to other parts of its society. I use military expenditure as a percentage of GDP data compiled by the Stockholm International Peace Research Institute (SIPRI). The data set has 173 countries from 1949-2019, making it one of the largest in terms of countries and observations available. Upon conducting a Supremum Wald structural break test to detect policy shifts around military spending, I find that countries shift around 3% of GDP.[11] Therefore, all countries spending 3% or greater on the military per year receive a value of 1 (militarized). All others 0 (demilitarized) in that year.

The average of negative structural breaks is shown in supplementary figure AA1.

Military Action: Inter and Intra-State Conflict

Militarization and demilitarization are ultimately about preparation for conflict. As such, this preparation begets conflict. To determine whether a country is demilitarized, it is important to ask if that country is actively using this preparation to engage in violent conflict. There are several sources of data for state-level conflict. I choose to combine two commonly used data sets to provide more accurate coverage of conflict. First, the Correlates of War (COW) Intra-State War data v5.1 provides a dyadic identification of state vs state conflict from 1816-2007 [Sarkees and Wayman, 2010]. The COW Intra-State War data registers all conflicts with greater than or equal to 100 battlefield deaths and that occurs between two or more recognized sovereign states. I start by identifying which states were in conflict during a given year with this data set because it is a leading authority on large conflicts faced throughout history. I match each participant to my constructed data set and record a 1 for each country and year that experiences a significant inter-state conflict. Second, I also want to record intra-state conflicts (civil) as well as bring inter-state conflicts up to 2019. For this, I rely on the UCDP/PRIO UPPSALA conflict data (UCDP Dyadic Dataset version 20.1), a combination of Pettersson and Öberg [2020] and Harbom et al. [2008]. The UPPSALA data records all inter and intra-state conflicts from 1949-2019 with at least 25 battlefield related deaths. I choose to supplement the UPPSALA data with COW because UPPSALA only codes in conflicts which see a recognized declaration of war. This condition is problematic because it leaves out conflicts that would ostensibly be characterized as a major conflict but were not actually declared state on state wars. Some examples are, the U.S. war in Korea (considered a policing action), the U.S. war in Vietnam (U.S. intervention in a civil conflict), and the Soviet war in Afghanistan (considered an Afghan civil war with Soviet intervention). The COW data does not make this same distinction. By combining the two, I gain a more reliable coverage of all conflicts with at least 25 battlefield related deaths from 1960-2019. As such, the demilitarization indicator is a value of 1 for a year in which a country engaged in conflict and 0 when that country did not.

Personnel: Military Conscription

Military conscription is a method of meeting military manpower requirements by mandating service of a citizen by force. Whether a country utilizes conscription, or a volunteer system, can go a long way in explaining a key institution within the context of demilitarization (e.g., personnel). Volunteer armies are typically smaller as there is no requirement to serve in the armed forces and private sector jobs often offer greater utility to those individuals. Countries which use conscription may be doing it because of the threats they face relative the size of their population (i.e., Israel), or because of a need to increase personnel for a coming/ongoing conflict. Either way, conscription is a tool to increase the capacity of the military in terms of personnel and thus signals if the country is militarized or demilitarized. I use the Military Recruitment Data Set from Toronto [2007] which contains information on whether a country used a volunteer or conscription system to meet manpower requirements in their armed forces from 1800-2008. To the best of my knowledge, this is the only globally comprehensive data set concerning military recruitment methods. I manually bring the data set up to date following the existing methodology. I code the dataset so that a country takes on a value of 1 each year if it has forced conscription and a value of 0 if it uses a volunteer system.

Politics: Military Dictatorships

It is important to consider the political environment surrounding the military as an indicator of militarization. A country's politics can reflect its citizen's feelings about the military, and more generally about what the military should be doing. Recent studies have found that militarized politics may be the result of a non-democratic regime exerting its power to create the political environment it desires [Acemoglu et al., 2010]. Either way, the central government of a country has an enormous influence over military functions. As an institution, the thinking of a national government dictates spending, military manpower, nuclear programs, and whether to engage in violent conflict. To calculate the military nature of political institutions, I create a variable that takes on a value of 0 when a country does not have a military dictatorship and a value of 1 when a country's government is led by a military dictator. Data is initially merged in from the dataset of Cheibub et al. [2010]. However, this data only goes up to 2008. I again bring this dataset up to date following the original methodology.

Heavy Weapons (R&D): Nuclear Capabilities

Since the United States dropped two atomic bombs at the close of World War 2, nuclear weapons and their related technology have been the apex of heavy weapons. A nuclear weapons program is the epitome of militarization in the modern world and requires significant resources be devoted to military research and development. As such, I create a yearly observation for whether a country has a nuclear program. The variable equals 1 if for a given year a country has at least one nuclear weapon, an active nuclear weapons program, or if they are housing nuclear weapons as part of a sharing program, such as NATO. The variable equals 0 if all these conditions are untrue. I construct the data set from 1960-2019 primarily through information coming from the Institute for Science and International Security's historical overview of nuclear weapons and integrating data from a previous study on nuclear programs [Mayberry, 2022a].

Power Projection: Military Occupation of Foreign Lands

The origins of militarization are based in the conquests of imperialism. That action manifested itself in the occupation of foreign lands to extract the necessary resources to fuel industrialization. In defining demilitarization empirically, it is important to consider whether a country is occupying any land which does not fall under its sovereign jurisdiction. Observing foreign occupation also informs our understanding of how a country behaves with respect to violent conflict. A country being aggressive and projecting power militarily would certainly be considered militarized. I capture this behavior with a variable equal to 1 when a country is occupying a foreign land each year and 0 otherwise. A robust data set was recently created by Vishwasrao et al. [2019].

Military Industrial Complex: International Arms Trade

If a country has the capability to produce a vast quantity of advanced weaponry, then presumably countries without such infrastructure would have an incentive to purchase the excess supply. The infrastructure necessary to surge military production is a key element of militarization. I define the military industrial complex by whether a country is a net exporter of arms. I use the arms export/import database from SIPRI to calculate this variable. The military industrial complex variable takes a value of 1 if the total amount (in USD) of arms exports exceeds that of imports. The variable takes a value of 0 if the opposite is true. This provides a reliable indicator for the status of the military industrial complex in each country from 1960-2019.

1.2.2 Military Transition Algorithm

The goal of this algorithm is to determine if a state makes a permanent transition from militarized to demilitarized (or vice versa), and with what intensity the transition occurs. Determining permanent transitions creates specific cases that are ideal for analysis. I begin by identifying potential transitions from one state to another based on a negative shock to military spending as a percentage of GDP (military burden). I first identify every country-year pair that experiences a greater than 1%, permanent reduction of military burden in a 5-year period as a potential demilitarization. I then consult the seven institutional indicators previously described. If the negative shock to military burden is associated with two or more permanent transitions of institutional indicators, I consider that a permanent 'strong' demilitarization. An example of this would be the identification of a negative shock that leads to the permanent end of conscription and a country's nuclear program. Countries only experiencing one permanent institutional transition to a demilitarized state with the identifying negative shock are considered 'weak' permanent demilitarization episodes. I determine militarization episodes by first identifying positive shocks to the military burden of greater than 1% in a 5-year period as a potential militarization. If the country then experiences two permanent institutional transitions to a militarized state associated with the positive shock, I consider that a permanent militarization. Reversals are countries that undergo one of the two transitions, maintain that status for at least 10 years, and then transition back to the previous state. Countries with a lack of transitional behavior fall into one of the two control categories: always militarized or always demilitarized. Finally, I consult various historical and political sources to find qualitative evidence of the reasons for transition. This is to ground my discrete data of transitions in historical fact and reasoning.

1.2.3 Events Driving Demilitarization

The final step in identifying demilitarization episodes is to connect them with historical evidence of a policy shift around the military nature of institutions. A catalyst of some sort is needed to determine the discrete timing of initial demilitarization. If there is an event bringing on the demilitarization (i.e., leader death, coup, end of conflict), then the country is likely to be experiencing other changes as well. Knowing what caused each demilitarization episode helps to understand what sources of bias may be impacting my estimations as a result of extenuating circumstances. Therefore, I consult a series of historical and political references to determine the events that precipitate each demilitarization or militarization. The CIA World Factbook, the Freedom House and Polity Project country reports, as well as a variety of academic sources provide the necessary information. If an identification of an event leading to a militarization or demilitarization of a country's institutions cannot be made, then the episode is re-assessed and attributed to one of the two control categories (always militarized or always demilitarized), as there is no definitive transition. The final collection of permanent demilitarization, militarization, and reversal episodes, along with their descriptions, are contained table 1.1.

1.3 Econometric Approach and Estimation

In this section, I discuss the primary semiparametric DiD estimator. I estimate that on average, demilitarization is associated with a 1% higher annual GDP per capita than if the country had remained militarized. Dynamic analysis shows that on average, GDP per capita is 15-20% higher

20 years after transition. I also estimate that the process of militarization results in a GDP per capita that is on average 30% lower 20 years after transition, then if the country had remained demilitarized.

1.3.1 Semiparametric Estimators

The semiparametric estimation approach pioneered by Abadie [2005] offers a way to model selection into treatment when randomization is not possible. The primary assumption of this process is called conditional parallel trends. That is, parallel trends only hold for a treatment and untreated comparison group after conditioning on some matrix X. It is possible that this adaptation to the parallel trend's violation may be occurring due to covariates being imbalanced between treated and untreated groups because they model the conditional selection into treatment. However, this can be addressed by absorbing all the X information into a single scalar. In this case, a propensity score. To estimate the average treatment effect on the treated (ATT), I assume that selection into treatment can be modeled as a function of observables.[12] This assumption recognizes that treatment (demilitarization episodes) may be preceded by an Ashenfelter dip in GDP, as shown in figure 1.2. Second, the assumption establishes that untreated units have no additional confounding factors that influence the propensity to become treated.[13] There are three semiparametric strategies that build on one another to develop a doubly robust estimator.

The first strategy follows a linear regression framework of changes in GDP s years after a permanent treatment (demilitarization) with year fixed effects and four lags of GDP (at years $t-1, t-2, t-3$, and $t-4$) for untreated units to form a counterfactual for countries that demilitarize.[14] In order to capture long-run dynamics, this model is only equipped to consider permanent instances of treatment rather than those moving back and forth. In this model, $DEMIL_{ct}$ is an indicator variable taking a value of 1 if the country is demilitarized and 0 if the country is considered militarized each year. The control units are those that never receive a treatment. The conditional expectation of $\Delta y^s_{ct}(0)$ modeled as:

$$\mathbb{E}[\Delta y^s_{ct}(0)|X_{ct}, DEMIL_{ct} = 0, DEMIL_{ct-1} = 0] = X'_{ct}\pi^s \tag{4.1.1}$$

The average treatment effect (of demilitarization) on GDP s years after the initialization of an episode to be (Average Treatment Effect on the Treated–ATT):

$$ATT^s = \hat{\mathbb{E}}[\Delta y^s_{ct}(d)|DEMIL_{ct} = 0, DEMIL_{ct-1} = 0] - \hat{\mathbb{E}}[X'_{ct}|DEMIL_{ct} = 0, DEMIL_{ct-1} = 0]\hat{\pi}^s \tag{4.1.2}$$

where $\hat{\mathbb{E}}[X|S]$ is a sample average of X for all observations within a set, S. Since $\hat{\pi}^s$ is the OLS estimate of π^s, then $\hat{\mathbb{E}}[X'_{ct}|DEMIL_{ct} = 0, DEMIL_{ct-1} = 0]\hat{\pi}^s$ is the counterfactual estimate for GDP. In other words, this counterfactual is the cumulative growth for countries that demilitarized had they remained militarized at time t (beginning of the demilitarization episode).[15]

The second strategy uses inverse probability weighting.[16] The idea being to estimate the treatment (demilitarization) effect, but condition on the propensity score of transition. Estimating the propensity score of each unit (country) can be done with a simple probit regression of the probability of transitioning, conditional on $DEMIL_{ct-1} = 0$, with year fixed effects and four lags of GDP per capita. From here, simply estimate the effect of demilitarization on GDP with the efficient weighting scheme of Hirano et al. [2003]. This methodology uses the propensity score to calculate the weights for different observations, giving more weight to control countries (militarized) with a high propensity score and that have similar outcome variable (GDP) dynamics in the pre-treatment period. This gives an efficient control group that is adequately comparable to those remaining untreated.[17] The estimated propensity scores, $\hat{P}_{ct}$, to compute the effect of being treated (demilitarized) on outcome (GDP) as:

$$ATT^s = \mathbb{E}[\Delta y_{ct+n} \cdot w_{ct}|DEMIL_{ct-1} = 0] \tag{4.1.3}$$

with weights

$$w_{ct} = \frac{1}{\hat{\mathbb{E}}[DEMIL_{ct}]}(1\{DEMIL_{ct} = 1\} - 1\{DEMIL_{ct} = 0\}\frac{\hat{P}_{ct}}{1-\hat{P}_{ct}}) \tag{4.1.4}$$

The third and final semiparametric estimation is the combination of the two previous techniques. I will refer to this as the doubly robust estimator. That is, counterfactual adjustment with a linear regression and observational re-weighting based on propensity scores used together. The doubly robust estimator computes the effect of treatment (demilitarization) as:

$$ATT^s = \mathbb{E}[(\Delta y_{ct+n} - X_{ct}^{'}\pi^s) \cdot w_{ct}|DEMIL_{ct-1} = 0] \tag{4.1.5}$$

Here, $\hat{\pi}^s$ is the estimate for the counterfactual model

$$\mathbb{E}[^s_{ct}|X_{ct}, DEMIL_{ct} = 0, DEMIL_{ct-1} = 0] = X_{ct}^{'}\pi^s \tag{4.1.6}$$

The benefit of the doubly robust approach is that the estimation will be consistent if either of the previous estimations are valid [Imbens and Wooldridge, 2009].[18]

1.3.2 Callaway and Sant'Anna [2020] Semiparametric Estimator: CSDiD

The doubly robust semiparametric estimation framework from Abadie [2005] is calibrated for a roll-out of policy implementation. That is, the estimators treat all instances of demilitarization as if they are coming from the same year. However, Goodman-Bacon [2021] finds that the staggered adoption of policy may significantly bias estimates.[19] In a DiD estimation, the control group is made up of units whose treatment status does not change over time. The treatment group is for units that do experience a change in their treatment status. With multiple time periods and variation of treatment timing, some of the control units for the newly treated may be units that have been treated in a previous period. This leads to control units having treatment effect dynamics, making a causal interpretation nearly impossible. When the effect of treatment is positive for all units in all time periods, the previously treated units infecting the control group will cause the estimation of a negative effect (e.g., a positive effect being driven towards zero). A potential solution to this bias is a weighted group-time ATT (CSDiD semiparametric estimator) introduced by Callaway and Sant'Anna [2020] and that builds off the doubly robust estimator from Abadie [2005].

A weighted group-time ATT is an ATT specifically for a cohort of units treated at the same point in time. In this study, an example is Ethiopia and El Salvador both demilitarizing in 1992 after the end of respective civil conflicts. They will be referred to as the 1992 cohort. Another group of countries demilitarize in 1991, so they are the 1991 group. This continues for all countries demilitarizing during the same year. The group-time ATT can also be a dynamic term. In my case, it is necessary to calculate the ATT of the 1992 cohort in 2007, 15 years post-treatment, for long-run analysis. Each cohort has $T - Gt$ ATT parameters. Here, T is the last year in the panel and Gt is year of treatment for that group. The total number of weighted group-time ATT's is then the sum of all $T - Gt$ ATTs across all groups. The CSDiD estimator provides a simple way to aggregate all the ATTs into fewer, easy to understand parameters.[20]

Just as with the doubly robust semiparametric estimator in the previous subsection, CSDiD begins by estimating the propensity score of a treatment (transition to a demilitarized state from a militarized one). Rather than an individual score for each unit, CSDiD estimates a unique propensity score for every group based on treatment date. Treated units are first averaged together based on their time cohort to create multiple treatment groups. Then, pre-treatment data is used to calculate the propensity score of selecting into treatment (demilitarization). The ATT for CSDiD is then the same as the Abadie semiparametric estimator but separated into groups:

$$ATT^{s}_{g,t} = \hat{\mathbb{E}}[\Delta y^{s}_{t}(d)|DEMIL_{g} = 0, DEMIL_{g-1} = 0] - \hat{\mathbb{E}}[X^{'}_{t}|DEMIL_{g} = 0, DEMIL_{g-1} = 0]\hat{\pi}^{s} \tag{4.2.1}$$

The CSDiD estimator is appropriate when: (1) data is panel or repeated cross-sectional; (2) parallel trends are only possible by conditioning on X (conditional parallel trends); (3) treatment must be permanent; (4) treatment and comparison (control) groups must have units with the same approximate propensity score for some range of data (common support assumption).[21]

With these assumptions, Callaway and Sant'Anna [2020] created the CSDiD estimator that is able yield an unbiased and consistent estimate of each group's individual group-time ATT. This is expressed as:

$$ATT^{s}_{g,t} = \mathbb{E}[\Delta y_{gt+n} \cdot w_{gt} | DEMIL_{g-1} = 0] \tag{4.2.2}$$

The estimates for the effect of demilitarization and militarization using the CSDiD approach are listed in table 1.2. Panel A of that table shows CSDiD estimates for all permanent demilitarizations. This includes both strong and weak episodes. Panel B and C separate out demilitarizations by intensity with B estimating only strong episodes and C weak episodes. Panel D reports estimates for all episodes of militarization. Columns indicate a range of years around the transition and estimates are averaged together for those years.[22] Standard errors clustered at the country-level are reported in parentheses below each coefficient. Coefficients in bold are statistically significant at least at the 90% confidence interval. Statistical significance is reported with stars and are detailed in the notes below the table. Coefficients are of log GDP per capita multiplied by 100 for interpretation. Therefore, a coefficient of 12.200 (11 to 15 years after demilitarization) signifies that GDP per capita was more than 12 percent higher than if the country had remained militarized in that time period. The first column reports estimates for -20 to -1 years prior to demilitarization, or, pre-treatment period differences between soon to be treated units and comparison units.

In a binary estimation, there are two units used in the estimation: treated and the untreated comparison units. With the Abadie [2005] semiparametric framework, treatment happens only once (at one point in time) so the comparison group should always be large because you have access to all units. The CSDiD estimator does not necessarily have that luxury. As more and more units become treated over time, or if comparison units float between treated and untreated as time passes, the comparison pool shrinks.[23] In each panel of table 1.2, I show results for the CSDiD estimation but using 'not-yet' treated units in the control group alongside those 'never' receiving treatment. For robustness, I also include an estimate that models selection into treatment with a propensity score built on alternative, endogenous covariates. These covariates include a measure for democracy (Polity IV), population, capital stock, human capital (Human Capital Index), infant mortality rate, foreign direct investment inflows, and trade share of GDP.

Figure 1.4 plots the coefficients from panel A under not-yet treated conditions. The blue connected line plot is the corresponding coefficient for each year around demilitarization. The shaded area is a 95% confidence interval. In column (1) of table 1.2, the coefficient for the pre-treatment period is -0.051 percent and statistically insignificant (s.e. 1.377). In order to confirm that the inverse probably weighting has successfully modeled randomization into treatment, there can be no significant difference between treated and untreated units. This is confirmed by the small coefficient (about 1/20th of a percent difference over 20 years) and that the estimate is not statistically different from zero. If this estimate was large and statistically significant, it would be cause for concern and signify that untreated units could not be re-weighted to look like treated units in the pre-treatment period. Following the demilitarization episodes, GDP per capita of those countries receiving treatment slowly begins to outperform the GDP of the weighted comparison units. By column (4), 11 to 15 years after demilitarization, the treated units are on average 12.200 percent larger than untreated (s.e. 5.598). At this point, the difference between treated and untreated units becomes statistically significant. Results peak 26 to 30 years after demilitarization. The coefficient in column (7) is 20.473 (s.e. 11.235). This means that on average, the GDP per capita of countries that underwent demilitarization were roughly 20% larger 30 years after the transition than if they had remained militarized. Column (8) is the last reported coefficient (31 to 35 years after transition) and shows that the difference between treated and untreated units begin to wane and is statistically insignificant.

Figure 1.5 plots the coefficients for both strong (subplot a) and weak (subplot b) demilitarization episodes. The blue connected line plot is the estimation for the path of GDP per capita for demilitarizing countries based on the timing of the transition, and the shaded area is a 95% confidence interval. Figure 1.5 along with panel B and C of table 1.2 show that the positive economic gains coming from demilitarization episodes almost entirely driven by strong transitions. Strong demilitarization episodes are large (13.752%) and statistically significant (s.e. 6.771) 11 to 15 years after transition. The difference between strongly demilitarizing countries and untreated units continues to grow and peaks between 25 and 30 years after transition. The average estimated coefficient for strongly demilitarized countries 26 to 30 years after transition is 31.623 percent (s.e. 9.777) and is statistically significant at a 99% confidence interval. Weak demilitarization episodes do not experience this same growth effect. Instead, none of the estimated coefficients for weak episodes are statistically significant. The average post-treatment impact is initially positive, albeit statistically insignificant from zero, but becomes negative around 25 years after weak demilitarization. The results shown in figure 1.5 confirm that it is the combination of multiple institutional transitions driving growth rather than a single instance or simply a negative shift in spending. If countries were experiencing the same growth patterns, regardless of demilitarization intensity, I would be concerned that the effect was coming from more global trends or a single institution (i.e., resources–military spending). Instead, this is confirmation that countries engaging in strong demilitarization across multiple institutions saw GDP per capita outperform the counterfactual, rather than those instituting a weaker set of reforms.

Figure 1.6 plots the coefficients for militarization episodes. The blue connected line plot is the estimation for the path of GDP per capita for militarizing countries based on the timing of the transition, and the shaded area is a 95% confidence interval. Figure 1.6 and panel D of table 1.2 show that countries undergoing militarization experience a severely negative trend in GDP per capita. Looking at column (1) in panel D, not-yet treated controls specification, the inverse probability weighting provided a convincing counterfactual from the set of control countries (those always demilitarized). The coefficient in column (1) is -0.879, less than a one percent difference in the pre-treatment period. After transition, the negative effect of militarization on GDP per capita is felt almost immediately. The first 5 years after transition, column (2), shows a negative difference between the treated and untreated units of -9.798%. While column (2) is statistically insignificant, the estimate becomes statistically significant at a 95% confidence interval in column (3). The coefficient in column (3) is -22.024 percent (s.e. 8.994). The estimates reach the lowest around 25 years after militarization. Column (6), 21 to 25 years after transition, has a coefficient of -39.823

percent (s.e. 16.130). The estimates slightly rise in the 10 years after that. The interpretation of these results is that on average, countries that chose to militarize experienced a more than 30% lower GDP per capita than if they had remained demilitarized.

1.3.3 Reversals

Countries that experience a reversal of a previous military transition offer a unique opportunity to observe dynamic movements in GDP in multiple directions. As such, in table 1.1 I identify countries that underwent a transition, maintained the new state of military capacity for at least 10 years, and then transitioned back to the original state. I find three countries that demilitarized and then militarized after more than 10 years. However, these countries have a lack of pre-treatment data. Ukraine and Georgia experienced their initial transitions at the end of the Cold War and have no GDP data before that, as they were in the Soviet Union. Thailand experienced a similar demilitarization a few years before that but also lacks pre-treatment data.

On the other side, I find two countries that experienced a militarization and then reversed after 10 years: Chile and Sri Lanka. After World War 2, Chile experienced an extended period of peace. The military country was demilitarized by all measures I could find. In 1973, a U.S. backed military coup took place to depose President Salvador Allende. A military junta took control of the country under the leadership of General Augusto Pinochet. The new regime was incredibly violent and used Operation Condor to further militarize the country. The military dictatorship ended in 1990 with the return of democracy to Chile. The country underwent significant military reforms. Recently, Chile elected a 35-year-old leftist politician with substantial demilitarization goals. As the new president, Gabriel Boric appointed Maya Fernández Allende to be the new minister of national defense for Chile. Allende is of course the granddaughter of Salvador Allende.

After decolonization of Sri Lanka in 1948, the country remained demilitarized and relatively peaceful. However, in 1983, the country fell into a 26-year long civil war. The state military of Sri Lanka fought with the Liberation Tigers of Tamil Eelam who aimed for an independent nation of their own. The Liberation Tigers were finally defeated in 2009, bringing the civil war to an end.

Since 2009, the country has undergone significant demilitarization. Several tribunals have been conducted to hold to account those who committed war crimes on both sides. The country seems determined not to fall back into a state of sustained violence.

To measure the impact of these reversals on GDP, the CSDiD estimator is no longer appropriate. The semiparametric estimator is calibrated for permanent transitions and will not be informative in cases of reversal. An alternative estimation is the synthetic control method (SCM). This approach pioneered by Abadie and Gardeazabal [2003] creates a synthetic counterfactual of actual output by weighting a set of control countries to mimic the actual in the pre-treatment period. SCM is carried out in the following way:

If there is a collection of $C+1$ countries, and they are indexed as $i = 1, 2, \ldots, C+1$ for T time periods, $t = 1, 2, \ldots, T$, the synthetic control method states that country $i = 1$ is given a treatment and the remaining C countries are untreated control units, making up the donor pool.[24] T_0 is the number of pre-treatment periods and T_1 is the number of post-treatment periods, meaning that $T_0 + T_1 = T$. The effect of treatment for unit i at time t is represented by $\theta_{it} = Y_{it}^A - Y_{it}^B$. In this equation, Y_{it}^A is log real per capita GDP for unit i at time t if treatment begins in $T_0 + 1$ and Y_{it}^B is the same but in the absence of treatment. Because only one country is exposed to the treatment (country $i = 1$), I must estimate $\theta_{1,0}, \ldots, \theta_{1,T}$. Y_{it}^B is estimated with the following factor model:

$$Y_{it}^B = \alpha_t + \beta_t X_i + \delta_t Z_i + \varepsilon_{it} \tag{4.3.1}$$

Here, α_t is an unknown common factor invariant across units, X_i is a covariate vector not affected by nuclear weapons, β_t is a vector of unknown time-specific parameters, δ_t is a vector of unknown common factors, Z_i is country-specific unobservables and ε_{it} is the error term for zero-mean transitory shocks.

SCM creates the missing counterfactual, Y_{it}^B, from countries in the donor pool that do not participate in nuclear development. Abadie et al. [2010] explains this process in the following way: Let $W = (w_2, \ldots, w_{C+1})'$ be $(C \times 1)$ vector of weights such that $0 \leq w_j \leq 1$ for $j = 2, 3, \ldots, C+1$ and $\sum_{j=2}^{C+1} w_j = 1$. I define the linear combination of pre-treatment log real per capita GDP values by $\bar{Y}_j^K = \sum_{m=1}^{T_0} k_m Y_{jm}$. Therefore, if the condition:

$$\sum_{j=2}^{S+1} w_j^* Z_j \wedge \sum_{j=2}^{S+1} w_j^* \bar{Y}_j^K = \bar{Y}_1^k \tag{4.3.2}$$

holds[25], then the estimate of the effect of treatment, $\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{S+1} W_j^* Y_{jt}$, can be considered an unbiased estimator of α_{1t}. With w_j^* being the assigned weight for the j^{th} country in the donor pool remaining untreated.

SCM calls for the minimization of the distance between the vector of pre-treatment characteristics for treated (X_1) and the weighted matrix of pre-treatment characteristics for unexposed units (X_0). W^* is the chosen vector to do this, expressed as:

$$\| X_1 - X_0 W \| = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)} \tag{4.3.3}$$

with V being a symmetric and positive semidefinite matrix. The constraints of minimization are that the weight assigned for each country in the pool of non-treated must be between zero and one with the sum of those weights bounded by one. Those donor pool countries are assigned their weights by their comparability to pre-treatment real per capita GDP. That measure of comparability comes from the minimization of root mean square prediction error (RMSPE) in the pre-treatment period. The RMSPE is a measure for the lack of fit between the trajectory of the outcome variable and its synthetic counterpart [Abadie et al., 2015]. The pre-treatment RMSPE is $(\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t} - \sum_{j=2}^{S+1} w_j^* Y_{jt})^2)^{\frac{1}{2}}$ and the post-treatment RMSPE is $(\frac{1}{T_1}\sum_{t=T_0+1}^{T_1}(Y_{1t} - \sum_{j=2}^{S+1} w_j^* Y_{jt})^2)^{\frac{1}{2}}$. The number of pre- and post-treatment periods are T_0 and T_1. The outcome of the synthetic is $w_j^* Y_{jt}$ and it is created with j^{th}, the unexposed country with weight w^*, and Y_{1t}, the actual outcome of the treated.

I conduct a SCM estimation for the demil-mil-demil reversals of both Chile and Sri Lanka and present the findings in the figure 1.7. Subplot (a) features Chile and synthetic Chile while subplot (b) shows Sri Lanka and synthetic Sri Lanka. The blue line plot in each subplot is actual log GDP per capita of both countries per year, plotted from 1960-2019. The gray dashed line is the synthetic counterfactual matched in the pre-treatment period. The figures both show a steep decline in GDP compared to the synthetic counterfactual during or slightly before the militarization episode. After a period of time, both countries recover and then exceed the counterfactual with the reversal back to a demilitarized state. Sri Lanka begins outperforming the synthetic a few years before reversal, but output of the country takes off in comparison once the reversal is complete. Actual output in Chile does not fully return to the synthetic until a couple of years after reversal. The years that follow see actual Chile begin to significantly outperform the synthetic counterfactual. The purpose of the SCM exercise with reversal episodes is to reaffirm, in a single country example, the downward pressure on an economy from militarization and the growth effect associated with demilitarization.

1.4 Placebo Test: Safer Neighborhood, Still Militarized

A major threat to the causality of my estimation is the idea that a safer global environment drives growth rather than the mechanism of demilitarization. Collier [1999] finds that countries experience growth following the end of a civil conflict as a result of increased foreign capital flows (e.g. a reduction in threats faced). Capital is often risk adverse to violence. No one wants to build a factory somewhere it might get blown up. As I show in figure 1.1, we live in perhaps the most peaceful time in history. To test this proposition, I conduct another CSDiD estimate but use countries choosing to remain militarized even when they have a shock to the violent threats around them as a placebo treatment status.

There is a large set of countries that remain militarized for my entire data sample. At various points in time, these countries face reduced threats. If my results were being driven by a safer environment for those countries, then these militarized countries which see reduced threats would experience higher growth. If the results are in fact driven by the demilitarization of institutions, then countries remaining militarized would not see an impact.

To test this placebo theory, I compile a list of countries that remain militarized for the entire sample but see contiguous countries around them pursue a strong, permanent demilitarization. Countries experiencing a reduction in external threats but choosing not to demilitarize: United

States of America (1968), Belgium (1966), Colombia (1985), Italy (1966), Venezuela (1985), Guinea (1998), Democratic Republic of the Congo (2002), Somalia (1992), Botswana (1992), Malawi (1983), Spain (1975), United Kingdom (1966), Germany (1966), Switzerland (1966), Austria (1990), Serbia (1990), Bosnia and Herzegovina (1980), Moldova (1993), Iraq (2001), Saudi Arabia (2001), Eritrea (1992), Djibouti (1992), Vietnam (1999), Laos (1999), and Philippines (1998).

Using these country-year pairs, I perform the same CSDiD estimation from the previous section with the placebo rather than actual treatments. The results for this estimation are found in table 1.3. Panel A in table 1.3 shows the coefficients reported over years (in columns) around each placebo treatment. I estimate coefficients using not-yet treated controls, followed by never treated controls, and finishing with an alternative set of endogenous covariates to model selection into treatment. The alternative covariates are the same set as described in the previous section. Standard errors clustered at the country-level are reported in parentheses below each coefficient. Coefficients are of log GDP per capita multiplied by 100 for interpretation. The first column reports estimates for -20 to -1 years prior to demilitarization, or, pre-treatment period differences between soon to be treated units and comparison units.

Figure 1.8 plots the difference in GDP per capita log points between placebo treated and untreated units with not-yet treated controls, my primary specification. The blue connected line graph is difference in GDP per capita log points and the shaded area is a 95% confidence interval. In the pre-placebo treatment period (column (1) of table 1.3), the semiparametric specification does an excellent job of weighting. Over the 20-year time period, the average difference between placebo treated and untreated units is -0.159 percent (s.e. 2.428). However, the post-placebo treatment period features no statistically significant coefficients. The average coefficient does not exceed $\pm$ 5% until almost 25 years after the placebo treatment.

Figure 1.9 plots the CSDiD estimation with never treated controls (subplot a) and alternative covariate modeling into selection (subplot b). I find that despite this reduction in external threats, countries remaining militarized do not see the same economic benefit. The results show no statistically significant effect on GDP per capita. This is a confirmation that my results are not merely being driven by the reduction of threats. Meaning, becoming safer is not driving economic growth but rather the mechanism of demilitarization.

1.5 Semiparametric Instrumental Variable

The semiparametric DiD estimator successfully models pre-treatment behavior of treated and untreated units after conditioning on a vector of covariates. The CSDiD estimator also accounts for the staggered adoption of treatment by placing treated units into time cohorts. However, this technique is only able to model randomization based on weighting. It is possible that differences in the distribution of GDP between treated and untreated units may be reflecting differences generated by the treatment selection process, not just the effect of treatment. I institute a semiparametric instrumental-variables (IV) strategy to introduce plausibly exogenous variation for the selection into treatment. Exploiting variation in external threats faced by a country to instrument for selection into demilitarization, I find statistically significant evidence that demilitarization leads to on average, 20% higher GDP per capita (20 years after transition) than if the country had remained militarized.

1.5.1 Instrument

The end of the Cold War brought with it the dismantling of the Soviet Union. Former members and satellite states suddenly had no quarrel with the West as the threat of a U.S. invasion or a nuclear war dissipated. With this end, Eastern European countries began the process of demilitarization with the help of the U.S. government through the Nunn-Lugar Act [Shields and Potter, 1997]. Latin and South American countries, which had been heavily militarized throughout the 60s and 70s, changed their military institutions with a wave of new political leadership [Stearns, 2013]. Similar trends have occurred in sub-Saharan Africa and Southeast Asia. What these anecdotal events reveal, and as depicted by the map in figure 1.3, is that shifts in military capacity may evolving spatially. This theory, which I will discuss in the following paragraphs, is that when countries see a reduction in violent threats they face, especially close to home, there is incentive to demilitarize.

A significant finding in the study of demilitarization is that behavior towards another country may be a function of military power and proximity [Acemoglu and Yared, 2010]. Logically, this makes sense. Prior to World War 1, European countries entered armament agreements with weapons manufacturers to stockpile for future conflict [Stearns, 2013]. Germany had the latest long-range canons so France, being a bordering nation, felt they would be at a disadvantage in the event of a war without an upgrade to their weaponry. Having a neighbor with more and better guns means that they could potentially invade and conquer. When this is not occurring, countries have less incentive to stockpile weapons themselves because there is a reduced likelihood of that attack.

Incorporating the theory of national security and the understanding that military capacity evolves spatially, I exploit changes in the distribution of military capabilities in contiguous counties as a source of exogenous variation for military institutions. A recent database created by J Andrés Gannon tracks the distribution of military equipment for 173 countries from 1970-2014 [Gannon, 2021]. For this study, I separate those units of equipment into two categories: offensive and defensive. Offensive refers to any piece of equipment which could be used to attack another country, such as an intercontinental ballistic missile or military attack vehicle. Defensive is for units specifically designed for defense, such as an anti-missile defense system or ground-based air radar. I then matched this data to each country's set of contiguous countries and collapsed the data. For the United States, this means that the total offensive units would be the summation of offensive military capabilities of Cuba, the Bahamas, Mexico, Canada, and Russia.[26] Offensive units in contiguous countries are the specific external threats that may influence the likelihood of demilitarization and are what I will use as the instrumental variable.

I define a set of countries that may influence the demand for demilitarization in any given country. For each country c, I let $WEAPONS_{ct}$ denote the number of offensive weapon units (in thousands) a country has at any given time. I also let $CONT_c$ equal 1 or 0 depending on if a country is contiguous to another. Therefore, I am believing that the military institutions of country c are influenced by the set of countries closest to them. I then define the instrument of evolving external threat levels as:

$$Z_{ct} = \sum WEAPONS_{ct} \times CONT_c \tag{5.1.1}$$

For this equation, Z_{ct} is the sum of all offensive weapon units (in thousands) of contiguous countries. As that numbers decreases, the likelihood of demilitarization for the country of interest should increase.

For the exclusion restriction:

$$\mathbb{E}[\varepsilon_{ct} | y_{ct-1}, \ldots, y_{ct_0}, Z_{ct-1}, \ldots, Z_{ct_0}, \alpha_c, \delta_t] = 0 \tag{5.1.2}$$

for all $y_{ct-1}, \ldots, y_{ct_0}, Z_{ct-1}, \ldots, Z_{ct_0}, \alpha_c$, and δ_t and for all c and $t \geq t_0$. Here, the exclusion restriction requires that the contiguous offensive weapons variable, Z_{ct-n}, only impacts GDP of country c at time t through demilitarization, conditional on the lags of GDP and fixed effects. To be an appropriate IV, I need to meet the exclusion restriction. This should hold because if a contiguous countries' weapons were impacting the GDP of a given country, that would likely mean they are in conflict and thus not demilitarizing.

The relevance condition for the IV is clear when looking at figure 1.10. Subplot (a) depicts the positive relationship of contiguous offensive weapons on the militarization of institutions. The x-axis is the average number of militarized institutions (of the 7 introduced in section 2.2) from 1960-2019, plotted against a y-axis of average contiguous offensive weapons. Subplot (b) shows the negative relationship between the conditional probability of demilitarization and the IV. The x-axis is the average number of contiguous offensive weapons from the study timeframe, plotted against a y-axis of the conditional probability of being demilitarized (derived using same propensity score methodology from section 1.3). Contiguous offensive weapons have a statistically significant impact on demilitarization. I am assuming this causal relationship between the IV and treatment because of previous research on external threats and state responses discussed at the beginning of this subsection.

Finally, the exogeneity assumption requires that contiguous offensive weapon units are determinants of military institutional change but are not actually caused by the demilitarizing state. This would mean that the demilitarizing state, country A, is not causing the offensive armament of contiguous states, country B. If country A were building up its military to attack, then country B would be focused on defensive measures. Offensive measures would not necessarily be affected. And if country A were to demilitarize, this would have no direct influence over country B's decision to shift its distribution of military capabilities. Therefore, the buildup of offensive capabilities is not correlated with country A's decision to change its military institutions.

As I show in figure 1.11 subplot (a), the offensive weapons surrounding a country begin reducing dramatically prior to a demilitarization episode. This is in accordance with the relevance condition. Fewer external threats provide the opportunity for a country to demilitarize. Subplot (b) of figure 1.11 shows yearly changes in domestic offensive and defensive weapon systems around the time of demilitarization. This subplot shows that in the years immediately proceeding, and at the time of, demilitarization, domestic countries dramatically reduce the number of defensive weapons they possess (blue line plot–response to decline in contiguous offensive weapons). At the same time, domestic offensive weapons (gray, dashed line plot) see very little movement. From this, I can infer that defensive units are responding to changes in offensive units of neighboring countries, not the other way around. Offensive units are an internal decision not being influenced by other countries. Defensive unit changes are a response variable and are thus endogenously selected by external countries. In other words, country A is, in a way, selecting how many defensive weapon systems they have on their border by the internal decision of how many offensive weapon systems that possess. Country A has no selection over the contiguous offensive weapons surrounding them as they are selected based on the domestic choices of country B. This information shows that offensive weapons meet the exogeneity assumption, based on the domestic policies of country A, while defensive units do not.

1.5.2 Semiparametric IV Estimation Process

The semiparametric IV estimation process was pioneered by Abadie [2003]. Originally, this alternative IV process was created as a specification for estimating the treatment effect of a binary, endogenous regressor with a nonlinear model. The semiparametric IV estimation allows me to avoid Two-Stage Least Squares (2SLS), which in this context, would suffer from the same downward bias described by Goodman-Bacon [2021] and is not the ideal setting for conditional parallel trends as well as treatment response. I consider the following semiparametric IV model:

$$Y_{ct} = \mathbb{E}(Y_{ct}|Z_{1,ct}) = (DEMIL_{ct} - \mathbb{E}(DEMIL_{ct}|Z_{1,ct}))\beta + \varepsilon_{ct} \tag{6.2.1}$$

where the instrumental variable is $Z_{ct} = (Z_{1,ct}, Z_{2,ct})$ with $\mathbb{E}(\varepsilon_{ct}|Z_{ct}) = \mathbb{E}(\varepsilon_{ct}|Z_{1,ct} = 0$, for all t. I assume knowledge of the true conditional expectation $\mathbb{E}(Y_{ct}|Z_{1,ct} = m(Z_{1,ct}) + \mathbb{E}(DEMIL_{ct}|Z_{1,ct})\beta$. Where $m()$ is the nonparametric function by which the exogenous variable (IV) enters the equation. The endogenous variable $DEMIL_{ct}$ is the treatment status that influences the outcome, Y_{ct}, in a linear fashion. Essentially, the IV nonparametrically models selection into treatment for the endogenous binary treatment variable. Because conditional expectations are general unknown, I replace them with nonparametric conditional mean estimators $\hat{\mathbb{E}}(Y_{ct}|Z_{1,ct})$ and $\hat{\mathbb{E}}(DEMIL_{ct}|Z_{1,ct})$. Thus, I can regress $Y_{ct} - \hat{\mathbb{E}}(Y_{ct}|Z_{1,ct})$ on $DEMIL_{ct} - \hat{\mathbb{E}}(DEMIL_{ct}|Z_{1,ct})$ for an unbiased estimator. I place this process in the CSDiD framework with group-time estimators to estimate the treatment effects of demilitarization with the instrument of contiguous offensive weapon systems.

1.5.3 IV Results

Estimates for the effect of demilitarization and militarization, instrumented by contiguous offensive weapon systems, using the CSDiD approach are listed in table 1.4. Panel A of that table shows CSDiD IV estimates for all permanent demilitarizations. This includes both strong and weak episodes. Panel B and C separate out demilitarizations by intensity with B estimating only strong episodes and C weak episodes. Panel D reports estimates for all episodes of militarization.

Columns indicate a range of years around the transition and estimates are averaged together for those years. Standard errors clustered at the country-level are reported in parentheses below each coefficient. Coefficients in bold are statistically significant at least at the 90% confidence interval. Coefficients are of log GDP per capita multiplied by 100 for interpretation. Therefore, a coefficient of 16.713 (11 to 15 years after demilitarization) signifies that GDP per capita was more than 16 percent higher than if the country had remained militarized in that time period. The first column reports estimates for -20 to -1 years prior to demilitarization, or, pre-treatment period differences between soon to be treated units and comparison units.

Figure 1.12 plots the coefficients for panel A, all permanent demilitarization episodes. The results of the CSDiD estimation process for all permanent demilitarization episodes is roughly the same as the baseline CSDiD estimates in table 1.2. However, the IV estimates do yield slightly larger effect. 6 to 10 years after demilitarization (column (3)), the treatment effect is statistically significant at the 90% confidence interval. The coefficient reported in column (3) is 8.587% (s.e. 4.492). The estimation continues to rise and peaks just after 25 years post-transition. Column (7) shows average coefficients 26 to 30 years after demilitarization. The result is statistically significant at the 95% confidence interval and the coefficient is 30.233% (s.e. 14.378). Given that column (1) shows the semiparametric IV does an excellent job of weighting in the pre-treatment period (average difference between treated and untreated units over 20 years is less than a quarter of a percent), I am confident in saying that my baseline estimation is robust to endogenous selection into treatment and that my initial findings may even be slightly underestimated.

Figure 1.13 plots the coefficients for strong and weak permanent demilitarization episodes, estimated with the CSDiD IV approach. Subplot (a) shows strong demilitarization episodes. The blue connected line plot is for the coefficients of the estimation process and the shaded area is a 95% confidence interval. Subplot (b) show weak demilitarization episodes. Both plots show that the model is well-fit in the pre-treatment period. In column (1) panel B, strong demilitarization episodes exhibit a difference of 1.132% (s.e. 1.588) between treated and untreated units in the pre-treatment period. Weak demilitarization episodes in panel C have a difference of -1.581% (s.e.

2.611). Both show a similar pattern of economic growth as was depicted in table 1.2 with the baseline estimates. Strong demilitarization episodes max out closer to 30 years after treatment. Column (7) shows that average GDP per capita was 44.335% (s.e. 11.880) larger 26 to 30 years after demilitarization compared to the choice to remain militarized. This estimate is at the 99% confidence interval. Weak demilitarization episodes in panel C actually see statistically significant growth 11 to 20 years after transition. Column (5) has a coefficient of 16.102% (s.e. 9.530) that is at the 90% confidence interval. However, that growth trend decline rapidly 25 years after transition. Once again, we see that weak demilitarization episodes have very little impact on growth when compared to strong demilitarizations.

Figure 1.14 plots the coefficients for militarization episodes, estimated with the CSDiD IV approach. The blue connected line plot shows the coefficients at different timings around the militarization episode and the shaded area is a 95% confidence interval. Militarization episodes under the IV specification follow a virtually identical pattern to the non-IV specification. 6 to 10 years after militarization (column (3)), treated countries have on average 21.542% (s.e. 11.164) lower GDP per capita that if they had remained demilitarized. In column (8), the loss from militarization peaks at -34.595% (s.e. 19.344) and is at the 90% confidence interval. The IV estimations serve as a check on my baseline results and confirm that that differences in the distribution of GDP between treated and untreated units are not reflecting differences generated by the treatment selection process, but the actual effect of treatment. With the estimates in table 1.4, I have greater confidence that I am estimating the causal effect of demilitarization and militarization on GDP per capita.

1.6 Potential Mechanisms

Next, I turn my attention to the potential mechanisms which may be driving economic growth. Existing research on this topic has found that reduced military capacity spurs economic growth by a changing perception of the country on the international stage, as well as a shock to factors of the neoclassical growth framework. Wisniewski and Pathan [2014] find that reduced military spending leads to increased foreign direct investment (FDI). Similarly, Acemoglu and Yared [2010] find that by reducing the number of troops and money spent on the military, a country becomes a more attractive trade partner. Loayza et al. [1999] study the effects of decreased military spending on all three factors of neoclassical growth. With this understanding, I look for empirical evidence of these mechanisms impacting growth. I use the same CSDiD specification as my baseline results and evaluate several mechanisms. To do this, I replace log GDP per capita with each of the potential mechanisms iteratively as the dependent variable. Estimates are presented in table 1.5.

Figure 1.15 is dedicated to understanding how changes in the external appearance of a country may affect growth stimulating factors. Subplot (a) plots bilateral trade flows for strongly demilitarizing countries. The x-axis of the figure is the time around each demilitarization episode. Subplot (b) plots bilateral trade flows for all militarization episodes. Subplot (c) plots foreign direct investment inflows for strong demilitarization episodes. Subplot (d) plots FDI inflows for militarization episodes.

The evolution of trade flows around demilitarization and militarization is unsurprising. In panel A column (5) of table 1.5 (16 to 20 years after transition), strong demilitarization countries have a total bilateral trade (per capita) flow level that is 43.138% (s.e. 10.818) higher than if they had remained militarized. This coefficient is statistically significant at the 99% confidence interval. In that same time period, militarization episodes have a trade flow that is -49.312% (s.e. 25.473) lower than if the country had remained demilitarized. These results have a lot to do with sanctions and international perception. Countries are often economically sanctioned as a way to induce behavior changes. Mayberry [2022a] finds that Pakistan was severely sanctioned in an attempt to discourage the expansion of its nuclear weapons' program. Trade flows dramatically fell for Pakistan and its economy under-performed for over a decade. The average number of economic sanctions on strongly demilitarization countries 5 years before transition is more than 12. 5 years after demilitarization, that number is just over 7. Sanction's relief and sanction's punishment are inextricably linked to military behavior. Thus, the choice between demilitarization and militarization will have a substantial influence on the ability of a country to trade internationally.

Foreign direct investment inflows also expand significantly for strongly demilitarizing countries. In panel B column (6) of table 1.5 (21 to 25 years after transition), strong demilitarization countries have foreign direct investment inflows (per capita) that are 137.370% (s.e. 72.173) higher than if the country had remained militarized. This coefficient is statistically significant at the 90% confidence interval. Countries choosing to militarize have no statistically significant difference from the semiparametric counterfactual. This result confirms early findings from Collier [1999]. Foreign capital is risk averse and weary of violent conflict. No one wants to build a factory where it might be blown up or attacked. This outcome is increasingly likely in a country that is heavily militarized and prepared for violent conflict. As shown in figure 1.15 subplot (c), there seems to be a large foreign capital influx as a result of demilitarization. Together with subplot (a) and (b), these results empirically confirm that the international community views demilitarized countries as more favorable investment opportunities and more viable trade partners.

Figure 1.16 is dedicated to understanding how a country allocated resources which in turn affect growth. Subplot (a) plots total factor productivity for strongly demilitarizing countries. The x-axis of the figure is the time around each demilitarization episode. Subplot (b) plots TFP for all militarization episodes. Subplot (c) plots total capital stock for strong demilitarization episodes. Subplot (d) plots capital stock for militarization episodes.

The evolution of total factor productivity can be ascribed to refocusing of research and development resources to market-oriented goals [Knight et al., 1996]. In panel D column (7) of table 1.5 (26 to 30 years after transition), strong demilitarization countries have a welfare-relevant TFP level that is 21.410% (s.e. 6.816) higher than if they had remained militarized. This coefficient is statistically significant at the 99% confidence interval. Countries choosing to militarize have no statistically significant difference from the semiparametric counterfactual until more than 30 years after transition. While these results are not as compelling as some other potential mechanisms, it certainly raises questions as to whether R&D focused on market-oriented solutions (as opposed to military R&D) may explain the economic growth associated with demilitarization.

Capital stock levels expand significantly for strongly demilitarizing countries. In panel C column (5) of table 1.5 (16 to 20 years after transition), strong demilitarization countries have a capital stock level (per capita) that is 76.186% (s.e.25.526) higher than if the country had remained militarized. The difference between demilitarizing countries and the counterfactual continues to expand and reaches 170.896% (s.e. 50.257) in column (8). This coefficient is statistically significant at the 99% confidence interval. Countries choosing to militarize have no statistically significant difference from the semiparametric counterfactual. This result is confirmation of some of the original Guns vs Butter arguments. I prefer to think of this as Tanks vs Tractors. Guns vs Butter creates an image of consumption whereas Tanks vs Tractors is a state-level decision on where to investment resources. With demilitarization, a country allocates more resources to economically productive capital accumulation. Tanks are not economically productive pieces of capital as they are only useful in a military setting. Tractors on the other hand, are economically productive capital with countless uses. As shown in figure 1.16 subplot (c) and (d), the large increases in capital for demilitarizing countries are immediate, large, and sustained. No such growth occurs for countries choosing to militarize.

Figure 1.17 is dedicated to understanding how a country shifts policy priorities around demilitarization. Subplot (a) plots infant mortality rate for strongly demilitarizing countries. The x-axis of the figure is the time around each demilitarization episode. Subplot (b) plots infant mortality rate for all militarization episodes.

The evolution of infant mortality rate around demilitarization and militarization is something that surprised me in writing this paper. In panel E column (5) of table 1.5 (16 to 20 years after transition), strong demilitarization countries have an infant mortality rate that is -16.524% (s.e. 5.837) lower than if they had remained militarized. This coefficient is statistically significant at the 99% confidence interval. In that same time period, militarization episodes have an infant mortality rate that is 22.350% (s.e. 10.668) higher than if the country had remained demilitarized. One observation I have of demilitarizing countries is that they may be shifting public funds that would normally be spent on the military into healthcare. The long-run impact may be a larger, healthier labor force for those countries. Conversely, it is also possible that ending a violent conflict or violent society may generally improve infant mortality. If there are less bombs exploding, it tracks that there would be fewer infant deaths. Summarily, total factor productivity, labor force, and the capital stock of a country constitute the inputs of the neoclassical growth framework. The figures presented in this section and show how they are all positively affected following demilitarization. This helps to explain the large and significant economic growth associate with demilitarization, and the downward trend in growth I see with militarization.

1.7 Conclusion

In this paper, I offer a new perspective on global political transitions. I find that demilitarization has been a significant political development in the past several decades. The end of the Cold War brought with it a new outlook on defense policy for many countries and a shift in the demand for securitization. I create a new data set to explore the institutional military changes of countries around the world. In order to estimate how demilitarization has impacted GDP per capita, there are several empirical challenges that I must overcome. I utilize a semiparemetric estimation framework calibrated to handle staggered adoption of treatment, divergence of treated and untreated units in the pre-treatment period, and endogenous selection into treatment. Reassuringly, these estimations all yield similar results. I estimate that demilitarization is associated with a 1% higher annual GDP per capita than if the country had remained militarized. Dynamic analysis shows that on average, GDP per capita is 15-20% higher 20 years after transition. These results are found to be driven by cases of stronger, more substantial military reforms. I also find that militarization is associated with a -2% lower annual GDP per capita than if the country had remained demilitarized. Dynamic analysis shows that on average, GDP per capita is around 30% lower 20 years after transition.

This result appears importantly driven by external and internal investment decisions. Increased foreign direct investment and larger international trade flows depict an environment described by Acemoglu and Yared [2010] and Wisniewski and Pathan [2014]. Countries may shift trade and financial flows based on military institutions. That is, the international community may be viewing a country with demilitarized institutions as a more stable and profitable investment opportunity. Internally, demilitarizing countries reallocate money and resources into more economically productive avenues. Increasing TFP through increased R&D, having a positive impact on the labor force with improved healthcare, and making the long-term investment in market-oriented capital to create a more prosperous society. Demilitarization appears to have a major impact on the way a country views its economy. Together, my findings provide empirical evidence of a Peace Dividend.

The limitations of this study are based on the lack of randomization for selection into treatment. As with other studies on the effect of institutions for economic growth, countries choose to take on reforms for endogenous reasons. Future work on this important question should look for specific natural experiments or possible micro-level variation to further establish causality. Until that point, this paper should be viewed more for introducing the broader concept of demilitarization and reporting important facts of the case. Causality in this paper relies on the varied estimation techniques used. This is of course just a stopgap for actual exogenous variation that rarely exists in a macro-setting. This study will hopefully spur on a new discussion among political economists regarding attitudes towards violent conflict. Specifically, how they have evolved and how they may benefit global economies in the way democratization and liberalization have been found to do in recent decades.

Notes

[1]There has been an historical skepticism among academics and politicians who believe that militarization promotes economic growth through positive security related effects, research and development (R&D) breakthroughs, and fiscal stimulus (Hamilton et al. [2009]; Alptekin and Levine [2012])

[2]The Peace Dividend was part of a campaign slogan for President George H.W. Bush during the 1992 election against future President Bill Clinton. The idea is that a reduction in military spending, forces, and posturing would bring economic prosperity to not only the U.S., but to all countries that took part. Empirically tested by Knight et al. [1996], Mintz and Stevenson [1995], Mintz and Huang [1990], and Gleditsch et al. [1996].

[3]Studies focused on other institutional transitions that have garnered more academic attention. For democratization, see: Barro [1991]; Papaioannou and Siourounis [2008]; Acemoglu et al. [2019]. For economic liberalization, see: Sachs et al. [1995]; Wacziarg and Welch [2008]; Grier and Grier [2021]

[4]Known as demilitarization.

[5]The parallel trends assumption states that, although treatment and comparison groups may have different levels of the outcome prior to the start of treatment, their trends in pre-treatment outcomes should be the same. The Ashenfelter Dip, described in Ashenfelter [1978], is an empirical regularity that the mean outcome of treatment units declines during the period just prior to treatment.

[6]Other papers covering this topic: Athey and Imbens [2021]; Ben-Michael et al. [2019]; Sun and Abraham [2020]

[7]Contiguous threats are a sum of offensive military units from countries which are considered attached to the country in question. This is discussed in detail later in the paper.

[8]Dunne and Tian [2020] state that: "...a long-standing, impressively large, and growing literature appeared to have failed to result in a scholarly consensus on the effects of military expenditure on economic growth. But the availability of 20 more years of data since the end of the Cold War has helped researchers ... the findings reported here suggest that reducing military expenditure need not be costly and may contribute to improved economic performance, especially in developing countries."

[9] Alptekin and Levine [2012] conduct a meta-analysis of existing military expenditure studies and find "that the hypothesis of a negative military expenditure–growth relationship is not supported for both LDCs and in general, while a positive effect of military expenditure on economic growth is supported for developed countries."

[10]I am defining military capacity as the state which a country falls into. Either militarized or demilitarized.

[11]Abu-Qarn and Abu-Bader [2008] show that detecting a structural break in the percentage of GDP allocated to military expenditures meets the criteria for identifying the moments of change. Zivot and Andrews [2002] tests for the null hypothesis of existence of a unit root against an alternative of a single structural break. Model A.1.1 allows on time change in the level of series, model A.1.2 allows one time change in the slope of the trend function for the series,

and model A.1.3 allows both [Manamperi, 2016]. Regressions are as follows:

$$\Delta y = \mu + \beta_t + \alpha y_{t-1} + \theta DU_t + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \tag{A.1.1}$$

$$\Delta y = \mu + \beta_t + \alpha y_{t-1} + \theta DT_t + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \tag{A.1.2}$$

$$\Delta y = \mu + \beta_t + \alpha y_{t-1} + \theta DU_t + \theta DT_t + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \tag{A.1.3}$$

where DU_t and DT_t are break dummy variables for a mean shift and a trend shift, occurring at every possible break point $T_B(1 < T_B < T)$.

$$DU_t = \begin{cases} 1; & \text{if } t > T_B \\ 0; & \text{otherwise} \end{cases} \tag{A.1.4}$$

$$DT_t = \begin{cases} t - T_B; & \text{if } t > T_B \\ 0; & \text{otherwise} \end{cases} \tag{A.1.5}$$

The null hypothesis is $H_0 : \alpha = 0$, series exhibits a unit root without a drift and excludes any structural break points. Alternative hypothesis is $H_a : a < 0$, series is trend stationary with an unknown one time break. Number of lags, k, is determined for each possible break point by Akaike information criteria [Manamperi, 2016]. By using this alternative hypothesis to identify moments of structural break that would otherwise interrupt the time series and most econometric models, I can establish points in which a given country diverged on its path of military decision making. I apply this test to each country in the SIPRI military expenditure as a percentage of GDP data set from 1960-2019 and compile all statistically significant instances of structural breaks.

[12]For me, this is the lags of GDP and time effects.

[13]This assumption establishes independence conditional only on $DEMIL_{ct-1} = 0$, because I am just looking at the actual transitions to a demilitarized state.

[14]See Jordà [2005] and Kline [2011] for example.

[15]I am not imposing any linear dynamics on GDP here, as I am estimating the counterfactual separately for each s.

[16]See Angrist and Kuersteiner [2011] and Angrist et al. [2018] for example

[17]In the appendix, supplementary table **??** and supplementary figure **??** show the results from the probit model and the implied propensity scores. These results confirm that propensity scores for demilitarizing countries and those remaining militarized have a common support.

[18]Those are the linear model for potential outcomes and the probit model for demilitarizations.

[19]See Athey and Imbens [2021]; Ben-Michael et al. [2019]; Goodman-Bacon [2021]; Sun and Abraham [2020]; and De Chaisemartin and d'Haultfoeuille [2020] for reference.

[20]Helpful explanation of CSDiD: https://causalinf.substack.com/p/callaway-and-santanna-dd-estimator

[21]Graphical evidence confirming the common support assumption is found in supplementary figure AA2. All other assumptions are consistent with the Abadie doubly robust estimator and are evident upon observing the data.

[22]For example, the estimate for year 1 to 5 post-demilitarization is the average treatment effect for those years.

[23]The 'floating' units are found to be a cardinal sin in Goodman-Bacon [2021]. Using a previously treated unit in the comparison group could significantly bias results.

[24]For more information on SCM, see Abadie et al. [2010] or Bilgel and Karahasan [2019]

[25]$\wedge$ is a symbol for logical AND, meaning both conditions must be satisfied.

[26]The COW contiguous database accounts for water contiguity. From COW: "Water contiguity is based on whether a straight line of no more than a certain distance can be drawn between a point on the border of one state, across open water (uninterrupted by the territory of a third state), to the closest point on the homeland territory of another state. Four different levels of water contiguity are recorded, based on the distance between the two states' territories: up to 12 miles (reflecting the widely recognized 12-mile limit for territorial waters), 24 miles (reflecting the maximum distance at which two states' 12-mile territorial limits can intersect), 150 miles (from the original 1816-1965 version of the data set, reflecting what was considered the average distance that a sailing ship could travel in one day), and 400 miles (the maximum distance at which two 200-mile exclusive economic zones can intersect)." This condition brings Russia, the Bahamas, and Cuba into the sphere of contiguous countries for the United States.

Tables

Table 1.1: Recent Military Transitions Chronology (1960-2019)

Strong, Permanent Demilitarization Episodes (32 in total)	
Country and Year	Description
Albania (1992)	End of the Cold War, former Soviet satellite.
Angola (2002)	End of Angolan Civil War.
Argentina (1982)	Conscription ended by law on January 5th, 1995.
Australia (1972)	End of Australian involvement in Vietnam. Re-evaluation of military polities and position in the world.
Bolivia (1983)	End of military dictatorship in 1982. Reforms to military followed.
Bosnia and Herzegovina (2007)	Unification of forces in 2005. End of conscription in 2006. Finalized reforms about a decade after Bosnian War.
Brazil (1985)	End of military regime in 1985. Nuclear program dismantled in 1990.
Bulgaria (1994)	Member of the Warsaw Pact and close ally of the Soviet Union. Political transition after the Cold War leads to military reforms.
Cambodia (1999)	Coup in 1997 leading to the eventual end of civil conflict and the disarmament of the Khmer Rouge.
Canada (1968)	1968 was the year of unification for the Canadian armed forces after a white paper in 64 advocated for it. This lead to a condensing of military structure and influence. Eventually removed U.S. nuclear weapons stationed in Canada.
Croatia (1998)	Formalized independence by 1998 and joined the NATO Partnership for Peace in 2000, leading to post-conflict demilitarization.
Dominican Republic (1966)	Assassination of military-centric dictator Trujillo in 1961 eventually lead to military reforms. Namely, conscription and resource allocation.
El Salvador (1992)	End of Salvadoran Civil War in early 1992.
Ethiopia (1992)	End of Ethiopian Civil War in 1991.
France (1966)	Under de Gaulle, launched the Force de dissuasion in 1961. He signed the Élysée Treaty in 1963, building Franco-German cooperation, a key to European integration. In 1966, he withdrew France from NATO integrated military command and had American military personnel stationed on French soil sent home. All part of broad initiative to demilitarize France.

Greece (1980)	End of military regime in 1974. Rejoins NATO in 1980.
Honduras (1991)	The ending of civil wars in neighboring countries El Salvador and Nicaragua (and also Guatemala in 1996) lead to substantial military budget cuts.
Hungary (1990)	Former Soviet satellite, ceased having military forces supplied by the Soviet Union after the end of the Cold War. Significantly reduced military capacity.
Indonesia (1998)	Ousted military dictator Suharto in 1998. Democratic reforms lead to reduction in military power and capacity.
Kuwait (2001)	After 9/11, Kuwait declared one of 15 strategic non-Nato allies in the war on terror. U.S. military builds 8 bases in the country. Kuwait strategically reduces military capacity.
Malaysia (1986)	The ascension of Mahathir Mohamad to Prime Minister in 1981 saw the implementation of a number of reforms. These included reforms to the military and other institutions in an effort to promote economic growth.
Nicaragua (1990)	Contra War (civil conflict) ended with general election in 1990.
Panama (2000)	Mireya Moscoso, widow of former President Arnulfo Arias Madrid who was removed in a military coup 3 different times, becomes president at the end of 1999. Like her former husband, Moscoso strongly opposed military influence in Panamanian politics.
Paraguay (1989)	Military dictatorship involved in Operation Condor ends in 1989.
Peru (1991)	Strong military infrastructure up to the 1990s. The Peruvian armed forces grew frustrated with the inability of the García administration to handle the nation's crises and drafted Plan Verde – which involved a genocide of indigenous people, government censorship, and the establishment of a military junta to lead the country. Fujimora becomes president in 1990, adopts some of the Plan Verde policies, but takes power away from military and reduces its capacity.
Poland (1989)	Former Soviet satellite state. Tremendous amount of political and military reform following election of partially free parliament in 1989 and eventual collapse of the Soviet Union/end of Cold War.
Portugal (1975)	Carnation Revolution ends dictatorship and reduces military prevalence.
Romania (1993)	End of Cold War, former Soviet satellite state.
Sierra Leone (1998)	End of Sierra Leone Civil War that lasted from 1991-2002. Peace talks seriously begin in 1998.

Slovakia (2000)	Former Soviet Satellite state when part of Czechoslovakia. After the Cold War and break with Czech, military reforms instituted as there was less perceived threat of conflict.
South Africa (1992)	End of the Apartheid. A number of reforms to reduce military capacity and power. Only country in history to successfully develop and nuclear weapon and then completely dismantle stockpile.
Tanzania (1983)	Following the invasion and occupation of Uganda (Idi Amin) in 1980 after a Uganda invasion in 1978, started to demilitarize.

Weak, Permanent Demilitarization Episodes (19 in total)

Country and Year	Description
Bahrain (1989)	Large reduction in military capacity at the end of Iran-Iraq war.
Belarus (1998)	At the end of the Cold War, Soviet nuclear weapons were still deployed in Belarus. In 1992, Belarus signed the Lisbon Protocol, agreeing to join the Treaty on the Non-Proliferation of Nuclear Weapons. Weapons were eventually dismantled. Country still maintains a robust military industrial complex.
Benin (1993)	After decades of coups and military dictatorships, the country creates a multi party system in 1991 that ends much of the internal conflict, military reforms.
Czech Republic (2007)	Varied set of reforms, includes ending conscription in 2005.
Ecuador (1979)	End of military lead governments in 1979.
Ghana (1994)	End of Konkomba–Nanumba conflict (also known as the Guinea fowl war).
Guyana (1985)	Massive decline in the Guyana economy throughout the 1980s. Conscription ended and other reforms taken to save money and rebound economy.
Kenya (1983)	Failed military coup in 1982 increases distrust and military, leads to reforms.
Latvia (2006)	Conscription abolished in 2007 as part of a refocusing for the Latvian armed forces after involvement in both Afghanistan and Iraq in the early 2000s.
Liberia (2004)	Second Liberian Civil War ends in 2003.
Lithuania (2008)	Joins NATO in 2004, ends conscription in 2008.
Mongolia (1992)	Close ally of the Soviet Union. Military capacity reduces after Cold War.
Mozambique (1991)	Peace talks for Mozambican Civil War start in 1991, war ends in 1992.
Namibia (1999)	End of Caprivi conflict.
Norway (1981)	Tax cuts and other such measures to improve stagflated economy, military spending cuts were part of this.

Slovenia (2003)	Reorganization of military after the Yugoslav Wars, leading to abolishment of conscription in 2003.
Uruguay (1986)	By 1984, the Civic-Military Dictatorship which had run the country since the U.S. backed coup in 1973 faced a general strike and increased opposition. This lead to elections in late-1984 and the eventual return to democracy by 1985. The subsequent reduction in military power followed.
Zambia (1991)	Many protesters were killed by the Zambian regime in breakthrough June 1990 protests. In 1990 President survived an attempted coup, and in 1991 he agreed to reinstate multiparty democracy, leading to military reforms.
Zimbabwe (1982)	End of Rhodesian Bush War in 1979. Military transition follows,.

Permanent Militarization Episodes (12 in total)

Country and Year	Description
Burundi (1976)	Military coup in 1976. Violent period follows, civil war and genocide.
Central African Republic (2004)	Central African civil war started in 2004.
Chad (1965)	Civil war begins in 1965. Constant conflict and military dictators have dominated the country since.
Gambia (1994)	Military coup and continued assertion of Gambian military thereafter.
Iran (1980)	Following revolution, becomes increasingly militarized. Establishment of the Iranian Revolutionary Guard Corps, Iran-Iraq war, initiation of nuclear program, and involvement with international terror groups.
Mali (1968)	Mali has military coup in 1968 after breaking away from colonial rule, consistent conflict and militarization follows.
Niger (1974)	First military regime takes control of Niger in 1974, holds until the 1990s. Civil conflict follows.
Rwanda (1990)	Start of Rwandan Civil War and genocide.
Sudan (1969)	Military coup in 1969 followed by a 20 year civil war.
Syria (1969)	Following the Ba'athist coup in 1963, tensions began to arise between party leadership and Hafez al-Assad (leader of the military) in the late 1960s. The Syrian Corrective Revolution (bloodless military coup) took place in 1970 and installed Assad as the military dictator of the country. Assad's family has been in power ever since. A brutal civil war has raged in Syria since 2010.

Turkey (1975)	Highly militarized in the early 20th century. Demilitarized for significant period of time. Turkey invades and occupies Cyprus in 1975 and remains militarized from that point forward. Maintains occupation.
Uganda (1971)	Idi Amin rises to power, destabilization and conflict follows.

Reversal Episodes, Mil-Demil-Mil (3 in total)

Country and Year	Description
Thailand (1988)	Country with multiple transitions. Became a constitutional monarchy in 1932. Alternated between democracy and military rule ever since. Most recently, country was ruled by a series of parliamentarians that sought to reduce military influence beginning in 1988. Ended in 2006 with the return of military rule.
Ukraine (1994)	Dismantled all nuclear weapons substantially reduced military capacity after Cold War. Reversal in 2014 with the Russian invasion of Crimea and return to a militarized state.
Georgia (1993)	End of civil conflict following the end of the Cold War and collapse of the Soviet Union. Reversal to a militarized states takes place in 2008 with the invasion of Georgia by Russia.

Reversal Episodes, Demil-Mil-Demil (2 in total)

Country and Year	Description
Chile (1973)	Pinochet takes power in 1973 as the military and political dictator of the country. Highly militarized and violent period of time for Chile. Pinochet removed from power in 1990 and reforms follow, signaling the reversal of state. Gabriel Boric was recently elected and named Maya Fernandez Allende as the defence minister. Her grandfather was overthrown by Chile's military in 1973. She plans to continue military reforms.

Sri Lanka (1983)	After decolonisation of Sri Lanka in 1948, the country remained demilitarized and relatively peaceful. However, in 1983, the country fell into a 26-year long civil war. The state military of Sri Lanka fought with the Liberation Tigers of Tamil Eelam who aimed for an independent nation of their own. The Liberation Tigers were finally defeated in 2009, bringing the civil war to an end. Since 2009, the country has undergone significant demilitarization. Several tribunals have been conducted to hold to account those who committed war crimes on both sides. The country seems determined not to fall back into a state of sustained violence.

Table 1.2: CSDiD Estimates of the Effect of Demilitarization and Militarization on (Log) GDP Per Capita

	Average effects on log GDP per capita from:							
	-20 to -1 Years (1)	1 to 5 Years (2)	6 to 10 Years (3)	11 to 15 Years (4)	16 to 20 Years (5)	21 to 25 Years (6)	26 to 30 Years (7)	31 to 35 Years (8)
	A. Permanent Demilitarizations							
Not yet treated controls	-0.051	1.358	5.353	**12.200****	**14.584****	**18.499****	**20.473***	16.697
(clustered s.e.)	(1.377)	(2.401)	(3.986)	**(5.598)**	**(6.941)**	**(9.275)**	**(11.235)**	(14.295)
Never treated controls	-0.141	1.111	4.867	**11.287****	**13.601***	**17.625***	**20.085***	16.044
	(1.406)	(2.422)	(4.052)	**(5.596)**	**(7.015)**	**(9.331)**	**(11.249)**	(14.268)
Alt. covariates, not yet	0.647	1.513	3.703	10.680	**18.772****	**28.215****	**36.964****	10.159
	(2.697)	(3.876)	(6.118)	(7.632)	**(8.525)**	**(12.115)**	**(14.603)**	(24.728)
	B. Strong, Permanent Demilitarizations							
Not yet treated controls	0.831	2.831	7.451	**13.752****	**17.636****	**24.963*****	**31.623*****	**31.934****
(clustered s.e.)	(1.510)	(3.162)	(5.119)	**(6.771)**	**(7.694)**	**(9.134)**	**(9.777)**	**(12.450)**
Never treated controls	0.928	3.328	7.906	**14.018****	**17.728****	**25.038*****	**31.873*****	**32.030****
	(1.533)	(3.186)	(5.120)	**(6.807)**	**(7.756)**	**(9.195)**	**(9.813)**	**(12.471)**
Alt. covariates, not yet	0.554	1.397	11.297	**23.997****	**30.455****	**45.906****	**47.791****	**57.285*****
	(2.517)	(4.544)	(7.606)	**(10.331)**	**(12.833)**	**(18.580)**	**(20.903)**	**(19.843)**
	C. Weak, Permanent Demilitarizations							
Not yet treated controls	-1.759	-1.828	1.051	8.519	7.267	4.239	-2.597	-16.340
(clustered s.e.)	(2.406)	(2.813)	(4.455)	(6.154)	(8.945)	(15.736)	(21.732)	(27.013)
Never treated controls	-1.902	-2.366	0.489	7.838	6.796	4.055	-2.597	-16.340
	(2.419)	(2.840)	(4.457)	(6.046)	(9.014)	(15.779)	(21.732)	(27.013)
Alt. covariates, not yet	-1.627	-3.467	2.855	6.491	2.036	-11.438	-18.908	-25.885
	(4.363)	(7.988)	(9.611)	(8.323)	(19.843)	(33.122)	(47.840)	(56.258)
	D. Permanent Militarizations							
Not yet treated controls	-0.879	-9.798	**-22.024****	**-27.254*****	**-33.894*****	**-39.823****	**-33.594***	**-34.444***
(clustered s.e.)	(2.347)	(6.772)	**(8.994)**	**(8.396)**	**(12.579)**	**(16.130)**	**(19.195)**	**(20.045)**
Never treated controls	-1.029	-10.059	**-22.252****	**-27.797*****	**-34.741*****	**-40.792****	**-34.525***	**-35.147***
	(2.336)	(6.637)	**(8.920)**	**(8.597)**	**(12.729)**	**(16.275)**	**(19.330)**	**(20.086)**
Alt. covariates, not yet	-1.452	6.316	-4.357	**-30.927****	**-38.758****	**-35.153***	-22.006	-8.556
	(3.376)	(13.206)	(15.085)	**(13.637)**	**(15.908)**	**(18.543)**	(31.789)	(37.869)

Notes: Table shows CSDiD estimates of the effect of a demilitarization and militarization on log GDP per capita over different time horizons.

Table 1.3: CSDiD Estimates of the Effect of Placebo on (Log) GDP Per Capita

	Average effects on log GDP per capita from:							
	-20 to -1 Years (1)	1 to 5 Years (2)	6 to 10 Years (3)	11 to 15 Years (4)	16 to 20 Years (5)	21 to 25 Years (6)	26 to 30 Years (7)	31 to 35 Years (8)
	A. Placebo Treatments							
Not yet treated controls	-0.159	-1.986	-4.909	-2.592	-3.967	5.348	8.577	-16.369
(clustered s.e.)	(2.428)	(3.740)	(6.671)	(8.232)	(9.648)	(8.815)	(14.073)	(36.049)
Never treated controls	-0.168	-1.919	-4.968	-2.684	-3.865	5.642	7.652	-17.711
	(2.453)	(3.794)	(6.820)	(8.379)	(9.785)	(8.869)	(13.950)	(35.832)
Alt. covariates, not yet	0.283	-4.087	-13.141	-11.216	11.275	9.027	-14.609	-24.839
	(5.851)	(8.906)	(15.260)	(20.175)	(22.432)	(32.023)	(36.889)	(49.881)

Notes: Table shows CSDiD estimates of the effect of a placebo treatment on log GDP per capita over different time horizons. Placebo treatments are countries that see a reduced security threat (contiguous country strongly demilitarizes) but remain permanently militarized. I list estimates of the average effect on the treated. Log GDP per capita is multiplied by 100, estimates are 'percent larger than if country had not transitioned.' The lone panel features a doubly robust estimator with three estimation techniques. Below each estimate I report robust standard errors clustered at the country level. Stars reported for significant levels: *, **, ***, for 90, 95, and 95 percent, respectively. Statistically significant results are in bold to aid visual interpretation.

Table 1.4: CSDiD Causal IV Estimates of the Effect of Demilitarization and Militarization on (Log) GDP Per Capita

	Average effects on log GDP per capita from:							
	-20 to -1 Years (1)	1 to 5 Years (2)	6 to 10 Years (3)	11 to 15 Years (4)	16 to 20 Years (5)	21 to 25 Years (6)	26 to 30 Years (7)	31 to 35 Years (8)
	A. Permanent Demilitarizations							
Not yet treated controls	0.202	2.996	**8.587***	**16.713****	**20.904****	**25.997****	**30.233****	24.463
(clustered s.e.)	(1.446)	(2.565)	**(4.492)**	**(6.525)**	**(8.135)**	**(10.579)**	**(14.378)**	(16.492)
	B. Strong, Permanent Demilitarizations							
Not yet treated controls	1.132	4.386	**10.829****	**18.181****	**23.395*****	**31.884*****	**44.335*****	**44.772*****
	(1.588)	(3.325)	**(5.506)**	**(7.432)**	**(9.071)**	**(10.439)**	**(11.880)**	**(15.205)**
	C. Weak, Permanent Demilitarizations							
Not yet treated controls	-1.581	0.478	4.144	**14.073***	**16.102***	11.055	-2.522	-26.865
	(2.611)	(3.021)	(5.165)	**(7.362)**	**(9.530)**	(17.425)	(27.638)	(21.823)
	D. Permanent Militarizations							
Not yet treated controls	-2.275	-8.505	**-21.542***	**-23.502****	**-29.774****	**-33.141****	**-33.941***	**-34.595***
	(12.219)	(7.728)	**(11.164)**	**(9.942)**	**(12.584)**	**(15.676)**	**(20.486)**	**(19.344)**

Notes: Table shows CSDiD IV estimates of the effect of a demilitarization and militarization on log GDP per capita over different time horizons. Each estimate is instrumented with contiguous offensive weapon systems. I list estimates of the average effect on the treated. Log GDP per capita is multiplied by 100, estimates are 'percent larger than if country had not transitioned.' All panels feature a doubly robust estimator. Each panel addresses a different type of transition. Below each estimate I report robust standard errors clustered at the country level. Stars reported for significant levels: *, **, ***, for 90, 95, and 95 percent, respectively. Statistically significant results are in bold to aid visual interpretation.

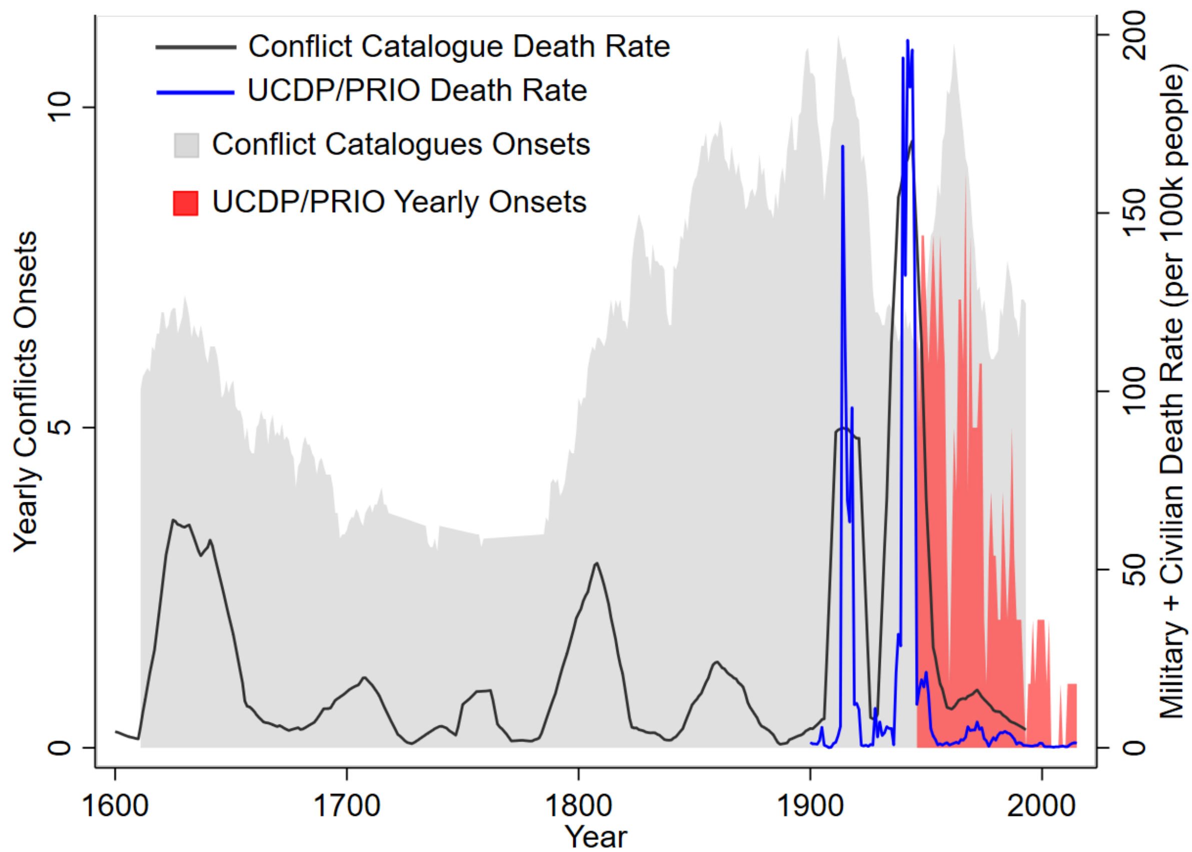
Table 1.5: CSDiD Estimates of the Effect of Strong Demilitarization on Potential Mechanisms

	Average effects on (log 'var')*100 from:							
	-20 to -1 Years (1)	1 to 5 Years (2)	6 to 10 Years (3)	11 to 15 Years (4)	16 to 20 Years (5)	21 to 25 Years (6)	26 to 30 Years (7)	31 to 35 Years (8)
	A. Total Bilateral Trade, per capita (international)							
Strong demilitarization	-0.914	5.052	**20.678*** **	**32.596*** **	**43.138*** **	**39.841*** **	**35.109** **	**57.732*** **
(clustered s.e.)	(3.575)	(5.097)	**(7.363)**	**(8.435)**	**(10.818)**	**(13.385)**	**(15.015)**	**(19.100)**
Militarization	1.283	-18.057	-14.208	-17.105	**-49.312* **	**-50.539* **	-55.621	-52.879
	(11.318)	(13.849)	(20.492)	(23.378)	**(25.473)**	**(29.737)**	(34.667)	(38.970)
	B. Foreign direct investment inflows, per capita							
Strong demilitarization	25.594	26.726	46.547	77.063	91.883	**137.370* **	**168.481* **	**235.323* **
	(39.479)	(22.742)	(31.725)	(50.505)	(58.664)	**(72.173)**	**(90.152)**	**(139.995)**
Militarization	5.311	12.781	26.245	5.481	10.915	20.022	31.370	22.934
	(9.074)	(13.607)	(21.699)	(30.966)	(28.982)	(33.825)	(44.069)	(49.404)
	C. Capital stock at current PPPs, per capita							
Strong demilitarization	7.809	**16.861*** **	**34.413** **	**51.038** **	**76.186*** **	**110.723*** **	**133.478*** **	**170.896*** **
	(3.532)	**(6.222)**	**(13.397)**	**(19.938)**	**(25.526)**	**(30.964)**	**(39.412)**	**(50.257)**
Militarization	-2.944	5.329	10.457	11.241	9.169	2.299	37.792	37.992
	(4.222)	(8.344)	(16.228)	(22.785)	(31.791)	(40.196)	(30.065)	(35.366)
	D. Welfare-relevant TFP levels at current PPPs							
Strong demilitarization	-0.096	1.947	6.342	**10.155* **	8.611	**12.782** **	**21.410*** **	**22.995*** **
	(1.453)	(2.623)	(4.029)	**(5.792)**	(5.544)	**(5.914)**	**(6.816)**	**(8.322)**
Militarization	-0.523	-3.298	-16.388	-15.048	-2.462	5.791	13.854	**21.094** **
	(2.875)	(9.017)	(11.282)	(9.409)	(12.178)	(13.711)	(16.303)	**(10.635)**
	E. Infant mortality rate							
Strong demilitarization	-0.026	-1.976	**-5.408* **	**-9.887** **	**-16.524*** **	**-26.355*** **	**-32.648*** **	**-33.164** **
	(0.429)	(1.531)	**(3.214)**	**(4.768)**	**(5.837)**	**(7.260)**	**(9.742)**	**(13.439)**
Militarization	1.886	**8.283*** **	**17.508*** **	**22.083*** **	**22.350** **	**21.978* **	23.297	25.056
	(0.731)	**(3.009)**	**(6.196)**	**(7.859)**	**(10.668)**	**(12.890)**	(17.207)	(19.774)

Notes: Table shows CSDiD estimates of the effect of a demilitarization and militarization on potential mechanisms over different time horizons.

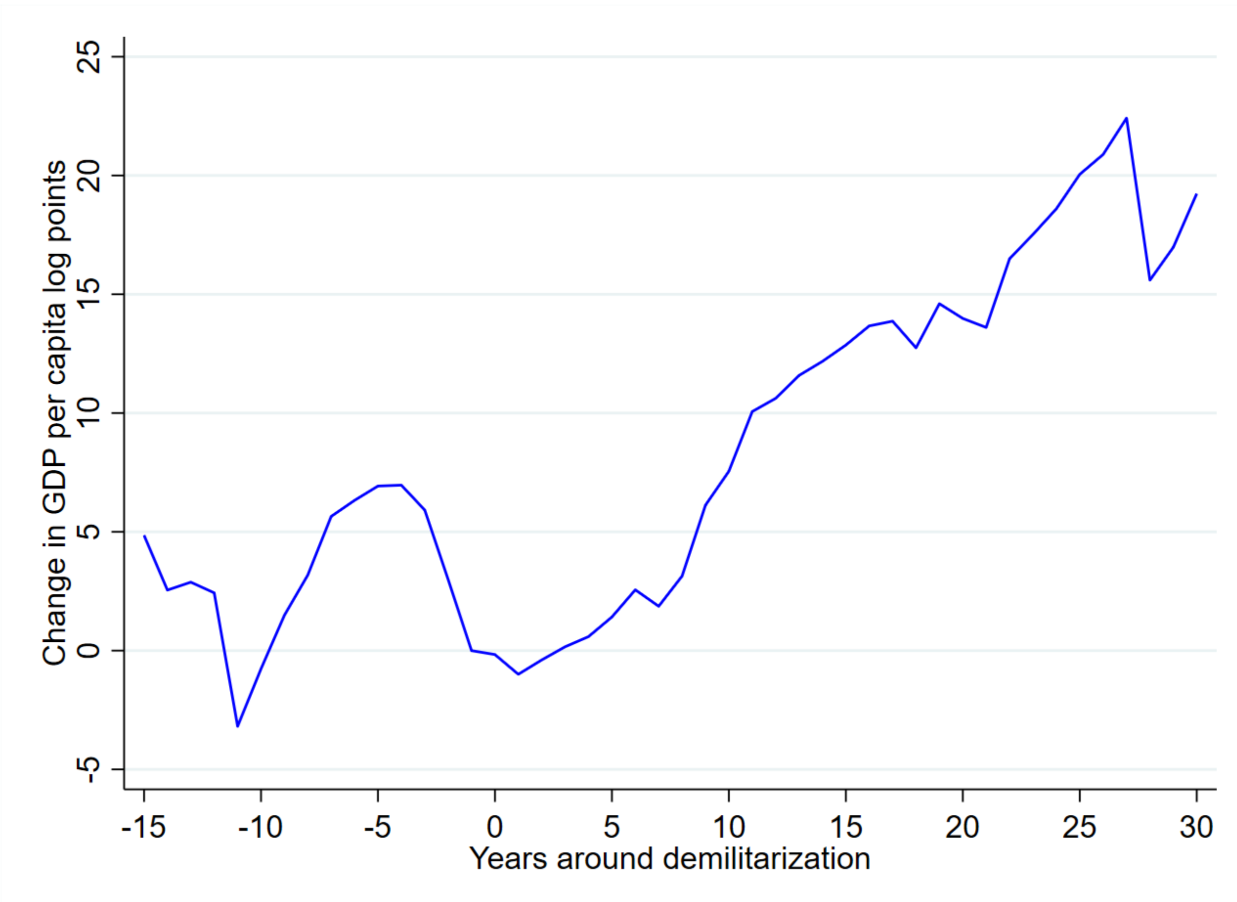
Figures

Figure 1.1: Long-Run Trends of Violent Conflict



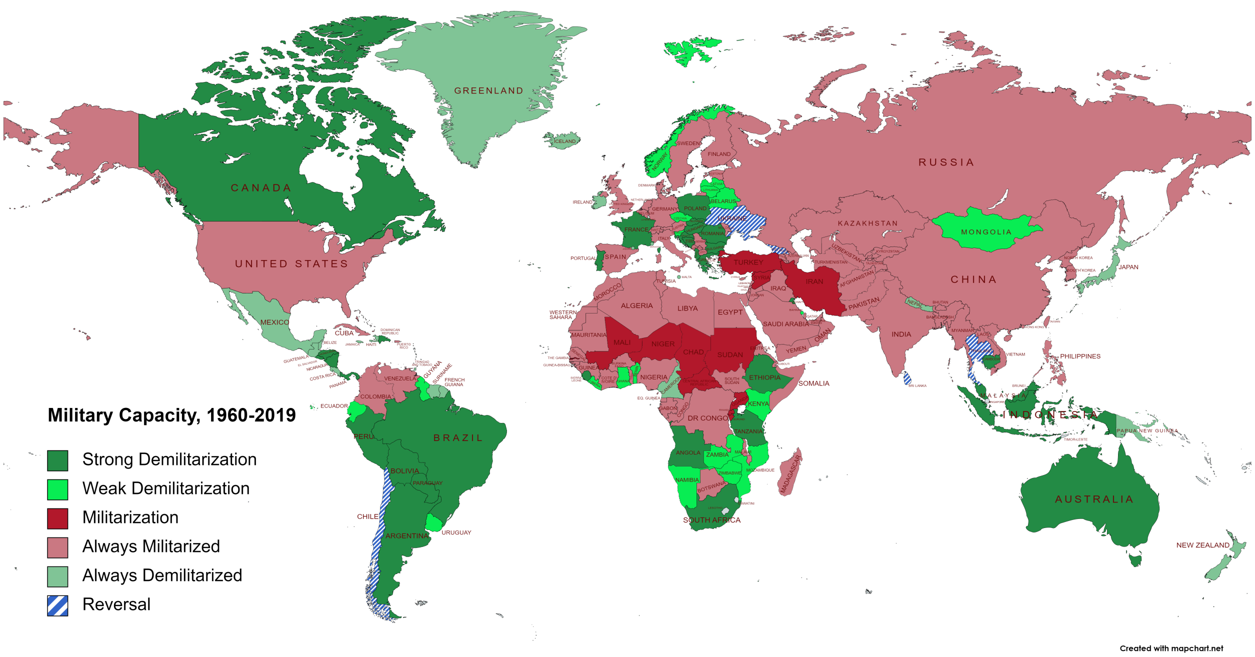
Notes: Figure 1.1 depicts the evolving nature of violent conflict since 1600. The Light gray area graph is the 15-year moving average of yearly conflict onsets from the Conflict Catalogue and is available up to 2000. The red area graph is yearly conflict onsets from the UCDP/PRIO dataset meeting the same qualifications as the Conflict Catalogue and is available from 1946 to present. The dark gray line graph is the 15-year moving average of civilian and military casualties per 100,000 people and comes from the Conflict Catalogue. The blue line graph is the yearly military casualties per 100,000 from the UCDP/PRIO dataset from conflicts meeting the same qualifications as the Conflict Catalogue.

Figure 1.2: Demilitarized vs. Militarized GDP Performance



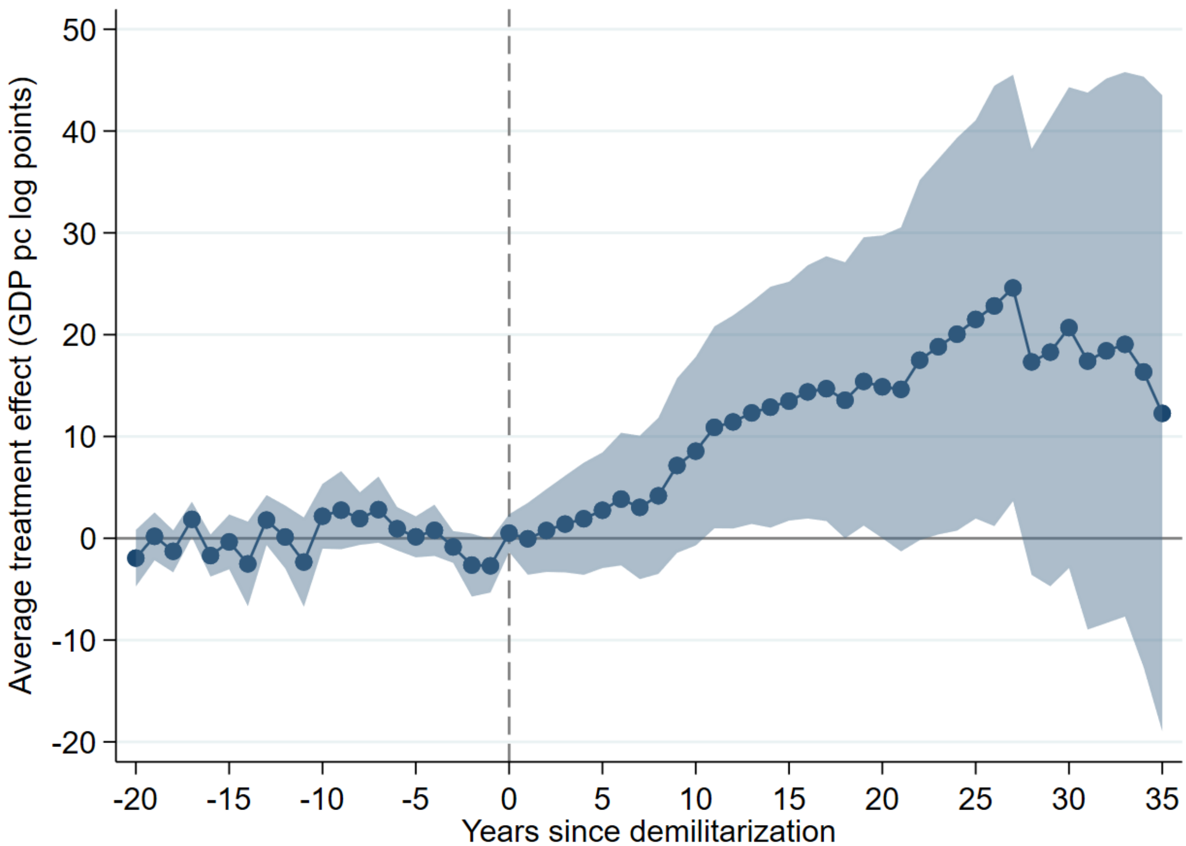
Notes: GDP per capita before and after a permanent (strong) demilitarization episode found in table 1.1. This figure plots GDP per capita in log points around a military transition relative to countries remaining militarized in the same year. I normalize log GDP per capita to 0 in the year preceding demilitarization. Time (in years) relative to the year of demilitarization runs on the horizontal axis.

Figure 1.3: Military Transition Episodes, 1960-2019



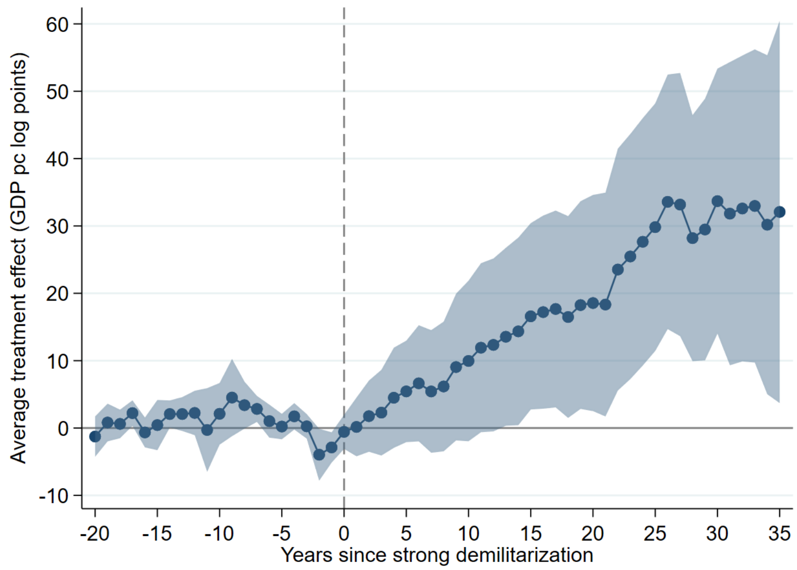
Notes: This map depicts demilitarization and militarization trends around the world. Dark green countries experience a strong, permanent demilitarization episode during between 1960 and 2019. Lighter green experienced a weak transition. Dark red identifies countries undergoing a militarization episode. Neutral red and green are for countries that are always sorted into one of the two categories. The 5 countries with blue stripes undergo a transition only to have it reversed after more than 10 years. Recognize that the demilitarization episodes are highly concentrated by region: Southeast Asia, Latin and South America, Sub-Saharan Africa, as well as Eastern Europe. All episodes are listed and qualitatively defined in table 1.1.

Figure 1.4: Effect of (all) demilitarization episodes on GDP per capita

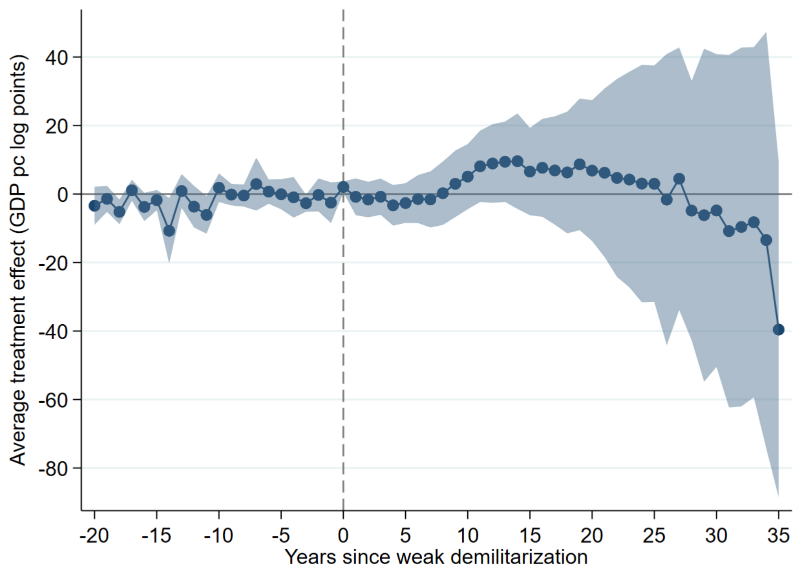


Notes: CSDiD group-time estimates of the over-time effects of all demilitarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of demilitarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that demilitarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust.

Figure 1.5: Effect of strong/weak demilitarization episodes on GDP per capita



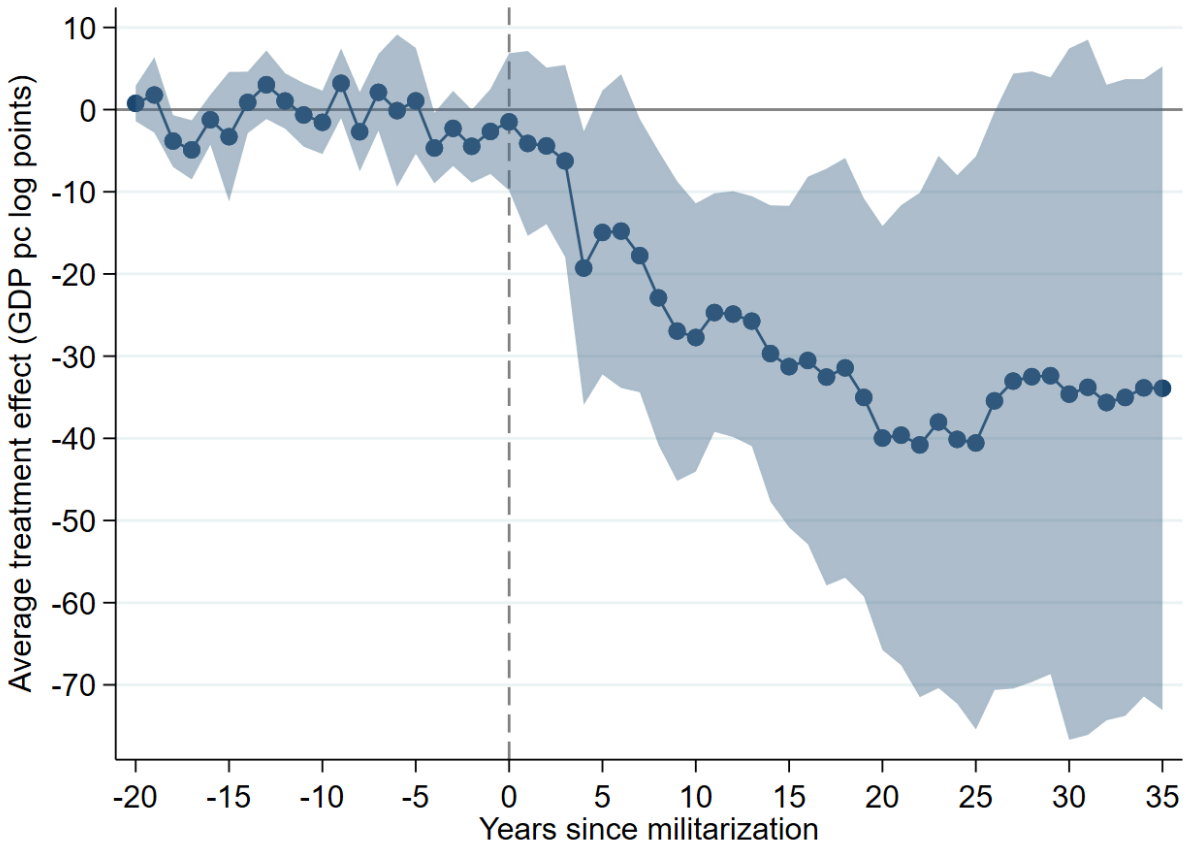
(a) Strong demilitarization episodes



(b) Weak demilitarization episodes

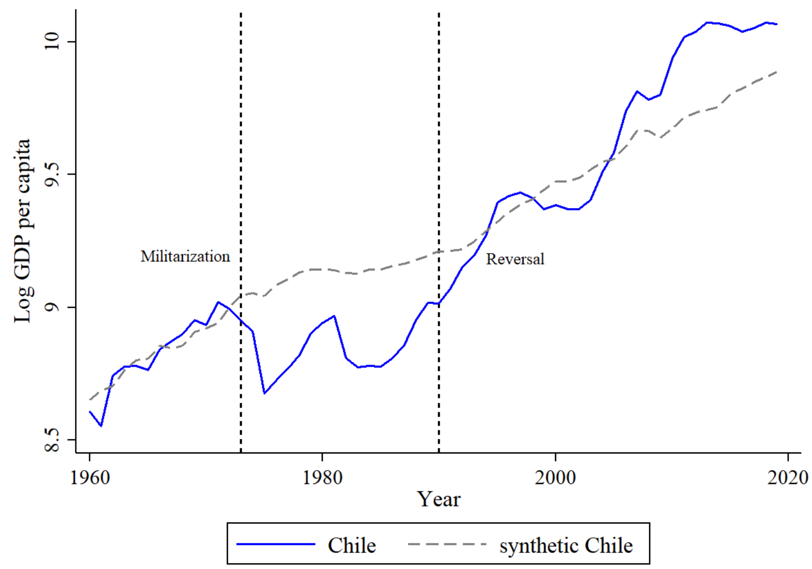
Notes: CSDiD group-time estimates of the over-time effects of strong and weak demilitarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of demilitarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that demilitarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust. Subplot (a) shows all cases of strong demilitarization. Subplot (b) shows all cases of weak demilitarization.

Figure 1.6: Effect of militarization episodes on GDP per capita

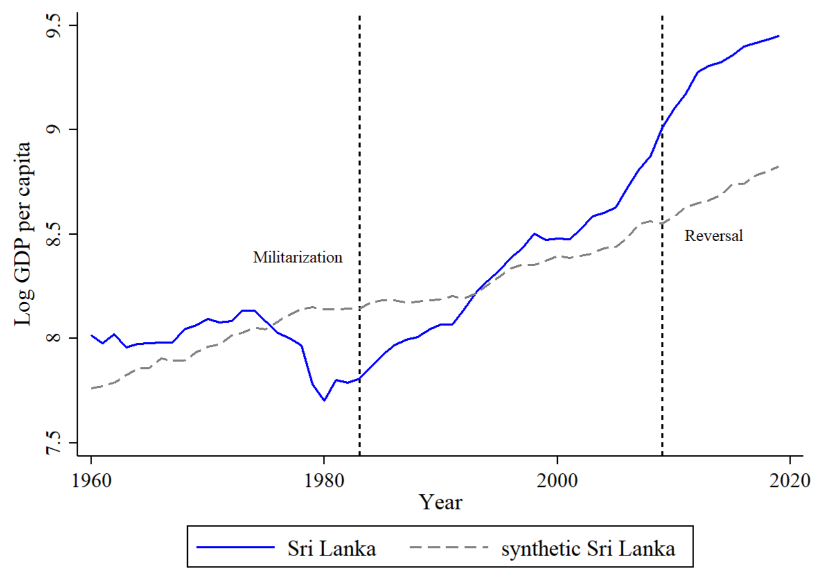


Notes: CSDiD group-time estimates of the over-time effects of militarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of demilitarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that militarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for militarizations based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust.

Figure 1.7: Synthetic Control Estimates: Effect military reversals on GDP per capita



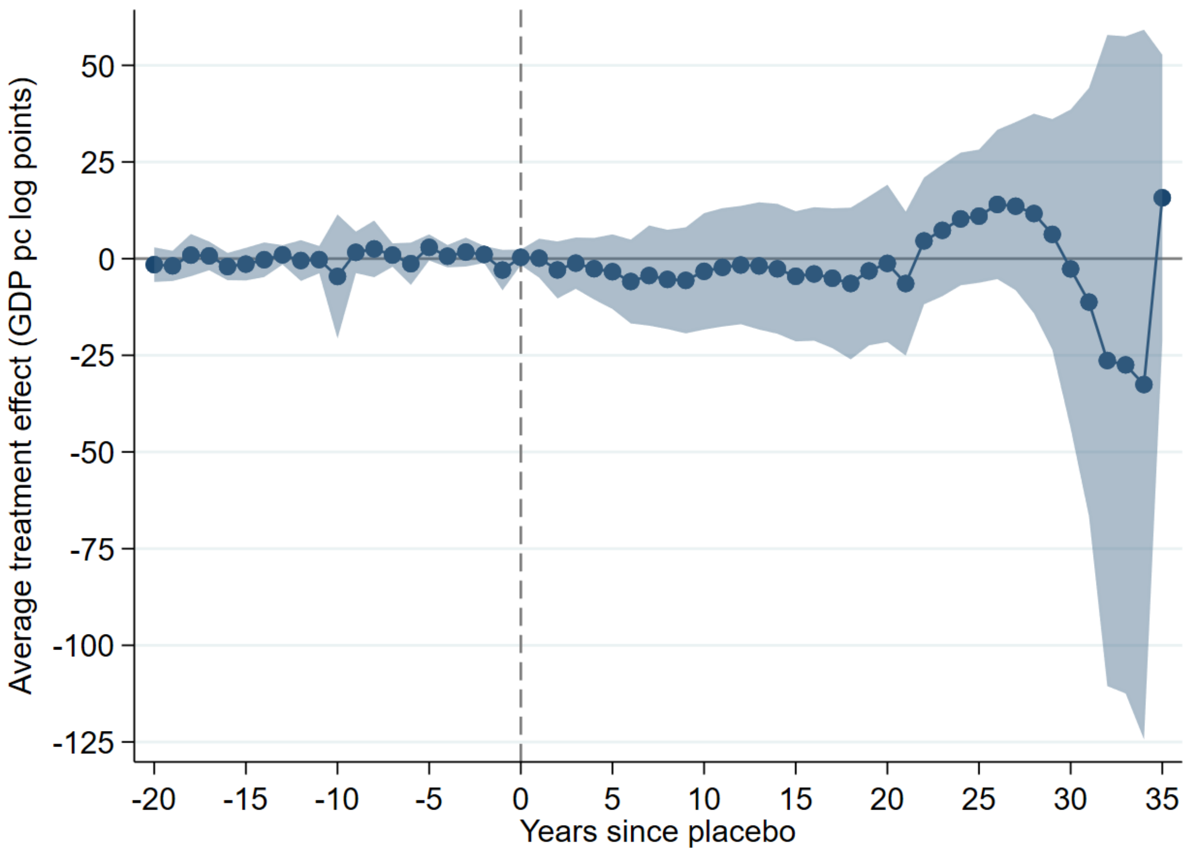
(a) Chile reversal case study



(b) Sri Lanka reversal case study

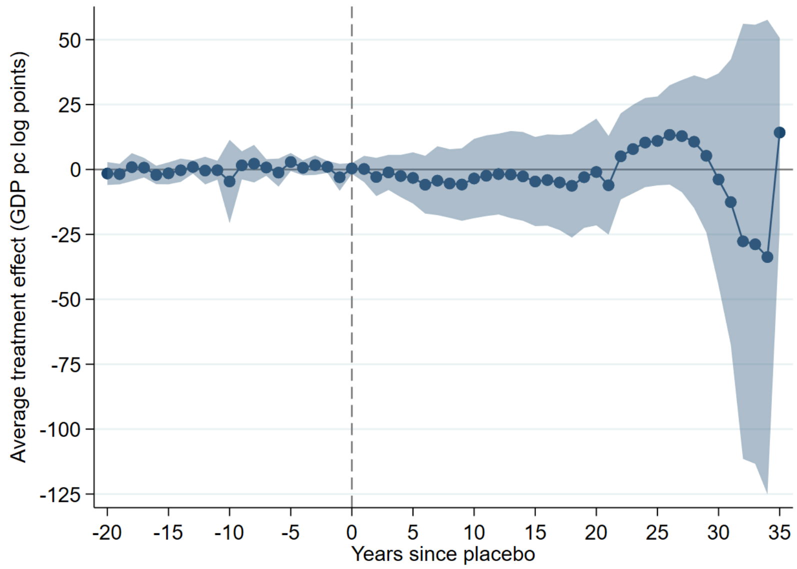
Notes: Synthetic control estimates of the over-time effects of military reversals on log of GDP. This figure plots synthetic control estimates of the effect of reversal (demilitarized to militarized to demilitarized) on GDP per capita in log points. The blue line plots actual GDP per capita of Chile and Sri Lanka over time. The gray, dotted line is the synthetic replication of Chile and Sri Lanka. The first vertical line on each plot is the point of militarization for each country (1973-Chile, 1983-Sri Lanka). The second vertical line on each plot is the point when the country reversed (1990-Chile, 2009-Sri Lanka). Subplot (a) shows evolving actual and synthetic GDP over time for Chile. Subplot (b) hows evolving actual and synthetic GDP over time for Sri Lanka.

Figure 1.8: Effect of placebo episodes on GDP per capita

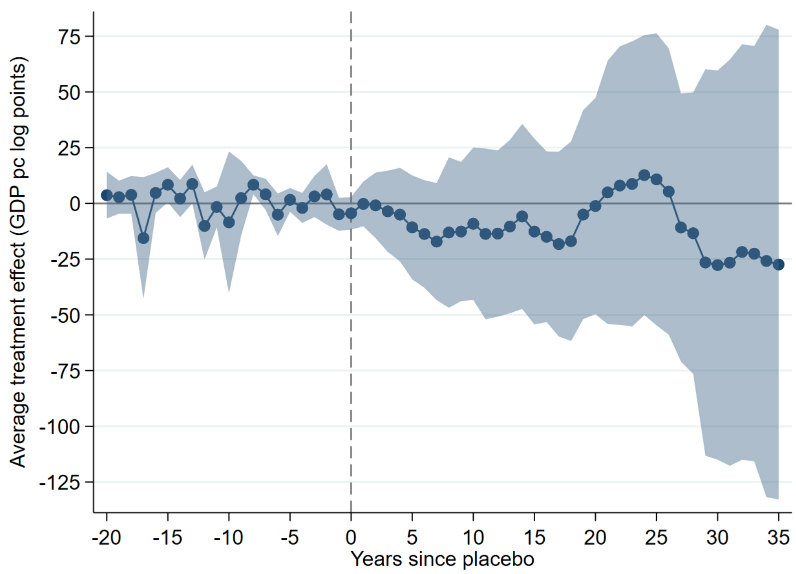


Notes: CSDiD group-time estimates of the over-time effects of all placebo episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of placebo treatments on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that received a placebo treatment (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of treatment runs on the horizontal axis. Placebo treatments are countries that have a contiguous neighbor (country) strongly demilitarize, but choose to remain permanently militarized. The estimates are obtained by assuming and estimating a probit model for placebo treatments based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust.

Figure 1.9: Effect of placebo episodes on GDP per capita, alternative controls



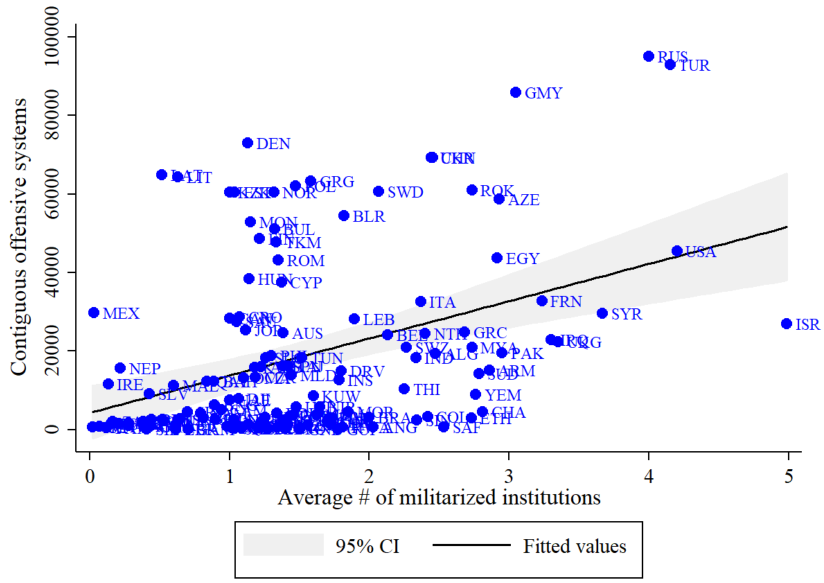
(a) Never-treated placebo



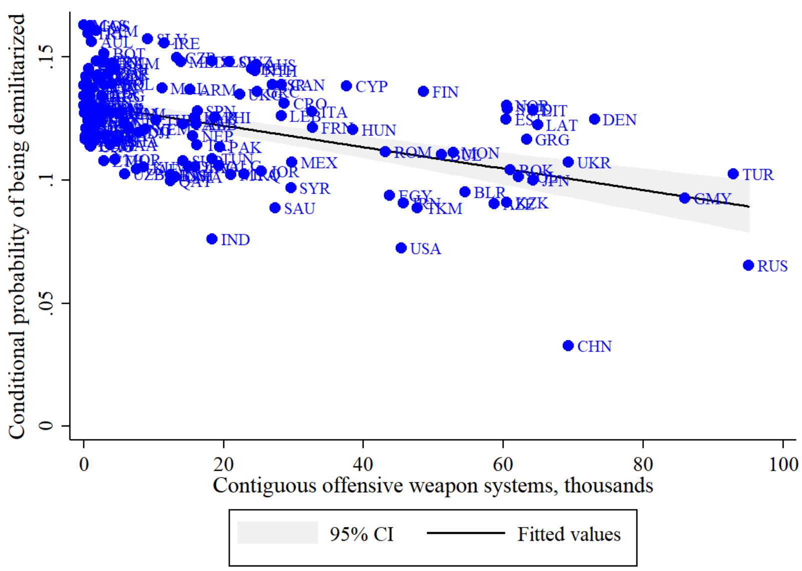
(b) Alternative covariate placebo

Notes: CSDiD group-time estimates of the over-time effects of all placebo episodes on log of GDP; doubly robust estimate with never treated and alternative covariate comparison units. This figure plots CSDID estimates of the effect of placebo treatments on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that received a placebo treatment (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Subplot (a) shows placebo treatments with never treated controls. Subplot (b) shows placebo treatments with selection based on alternative covariates.

Figure 1.10: Instrumental Variable–Relevance Assumption: Contiguous offensive weapons



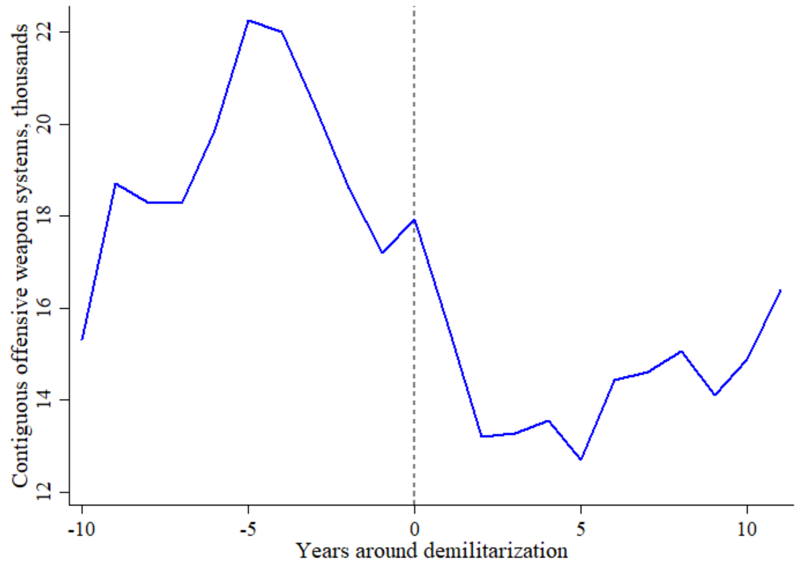
(a) Military institutions



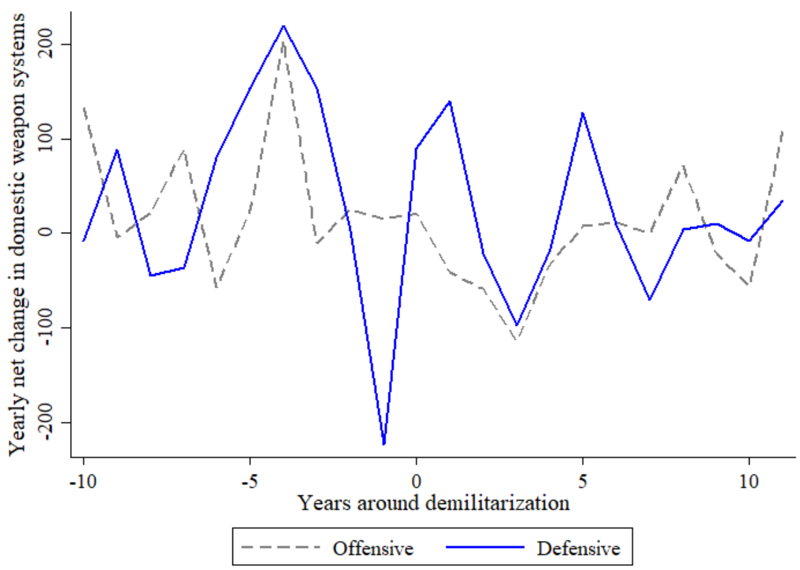
(b) Conditional probability of being demilitarized

Notes: This figure plots the relevance assumption of the instrumental variable (i.e. association between IV and independent variable), contiguous offensive weapon systems. Subplot (a) shows the relationship between contiguous offensive weapons and the number of militarized institutions (of the seven listed in section 2.2). As institutions make up an important component of deciding what state a country is in with respect to its military, I thought it necessary to show this relationship. Subplot (b) shows the relationship between the IV and the conditional probability of being demilitarized. I use a propensity score measure to estimate the conditional probability of being treated (demilitarized) to assess the relationship to the IV. Both subplots show individual countries (by mean) in a scatter plot with a linear regression fit with a 95% confidence interval.

Figure 1.11: Instrumental Variable–Exogeneity Assumption: Contiguous offensive weapons



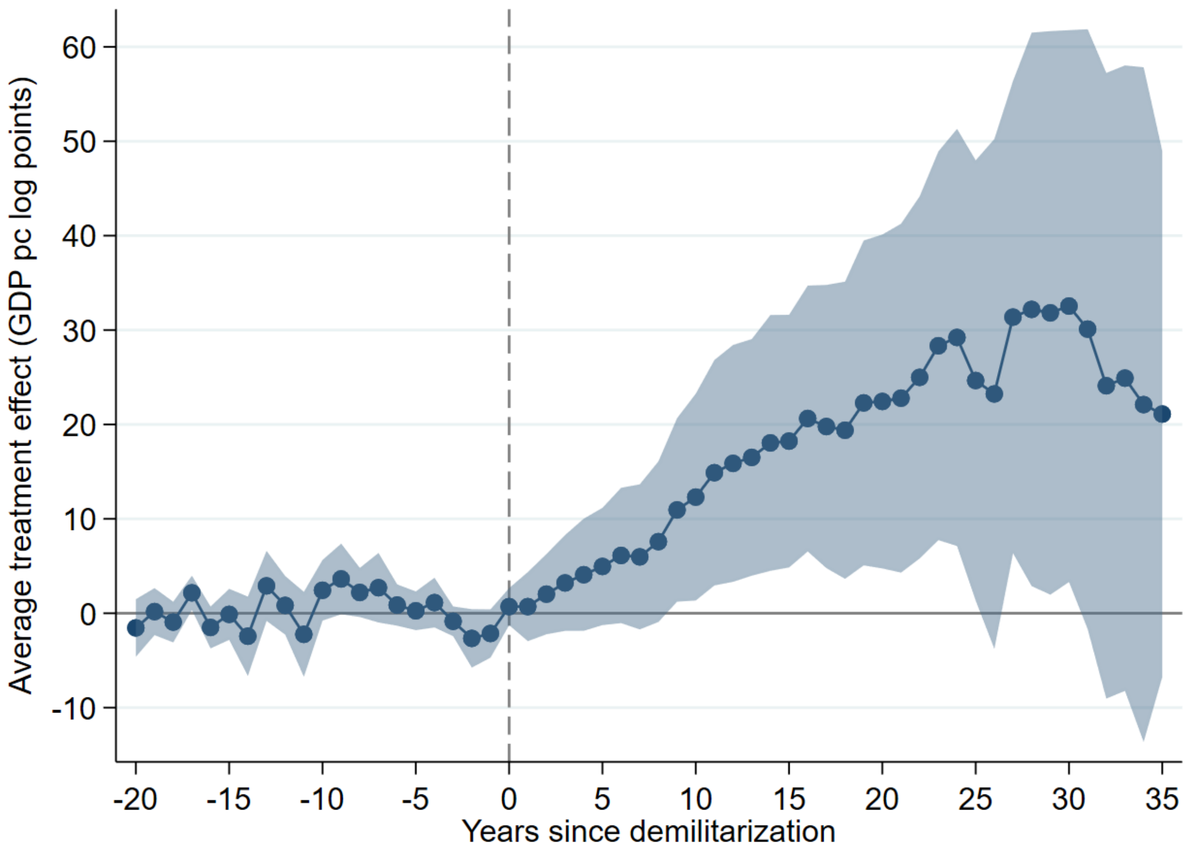
(a) Contiguous offensive weapon systems



(b) Domestic weapons, offensive and defensive

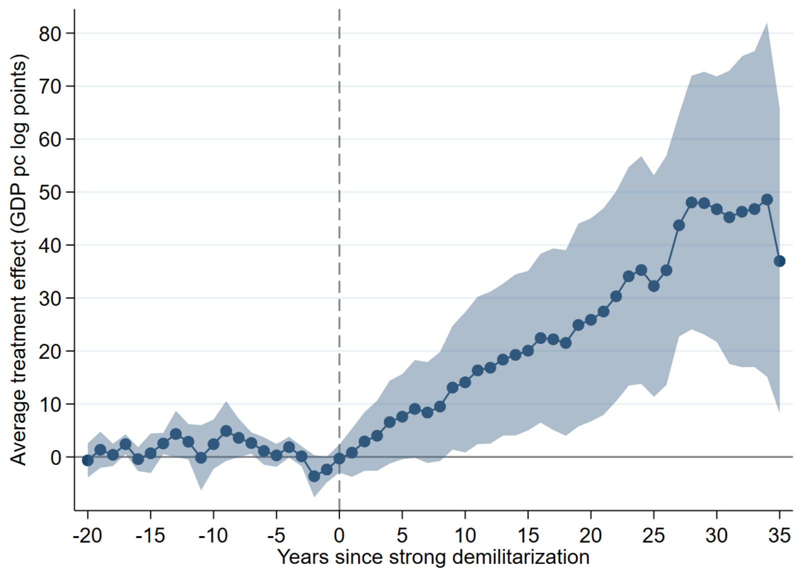
Notes: This figure plots the exogeneity assumption of the instrumental variable (i.e. instrument is not correlated with the error term of primary CSDiD estimate–military transitions on GDP), contiguous offensive weapon systems. Subplot (a) shows the behavior of contiguous offensive weapon systems (in thousands) around demilitarization (strong only) episodes. The blue line plot depicts the average of the IV around the gray vertical line (year of demilitarization). This subplot shows the dramatic decline in offensive weapons on a countries border prior to the decision to demilitarize. Subplot (b) shows evolution of domestic offensive and defensive weapons around demilitarization.

Figure 1.12: IV Estimate: Effect of (all) demilitarization episodes on GDP per capita

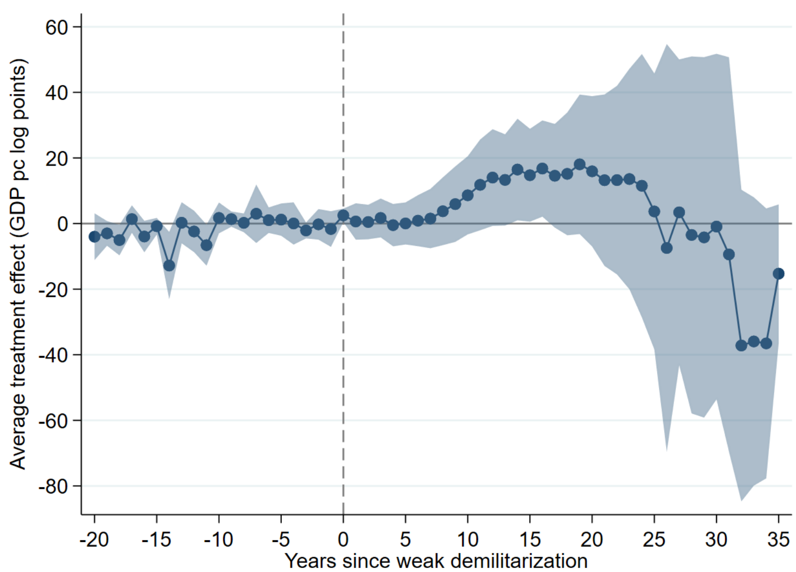


Notes: CSDiD IV group-time estimates of the over-time effects of all demilitarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID IV estimates of the effect of demilitarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that demilitarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations based on contiguous offensive weapon systems of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of on contiguous offensive weapon systems linearly, making this approach doubly robust. The difference between this figure and figure 1.4 is that I base the propensity score (and thus, treatment) on the instrumental variable–contiguous offensive weapon systems.

Figure 1.13: IV Estimate: Effect of strong/weak demilitarization episodes on GDP per capita



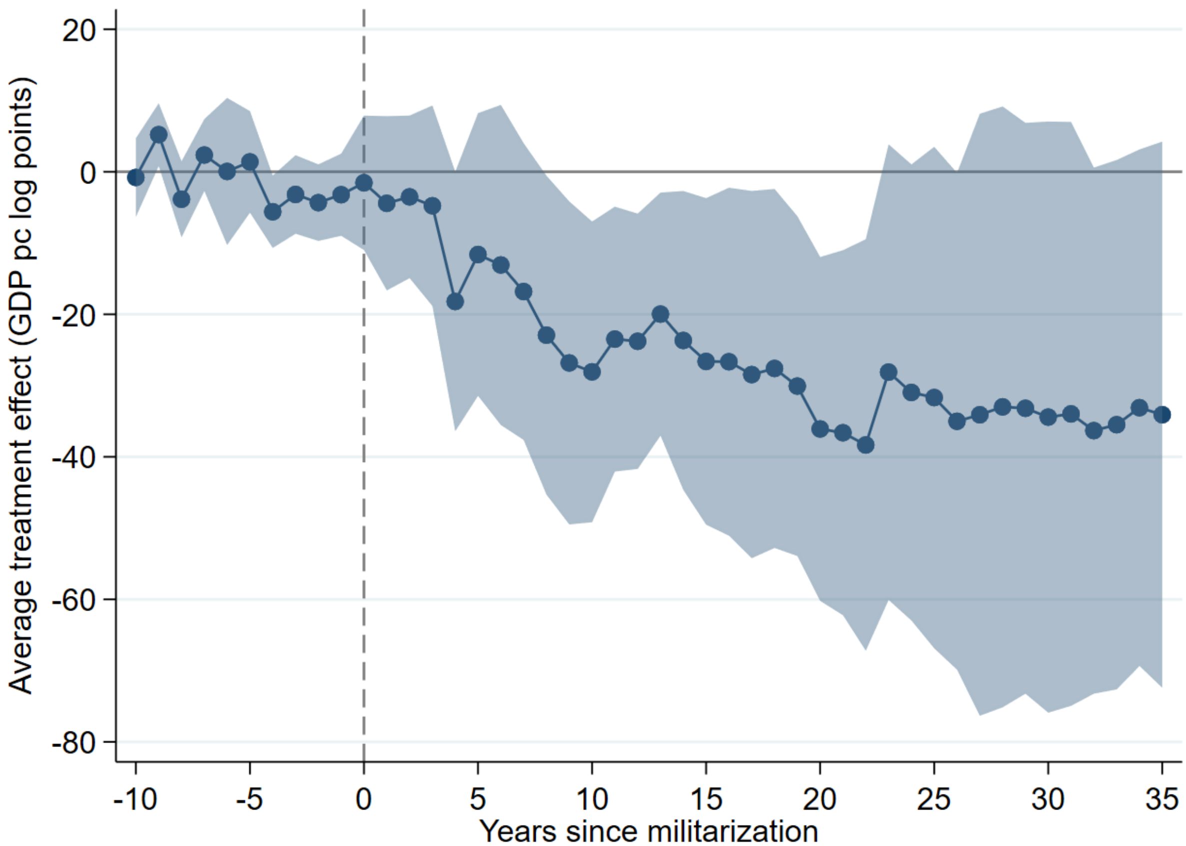
(a) Strong demilitarization episodes



(b) Weak demilitarization episodes

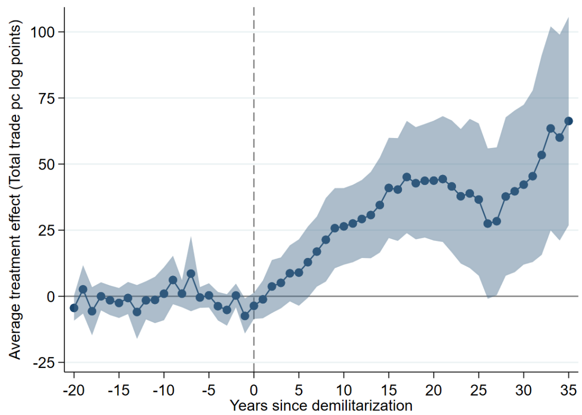
Notes: CSDiD IV group-time estimates of the over-time effects of strong and weak demilitarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID IV estimates of the effect of demilitarization on GDP per capita in log points. Subplot (a) shows all cases of strong demilitarization. Subplot (b) shows all cases of weak demilitarization. The difference between this figure and figure 1.5 is that I base the propensity score (and thus, treatment) on the instrumental variable–contiguous offensive weapon systems.

Figure 1.14: IV Estimate: Effect of militarization episodes on GDP per capita

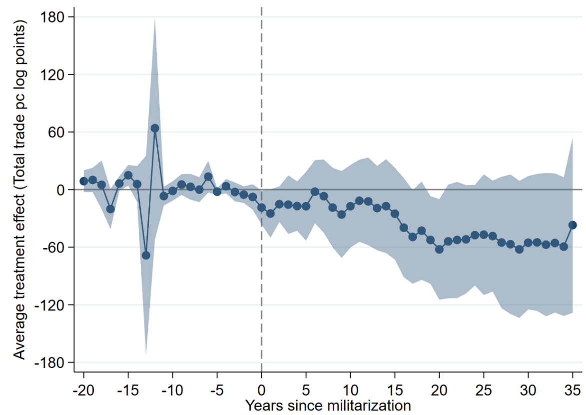


Notes: CSDiD IV group-time estimates of the over-time effects of militarization episodes on log of GDP; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID IV estimates of the effect of demilitarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that militarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for militarizations based on contiguous offensive weapon systems of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of on contiguous offensive weapon systems linearly, making this approach doubly robust. The difference between this figure and figure 1.6 is that I base the propensity score (and thus, treatment) on the instrumental variable–contiguous offensive weapon systems.

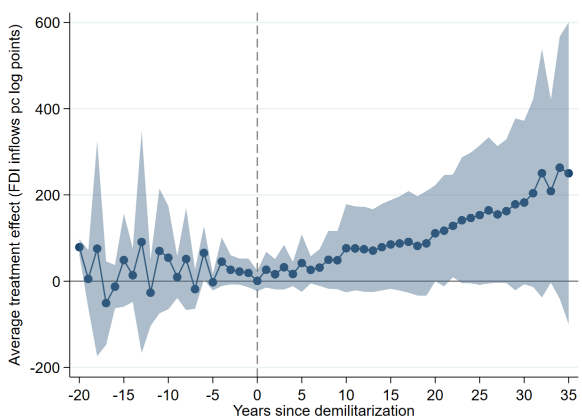
Figure 1.15: Trade and FDI: Demilitarization vs Militarization



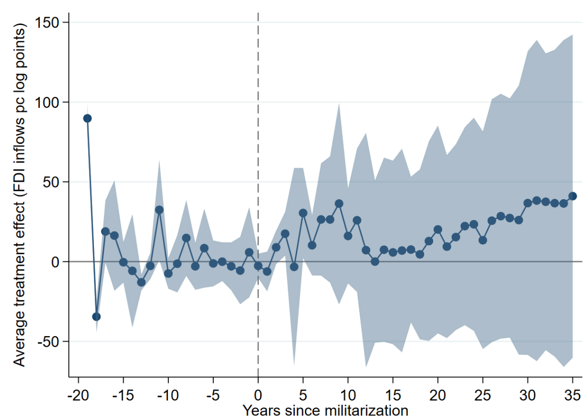
(a) Trade, strong demilitarizations



(b) Trade, militarizations



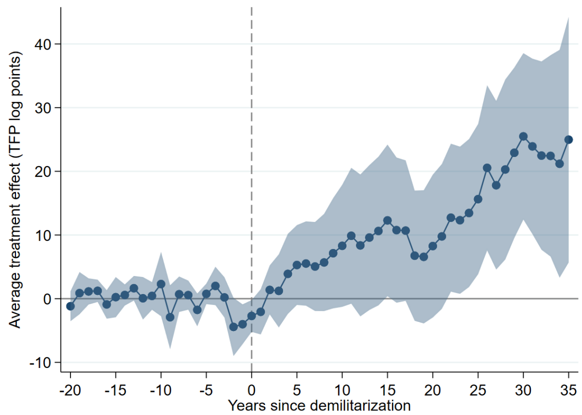
(c) FDI, strong demilitarizations



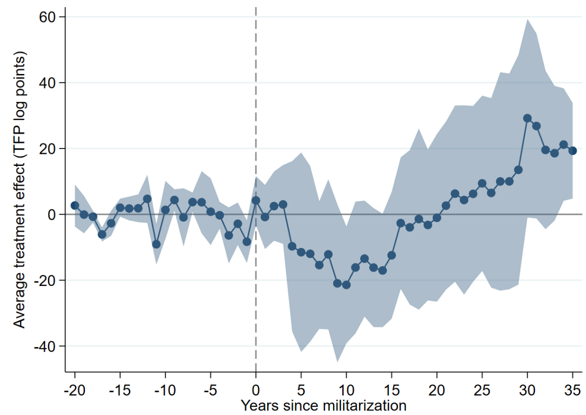
(d) FDI, militarizations

Notes: CSDiD group-time estimates of the over-time effects of strong demilitarization and militarization episodes on bilateral, international trade volumes and foreign direct investment inflows; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of demilitarization and militarization on total bilateral trade volumne and foreign direct investment per capita in log points. The blue, connected line plot estimates average effect on trade volume and FDI on countries that demilitarized or militarized (in log points–multiplied by 100 from interpretation of true percentage), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization/militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations/militarizations based on pre-treatment trade volumes and FDI inflows, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags on trade volumes and FDI inflows, making this approach doubly robust. Subplot (a) shows estimates of trade for all cases of strong demilitarization. Subplot (b) shows estimates of trade for all cases of militarization. Subplot (c) shows estimates of FDI for all cases of strong demilitarization. Subplot (b) shows estimates of FDI for all cases of militarization.

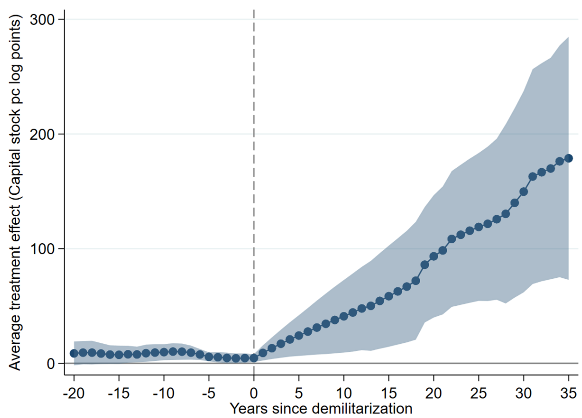
Figure 1.16: TFP and Capital Stock: Demilitarization vs Militarization



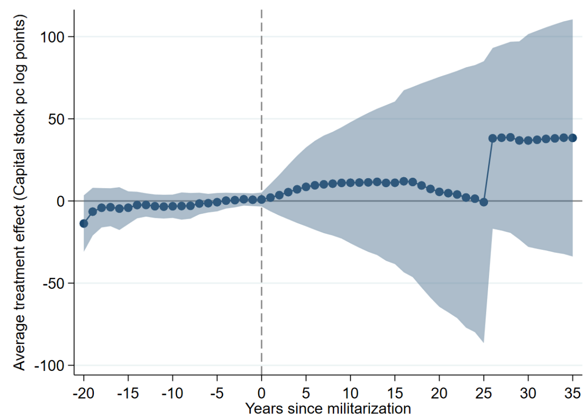
(a) TFP, strong demilitarizations



(b) TFP, militarizations



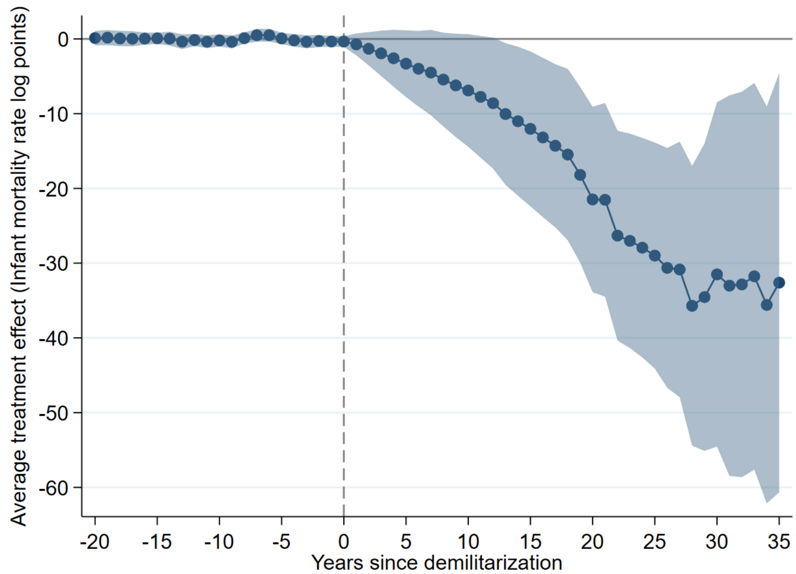
(c) Capital, strong demilitarization



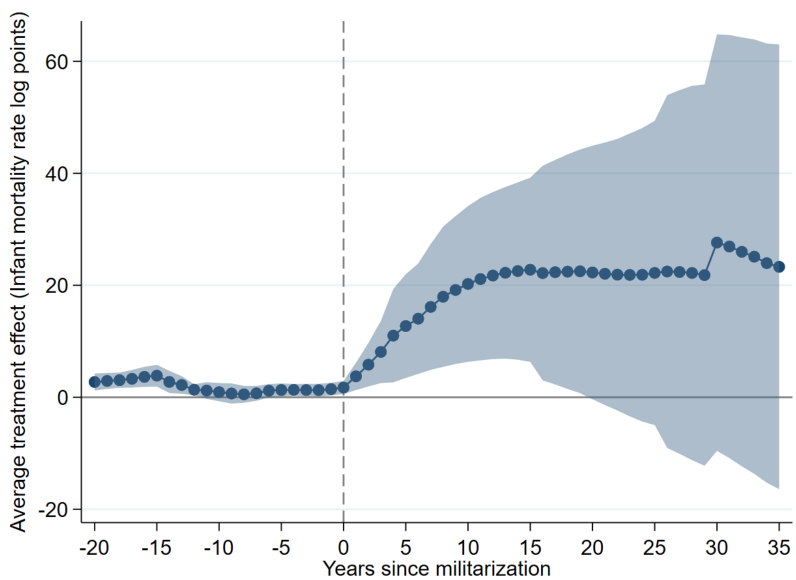
(d) Capital, militarizations

Notes: CSDiD group-time estimates of the over-time effects of strong demilitarization and militarization episodes on total factor productivity (TFP) and capital stock; doubly robust estimate with not-yet treated comparison units. This figure plots CSDID estimates of the effect of demilitarization and militarization on TFP and capital stock per capita in log points. The blue, connected line plot estimates average effect on TFP and capital on countries that demilitarized or militarized (in log points–multiplied by 100 from interpretation of true percentage), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization/militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations/militarizations based on pre-treatment TFP and capital, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags on TFP and capital stock, making this approach doubly robust. Subplot (a) shows estimates of TFP for all cases of strong demilitarization. Subplot (b) shows estimates of TFP for all cases of militarization. Subplot (c) shows estimates of capital stock per capita for all cases of strong demilitarization. Subplot (b) shows estimates of capital stock per capita for all cases of militarization.

Figure 1.17: CSDiD Estimate on Infant Mortality Rate: Demilitarization vs Militarization



(a) Strong demilitarization episodes



(b) Militarization episodes

Notes: CSDiD group-time estimates of the over-time effects of strong demilitarization and militarization episodes on infant mortality. This figure plots CSDID estimates of the effect of demilitarization and militarization on infant mortality rate in log points. The blue, connected line plot estimates average effect on infant mortality rate on countries that demilitarized or militarized (in log points–multiplied by 100 from interpretation of true percentage), with a 95 percent confidence interval shown by the grey, shaded area plot. Subplot (a) shows all cases of strong demilitarization. Subplot (b) shows all cases of militarization.

Chapter 2

Demilitarization and International Trade

In this chapter, I try to determine if a country's level of militarization has an impact on the intensive margin of international trade. This study utilizes historical panel data on bilateral international trade flows, formal military alliances, and military capacity for a large set of countries since 1870. Standard panel regressions with country and year fixed effects yield three stylized facts. First, there has been a broad increase in the use of formal military alliances the past 140 years. Countries that have entered into defense agreements have been able to significantly reduce their military capacity. Second, entry into a formal defense agreement is correlated with a large increase in bilateral trade at the country-pair level. Third, the interaction between defense agreements and military spending is typically negatively and significantly associated with trade. Meaning, countries engaged in a defense agreement trade more with the reduction of military capacity. I also consider the level of militarized external threats faced by country-pairs as an alternative source of variation to analyze the relationship between militarization and trade. My main contribution is to unveil these new stylized facts.

The remainder of the chapter is organized as follows. Section 2.1 reviews relevant literature. Section 2.2 introduces the panel data, descriptive statistics, and empirical specifications. Section 2.3 presents econometric results and discusses their robustness to a variety of factual and statistical concerns. Section 2.4 concludes.

2.1 Relevant Literature

This paper speaks to, at least, three strands of research. As shown in figure 2.1, military alliances have become a staple in international relations since the second world war. The value of such agreements to bilateral trade has been well-documented. Long [2003] finds that defense pacts are associated with higher trade among alliance members, but that trade between members of non-defense pacts is statistically indistinguishable from trade between non-allies. Gowa and Mansfield [1993] show that free trade is more likely within military alliances rather than across, and that alliances have a greater potential to evolve into free-trade coalitions. Finally, Mansfield and Bronson [1997] argue that while both military and trade agreements are likely to promote bilateral exchange, it is the interaction of the two that explains patterns of commerce. However, there is a lack of recent empirical evidence on the relation between defense agreements and trade. The dynamic relationship of bilateral trade within a defense agreement is depicted in figure 2.2. Using data on alliances and trade since 1870, figure 2.2 shows that country-pairs that enter a formal alliance do not have an out-sized trading relationship prior to the agreement. Post-agreement, trade at the country-pair level nearly doubles the average trading relationship. This suggests that defense agreements are driving trade rather than trade strengthening bonds and fostering international military cooperation, as presented by Jackson and Nei [2015]. To the best of my knowledge, no paper in this strand of work looks at the effect of military threats in non-defense and defense aligned country-pairs.

A second literature asks how being in a defense alliance might impact a state's military capacity. Motivated by earlier research in political science and economics, Thies [1987] and Garfinkel [1990] theoretically show how formal military alliances may shift expenditure choices. Empirical evidence on the subject is mixed. Diehl [1994], Palmer and Morgan [2011] and Flores [2011] find that membership in a formal military alliance increases military expenditure. Conybeare [1994] and Oneal and Whatley [1996] present empirical evidence that military spending decreases. Most and Siverson [1987] and Goldsmith [2003] find a null effect of alliance membership. Although this question has been approached from several directions, this research does not generally investigate the links between military capacity and trade within a formal alliance.

In a third strand of work on military capacity and economic outcomes, Rothschild [1973] argues that high military expenditure reduces export availabilities, particularly in the machinery and transport equipment sector. So rather than a Guns vs. Butter trade-off as discussed in Mintz and Huang [1991], it amounts to a Tanks vs. Tractors decision. This break in one of the most expansive trade sectors dampens export growth in general and threatens economic growth. Mayberry [2022b] summarizes more recent work that considers resource reallocation and finds a positive correlation between demilitarization and capital accumulation, as well as total factor productivity. Although I also emphasize the relationship between military capacity and state investments in this study, my emphasis is on the relationship between trade and the interaction between military capacity and defense alliances. This strand of research can potentially link demilitarization to increased trade, as presented by Acemoglu and Yared [2010], through improved factor endowments that create a comparative advantage.

2.2 Data and Empirical Specifications

2.2.1 Sources and Variable Definitions

Trade

To empirically investigate changes in trade patterns as a result of formal military alliances and demilitarization, I use an unbalanced panel with annual data for 14,932 country-pairs between 1870 and 2014. My main dependent variable, $Trade_{i,t}$, measures log total bilateral trade volume per capita between country-pair i in year t, with the dollar value of trade adjusted for inflation. The data comes from the Correlates of War Trade v4.0 database constructed by Barbieri et al.

[2009]. The baseline regressions use bilateral trade as a continuous dependent variable. This measure is affected by shifts in factors of the gravity model: the size of an economy, population, historical relationships, and distance are all determinants of trade [Anderson, 2011]. To mitigate such effects, I control for the size of economies, population, historical relationships, and distance between country-pair trading partners. These variables come from Fouquin et al. [2016]. As shown in table 2.1, the average yearly bilateral trade per capita between country-pairs is $23.9 dollars when they are engaged in a defense pact. For country-pairs with no formal alliance, the average is around $4.7, with large variation across country-pairs and time periods (shown in figure 2.2).

Formal Military Alliances

To measure formal military alliances, I use the Correlates of War Formal Alliance v4.1 data set from Gibler [2008]. Each formal alliance between at least two countries is classified as a defense pact, neutrality/non-aggression treaty, or entente agreement. A defense pact requires all members of an alliance to come to each other's aid militarily if attacked by a third party and is considered the highest level of military commitment in the data set. A non-aggression treaty is a signed agreement among countries to remain neutral in the case of a conflict and/or not to use/support the use of force against a member of the alliance. Entente agreements are considered the weakest level of commitment and simply obligates members to consult one another in times of crisis or armed conflict. This data set is matched based on the Correlates of War country codes to the trade data discussed previously.

$Defense_{i,t}$ is a binary indicator set equal to one if country-pair i is engaged in a defense pact in year t. This applies to defense agreements with more than two members as well. For example, all members of the North Atlantic Treaty Organization (NATO) commit to article 5 of the organizations charter. This article states that if one member of NATO is attacked by a third party, all members are obligated to come to that country's defense. If country A joins NATO in a given year, then the binary indicator $Defense_{i,t}$ will be equal to one for all country-pairs involving country A and other NATO member states. I only consider country-pairs engaged in a defense pact and not those with a non-aggression or entente agreement. This is due to the ambiguity and commonality of the latter two. The summary statistics in table 2.1 show the difference between country-pairs engaged in a defense agreement vs those that are not.

Militarized External Threats

As a source of alternative variation, I use militarized external threats. I proxy a country's degree of external threat by counting the number of militarized interstate disputes (MIDs) and adversaries against whom it has been involved, similar to a methodology devised by Aizenman and Glick [2006]. In contrast to Aizenman and Glick who focus exclusively on wars, my measure includes interactions like threats, raids, and blockades that fall under the category MID. Specifically, "militarized interstate disputes are united historical cases of conflict in which the threat, display or use of military force short of war by one member state is explicitly directed towards the government, official representatives, official forces, property, or territory of another state. Disputes are composed of incidents that range in intensity from threats to use force to actual combat short of war [Palmer et al., 2021]." I rely on the Correlates of War Militarized Interstate Disputes v5.0 databse for my calculation of the militarized external threat variable. Specifically, $Threats_{i,t}$ is defined as the total number of instances of MIDs a country-pair has experienced (combined number of the individual countries) and the number of adversaries faced during the period 1870 to 2014 period. Thus, militarized external threats faced by a country-pair rises with the number of MIDs in which they have been engaged and the number of adversaries they have faced. The variable is then logged to make the distribution of $Threats_{i,t}$ more symmetric as there tends to be a right skew.

Military Capacity

For military capacity, I use the combined country-pair level of log military expenditure per capita in the COW National Material Capabilities v6.0 database [Singer et al., 1972]. The NMC data set includes annual values for population, resource production, energy consumption, military personnel, and military expenditure for a large number of countries from 1816-2016. The Composite Index of National Capability (CINC) index included in the NMC is based on the six variables included and gives a statistical representation of each country's power. I summarize these values to the country-pair level on a yearly basis to create the relevant variables. I rely on $Spending_{i,t}$ as a primary independent variable for my main analysis. This variable is simply the log military expenditure per capita of each country-pair i on a yearly basis, t. Military expenditure is chosen as a proxy for the military capacity of a country-pair due to the reliability of data and the long history of use in empirical studies (Smith [1980]; Alptekin and Levine [2012]). Other variables from the NMC, such as CINC and military personnel per 1,000 population, make up the remaining covariates used in several regressions.

2.2.2 *Empirical Specifications*

My preferred econometric specification, used to unveil stylized facts, is as follows:

$$Trade_{i,t} = \alpha_0 + \alpha_1 Defense_{i,t} + \alpha_2 Spending_{i,t} + \alpha_3 Spending_{i,t} \times Defense_{i,t} + \alpha_4 X_{i,t} + \upsilon_i + \delta_t + \varepsilon_{i,t} \tag{2.1}$$

where the variables multiplying $Defense$ to $Spending$ are as described above. The main parameters of interest are α_1, which captures the predictive effect on trade of being in a defense pact for country-pair i in year t, α_2, which captures the predictive effect of military expenditure, and α_3, which captures the interaction of a defense alliance with military spending. My expectation is that α_1 should be positive and α_2 should be dominated by α_3 (i.e, the effect of military expenditure in a defense agreement is a magnitude larger than without the interaction term). I also believe that α_3 will be negative, suggesting that gains to trade in a defense agreement are larger as a country-pair demilitarization (i.e., reduce military expenditure and the like).

I include a set of control variables $X_{i,t}$, country-pair fixed effects υ_i, and year fixed effects δ_t. Hence, the associations I estimate are identified from time variation within country-pairs of the right-hand side variables relative to their world average levels. The baseline regressions results report heteroskedasticity-robust standard errors that are clustered at the country-pair level.

After presenting the results from my preferred specification, I implement a series of robustness tests, considering alternative inference methods, dependent variables, and controls. Of note, I present empirical evidence for my claim that the relationship between trade and demilitarization is reversed. I demonstrate this by regressing country-pair military capacity on trade and concluding that there is a null effect in section 2.3.4.

2.3 Empirical Evidence

2.3.1 Baseline Results

Table 2.2 shows the results from my baseline estimation of equation 2.1 in the yearly panel, with log bilateral trade volume per capita as the dependent variable. All specifications include country-pair and year fixed effects.

In columns (1) through (3), results are presented without gravity model controls. Column (1) shows that log country-pair bilateral trade volume per capita is positively and significantly associated with defense agreements. The point estimate is sizeable, with engagement in a defense agreement being predicted at 260% higher than if the country-pair was not engaged in such an agreement. The coefficient on log military spending per capita is positive and significant. However, the interaction of these two variables in the $Defense \times Spending$ coefficient is negative, significant, and a larger magnitude than the coefficient for spending alone. In column (1) the difference is 11.4%. The interpretation of the two coefficients is that for country-pairs in a defense agreement, every percentage point that military expenditure per capita is reduced, trade volume per capita increases by more than 11%. Country-pairs appear to receive a large trade bump as a result of being in a defense agreement, but that economic benefit can be increased through a reduction in military expenditure. In columns (2)-(3), I include additional covariates that may affect bilateral trade flows. Country-pair log GDP per capita, log population, log military personnel per capita, and log national capabilities (CINC) are introduced in these two columns. Column (2) controls for the size of the country-pair economy and population. Here, I estimate that country-pair trade volume per capita is 177.2% higher for those engaged in a defense agreement, and that reducing military expenditure per capita by 1% also increases trade flows by 10.4%. In column (3), the coefficient for a defense agreement reduces to 1.678 (167.8%) but remains positive and statistically significant. However, the introduction of controls for the size and capabilities of the country-pair militaries renders the spending coefficient negative and statistically insignificant. The $Defense \times Spending$ coefficient remains significant and in column (3) is -.133 (-13.3%). The coefficient implies that being engaged in a defense agreement and reducing military expenditure per capita by 1% is is associated with additional trade flows of 13.3%.

Columns (4)–(6) of table 2.2 add gravity model controls to the regression set up. These include distance between the countries in the country-pair, indicator if the countries share a common language, indicator if one country was ever a colony of the other, and an indicator if the two countries are contiguous. The results are quantitatively the same as columns (1-3), although they are estimated to be slightly smaller. Column (4) reports a coefficient for a defense agreement to be 1.502 (150.2%). The value gained from reducing military expenditure per capita by 1% while in a defense agreement is 2.1%. Column (5) is my preferred specification and includes controls for GDP and population. The estimated value to country-pair trade flows when the pair is engaged in a defense agreement is 119.9% percent. The added value of reducing military expenditure per capita by 1% is a 5.3% higher trade volume per capita. Column (6) re-introduces controls for the size and capabilities of the country-pair militaries. Again, the spending coefficient becomes insignificant, likely due to the natural correlation with the two covariates introduced. The interaction term remains positive and significant at -.105 (-10.5%).

2.3.2 Plausibility Checks

In my narrative, the benefit of joining a defense pact is it allows countries to spread the burden of military preparedness and defense among each other. This collective action reduces pressure on any one state and frees up resources for more economically productive outlets. Two plausibility checks support this narrative according to the results in tables 2.3 and 2.4.

First, figure 2.3 plots the long-run trends of military expenditure for countries in and out of defense pacts. Following WW2, countries in defense pacts saw their military expenditure per capita grow at a significantly slower rate than those not engaged in any such agreement. This is empirically tested in table 2.3. Column (1) regresses country-pair military expenditure on the indicator variable $Defense_{i,t}$. Column (2), my preferred specification, adds controls for the size of the combined economies and population of the country-pair. Both columns have a significant coefficient for $Defense_{i,t}$. Column (1) reports that participation in a defense pact leads to a military expenditure per capita that is 40.9% lower. Column (2) reduces the coefficient in terms of magnitude but not significance. The $Defense_{i,t}$ coefficient in column (2) is -.127 (-12.7%). Together, table 2.3 and figure 2.3 show that defense agreements reduce the military burden on countries involved, as evidenced by reduced military expenditure. Figure 2.4 is an example of why defense pact countries can reduce military expenditure. Figure 2.4 plots the likelihood of engaging in at least one militarized interstate dispute per year in the years around joining a defense pact. In the 25 years prior to entering such an agreement, the likelihood of experiencing at least on MID is a little under 3%. After joining a defense agreement, that likelihood falls to about 1%. A clear break in the external threats faced and a plausible explanation for why a country may reduce military expenditures when entered into a defense agreement.

Where do these excess resources go? In table 2.4, I test two potential avenues for resource reallocation that may explain increased trade volumes. First, I look at total factor productivity (TFP) as investment in market-oriented research that leads to increased productivity would create a comparative advantage. Columns (1)-(3) follow the exact specifications as table 2.2, only changing the depended variable to a measure of TFP from the Penn World Tables (v10.0). Column (1) has qualitatively the same findings as previous analysis, but when additional controls are introduced in columns (2) and (3), the main results become statistically insignificant.

In columns (4)-(6), I find a statistically significant impact on capital stock. As capital is one of the factor endowments of production that leads to a comparative advantage, and ultimately more trade, being able to allocate resources to capital stock and away from military capacity is a logical explanation for my main findings. In columns (4)-(6) of table 2.4, I repeat the previous exercise and substitute capital stock levels at constant national prices into the dependent variable. All columns report statistically significant results. In my primary specification in column (5), I find that capital stock levels are 12.8% (coef. .128) higher if a country-pair is engaged in a defense agreement. Also, the military expenditure coefficient is .015 and the defense military spending interaction coefficient is -.023. Meaning, reducing military expenditure per capita by 1% while engaged in a defense pact increases capital stock levels by 0.8%. This increase in part explains how and why trade expands for country-pairs in a defense agreement that then demilitarize.

2.3.3 Trade and Militarized External Threats

I have documented that bilateral trade is positively related to defense agreements and to the interaction between defense agreements and reduced military spending. Moreover, I have found suggestive evidence that demilitarization leads to a reallocation of resources into economically productive areas that create a comparative advantage, leading to increased trade. I caution against a causal interpretation of these stylized facts, since the OLS regressions could suffer from omitted variable bias.

Although I cannot credibly estimate the causal effect of military expenditure on trade, I present some additional evidence supporting the stylized facts unveiled in the previous subsections. Specifically, I consider another source of variation in military expenditure trends, namely militarized external threats faced by each country-pair. I first show reduced-form regressions of trade on this new militarized external threat variable variable. I then use this variable as an instrument for the military expenditure and defense agreement variables, without claiming that the exclusion restriction is satisfied.

I construct a continuous variable for each country-pair, using information on militarized external threats each year from the Correlates of War Militarized Interstate Disputes database. This is a similar approach to Aizenman and Glick [2006], which proxied national threat levels by ac-counting for engagements, number of adversaries, and number of years in disputes. Instead of this, I simply take the log value of threats faced by a country-pair as proxied by the total number of militarized interstate disputes (MIDs). For country-pair i, $Threats_{i,t}$ is the log value of MIDs in year t. In the data, $Threats_{i,t}$ is indeed a good predictor of the original military expenditure data variable, suggesting that when a country-pair faces increased external threats (exogenously), it is likely to increase defense spending as a response.

Table 2.5 reports the results from reduced-form regressions. They have the same specification as the baseline regressions in table 2.2, except that I replace $Spending$ and $Defense \times Spending$ with the militarized external threat proxy (for both individual and interaction coefficient). The results are qualitatively similar to the baseline results. Comparing the results in column (2) in table 2.5 with those in column (3) of table 2.2, the three central coefficients all maintain their signs and are significant at the 1% level. The point estimate is higher for all variables in the reduced form setting but that is expected with the limited controls and greater variability of the coefficient.

In table 2.6, I use militarized external threats to instrument for spending. This instrument is imperfect, as a country-pair could provoke other countries into starting a MID. However, I view the results of the IV-specification as a useful (descriptive) addition to the other stylized facts documented in this paper, not a causal justification.

To run the IV, I also need a second instrument for the interaction term between spending and defense agreements. As in the reduced-form regressions, I use the interaction of militarized external threats with $Defense$ as the IV. The standard errors in all the IV regressions are heteroskedasticity-robust and clustered at the country-pair level (with the exception of the first-stage in order to calculate the F-statistic of excluded instruments).[27]

To estimate, I run IV (2SLS) regressions with either one instrument and one endogenous regressor ($Spending$) or with two instruments and two endogenous regressors ($Spending$ and $Defense \times Spending$). The results are reported in tables 2.6 and 2.7. Table 2.6 shows that the first-stage estimates have the expected signs and that the instruments are not weak. Table 2.7 reports the second-stage estimates. The point estimates on $Spending$, $Defense$, and $Defense \times Spending$

are all larger than in the OLS regressions. Military spending as its own coefficient also is no longer statistically significant. However, $Defense$ and $Defense \times Spending$ are both statistically significant at the 1% level. Furthermore, the interaction term with defense and spending still dominates the spending coefficient in terms of magnitude, just as in the OLS regression. Thus, confirming the fact that military expenditure is a greater determinant of bilateral trade when a country-pair is engaged in a defense agreement. Table 2.7 also presents additional test statistics, which reject weak identification. Overall, the reduced-form and IV results are in line with the previously reported stylized facts. However, I should again state that the IV results should be interpreted with caution as they are not a perfect solution to dealing with omitted variable bias. Militarized external threats may not be fully exogenous to a country-pair due to spillovers. Instead, my results may demonstrate a broader pattern of increased international trade when there exists less of a military threat around the world.

2.3.4 Reverse Causality

A major concern for the validity of my estimations is that the rise of defense agreements and demilitarization is being driven by globalization, not the other way around (i.e., reverse causality). As a simple falsification test to rule out reverse causality, I repeat my initial OLS regression specification but substitute military expenditure into the dependent variable and make trade volume a key independent variable. That way I can estimate the effect of trade on demilitarization.

In table 2.8, I present my findings of this falsification test. Across my two preferred specifications, I find no statistically significant relationship between bilateral trade volume and military expenditure. This leads me to believe that globalization may have little to do with the demilitarization process. I see this result as loose confirmation of the direction of causality for my stylized facts.

2.3.5 Summary of Findings

Taken together, my empirical results provide a robust set of stylized facts, which is new to the best of my knowledge. With the rise of defense pacts in the past 7 decades that I have previously documented, country-pairs engaged in such agreements trade more. The interaction between defense agreement indicators and military spending appears to be negative and dominates in terms of magnitude the effect of military expenditure on its own. Meaning, gains from trade in defense agreements are exacerbated when members of the country-pair demilitarize.

2.4 Conclusion

This paper has uncovered three new stylized facts. First, entry into formal defense alliances is correlated with a reduction in military capacity, as evidenced by reduced military expenditure per capita. Second, bilateral trade is positively correlated with participation in defense agreements at the country-pair level. Third, gains in trade from these formal alliances are extended through demilitarization.

My approach to this topic could profitably be extended in several directions. One important extension would be to try and expand on the bilateral relationship of countries engaged in defense agreements. Throughout my estimates, there is a strong, positive relationship between defense agreements and trade. While nothing about NATO or similar defense pact institutions directly coordinates trade, it seems that merely by having closer association with a country through military integration stimulates trade. Diving deeper into the mechanisms of this relationship could be an interesting extension.

A second extension would be to look at the interaction term with more depth. As I document, country-pairs that are engaged in a defense pact and reduce military spending see greater trade volumes. I also find a strong, positive relationship to an increased capital accumulation as a result of the reallocation of resources. It would be interesting to see what parts of military capacity are cut back to fuel this reallocation. For example, NATO has a nuclear sharing agreement that places

U.S. made nuclear weapons in NATO countries. Therefore, it doesn't make sense for another NATO country to spend a large sum of money developing its own nuclear capabilities. Further examination of areas where countries can demilitarize as a result of defensive agreements could produce novel findings.

Notes

[27]I also report various test statistics in the second-stage: Kleibergen–Paap rk LM-statistic, Cragg–Donald Wald F-statistic, and Kleibergen–Paap Wald rk F-statistic.

Tables

Table 2.1: Summary Statistics: Country-Pairs (combined)

Variable	Obs.	Mean	Std. Dev	Min	Max
	Panel A: Defense Pact				
Bilateral Trade p.c., USD	37,417	23.883	123.149	0	5,166.031
Military Spending p.c., USD	34,291	178.555	328.317	0	8,972.88
Military Personnel, per 1,000 capita	36,905	5.456	4.875	0	109.332
National Capabilities, total CINC	37,417	.024	.052	3.35e-06	.386
GDP p.c., USD	9,774	25,255.25	20,631.19	1,956	204,003
Population, total (thousands)	37,417	55,523.89	83,838.55	106	1,401,828
	Panel B: No Formal Alliance				
Bilateral Trade p.c., USD	433,414	4.708	37.723	0	5,086.526
Military Spending p.c., USD	398,732	171.911	266.700	0	16,279.87
Military Personnel, per 1,000 capita	423,126	6.292	5.780	0	124.928
National Capabilities, total CINC	433,414	.020	.039	3.26e-06	.500
GDP p.c., USD	84,035	23,563.27	19,422.18	1,226	237,285
Population, total (thousands)	433,414	86,977.25	197,620.8	125	2,683,969

Notes: Unbalanced panel of 14,932 country-pairs over the period 1870–2014. All dollar figures specified in USD and adjusted for inflation. Panels separate country-pairs by military alliance status. Panel A is for country-pairs that are in (at least) a defense pact. Panel B is for country-pairs that are not in a formal alliance at that time.

Table 2.2: Formal Alliances, Military Capacity, and International Trade Flows: 1870-2014

	Dependent Variable: Country-Pair Log Trade Volume Per Capita					
	Baseline Specification			Gravity Model Controls		
	(1)	(2)	(3)	(4)	(5)	(6)
Defense Agreement	2.604***	1.772***	1.678***	1.502***	1.199***	1.296***
(clustered s.e.)	(.153)	(.281)	(.283)	(.246)	(.260)	(.282)
Log Military Spending, p.c.	.207***	.071**	-.040	.192***	.074**	-.044
	(.016)	(.032)	(.034)	(.031)	(.031)	(.034)
Defense X Spending	-.321***	-.175***	-.133**	-.213***	-.127**	-.105**
	(.031)	(.053)	(.054)	(.048)	(.049)	(.053)
Log GDP per capita		.670***	.538***		.723***	.565***
		(.106)	(.106)		(.099)	(.103)
Log Population		-1.051***	-2.019***		-1.030***	-2.088***
		(.058)	(.113)		(.057)	(.114)
Log Military Personnel, p.c.			-.532***			-.527***
			(.061)			(.058)
Log CINC (national capabilities)			.946***			.999***
			(.105)			(.102)
Gravity Model Controls				X	X	X
Country-Pair FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Root MSE	2.000	1.761	1.741	1.857	1.712	1.712
R-Squared	.622	.675	.681	.655	.693	.692
Observations	439,831	89,047	88,267	108,334	89,022	88,242

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. In columns (1)–(3) regressions are conducted without gravity models controls. In columns (4)–(5) gravity model controls are added that include distance between the countries in the country-pair, indicator if they countries share a common language, indicator if one country was ever a colony of the other, and an indicator if the two countries are contiguous. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

Table 2.3: The Effect of Formal Alliances on Military Capacity: 1870-2014

	Dependent Variable: Country-Pair Log Military Expenditure Per Capita	
	(1)	(2)
Defense Agreement	-.409***	-.127***
(clustered s.e.)	(.025)	(.044)
Log GDP per capita		.765***
		(.042)
Log Population		-.184***
		(.032)
Country-Pair FE	X	X
Year FE	X	X
Root MSE	.706	.647
R-Squared	.825	.847
Observations	439,831	89,047

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

Table 2.4: Formal Alliances, Military Capacity, and Resource Reallocation: 1960-2014

	Dependent Variables: Country-Pair Log of TFP and Capital Stock					
	Total Factor Productivity			Capital Stock at Constant National Prices		
	(1)	(2)	(3)	(4)	(5)	(6)
Defense Agreement	.059**	.047**	.044**	.132***	.128***	.124***
(clustered s.e.)	(.023)	(.020)	(.019)	(.026)	(.027)	(.027)
Log Military Spending, p.c.	.027***	.005**	.010**	.027***	.015***	-.017**
	(.003)	(.003)	(.004)	(.004)	(.005)	(.008)
Defense X Spending	-.016***	-.006	-.005	-.030***	-.023***	-.021***
	(.005)	(.004)	(.004)	(.005)	(.005)	(.005)
Log GDP per capita		.270***	.263***		.202***	.202***
		(.010)	(.010)		(.017)	(.017)
Log Population		-.019***	-.039***		.035***	-.060***
		(.004)	(.011)		(.006)	(.016)
Log Military Personnel, p.c.			-.039***			.016**
			(.006)			(.008)
Log CINC (national capabilities)			.018*			.098***
			(.010)			(.015)
Country-Pair FE	X	X	X	X	X	X
Year FE	X	X	X	X	X	X
Root MSE	.127	.113	.112	.163	.159	.157
R-Squared	.760	.796	.798	.943	.947	.948
Observations	47,226	46,299	46,111	51,568	49,529	49,240

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. In columns (1)–(3) the dependent variable is total factor productivity (TFP) at current PPPs. In columns (4)–(6) the dependent variable is capital stock at constant national prices. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

Table 2.5: Militarized External Threats: Reduced Form Regressions

	Dependent Variable: Country-Pair Log Trade Volume Per Capita	
	(1)	(2)
Defense Agreement	1.151***	5.274***
(clustered s.e.)	(.015)	(.052)
Log Militarized External Threats	-.424***	-.386***
	(.010)	(.009)
Defense X External Threats		-.927***
		(.011)
Country-Pair FE	X	X
Year FE	X	X
Root MSE	2.023	2.007
R-Squared	.612	.618
Observations	449,965	449,965

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

Table 2.6: Militarized External Threats: First-Stage Regressions

	Military Expenditure p.c.	Military Expenditure p.c.	Military Expenditure X Defense Pact
	(1)	(2)	(3)
Defense Agreement	.009	-.620***	.939***
	(.008)	(.030)	(.026)
Log Militarized External Threats	.056***	.053***	-.051***
	(.006)	(.006)	(.005)
Defense X External Threats		.131***	.713***
		(.006)	(.005)
Log GDP per capita	.424***	.419***	-.054***
	(.007)	(.007)	(.006)
Log Population	-1.369***	-1.372***	-.009
	(.008)	(.008)	(.007)
Log Military Personnel, p.c.	.312***	.303***	.066***
	(.005)	(.005)	(.004)
Log CINC (national capabilities)	1.266***	1.270***	.036***
	(.007)	(.007)	(.006)
Excluded Instruments	Militarized External Threats	Militarized External Threats, External Threats X Defense Pact	Militarized External Threats, External Threats X Defense Pact
F-Statistic of Excluded Instruments	76.09	91.89	1594.60
Country-Pair FE	X	X	X
Year FE	X	X	X
Root MSE	.480	.479	.408
R-Squared	.916	.916	.913
Observations	88,099	88,099	88,099

Notes: All specifications include country-pair and time fixed effects. Robust standard errors in brackets. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

Table 2.7: Militarized External Threats: Second-Stage Regressions

	Dependent Variable: Country-Pair Log Trade Volume Per Capita	
	(1)	(2)
Defense Agreement	.835***	5.584***
(clustered s.e.)	(.119)	(1.332)
Log Military Spending, p.c.	1.052	.494
	(1.643)	(1.474)
Defense X Spending		-1.087***
		(.304)
Log GDP per capita	.101	.308
	(.701)	(.639)
Log Population	-.606	-1.354
	(2.239)	(2.009)
Log Military Personnel, p.c.	-.895*	-.591
	(.526)	(.445)
Log CINC (national capabilities)	-.385	.333
	(2.081)	(1.863)
Endogenous Regressors	Militarized Expenditure p.c.	Militarized Expenditure p.c. Military Expenditure X Defense Pact
Excluded Instruments	Militarized External Threats	Militarized External Threats, External Threats X Defense Pact
Kleibergen–Paap rk LM statistic	5.334	6.321
Cragg–Donald Wald F statistic	90.998	55.622
Kleibergen–Paap Wald rk F statistic	5.167	3.065
Gravity Model Controls	X	X
Country-Pair FE	X	X
Year FE	X	X
Root MSE	1.791	1.774
R-Squared	.661	.668
Observations	88,074	88,074

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

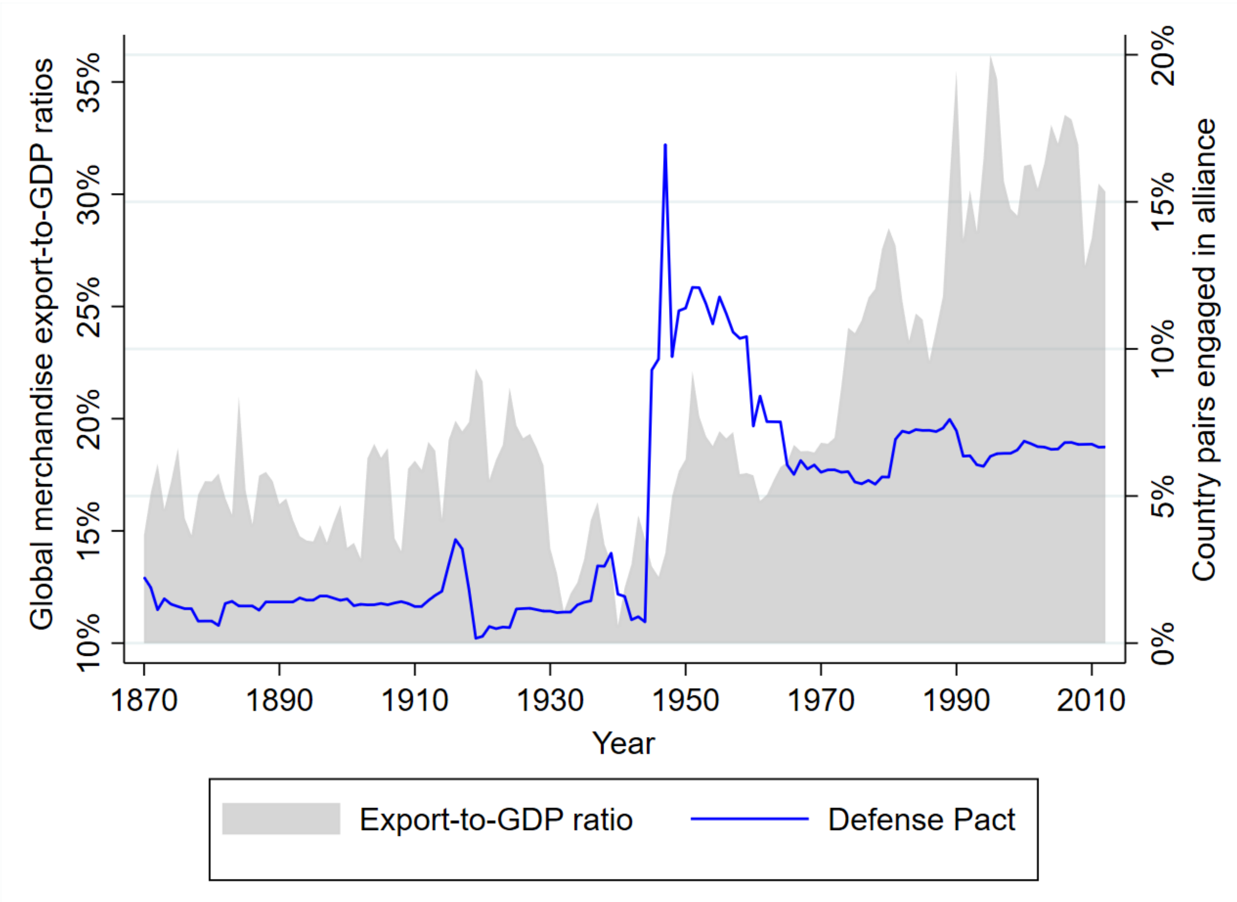
Table 2.8: Falsification Test: Reverse Causality

	Dependent Variable: Country-Pair Log Military Expenditure Per Capita	
	(1)	(2)
Defense Agreement		-.134***
(clustered s.e.)		(.045)
Log Bilateral Trade Volume Per Capita	.005	.007
	(.004)	(.004)
Log GDP per capita	.780***	.760***
	(.043)	(.042)
Log Population	-.180***	-.177***
	(.032)	(.032)
Country-Pair FE	X	X
Year FE	X	X
Root MSE	.647	.647
R-Squared	.846	.847
Observations	89,047	89,047

Notes: All specifications include country-pair and time fixed effects. Robust standard errors clustered at the country-pair level in brackets. $*\rho < 0.1$; $**\rho < 0.05$; $***\rho < 0.01$

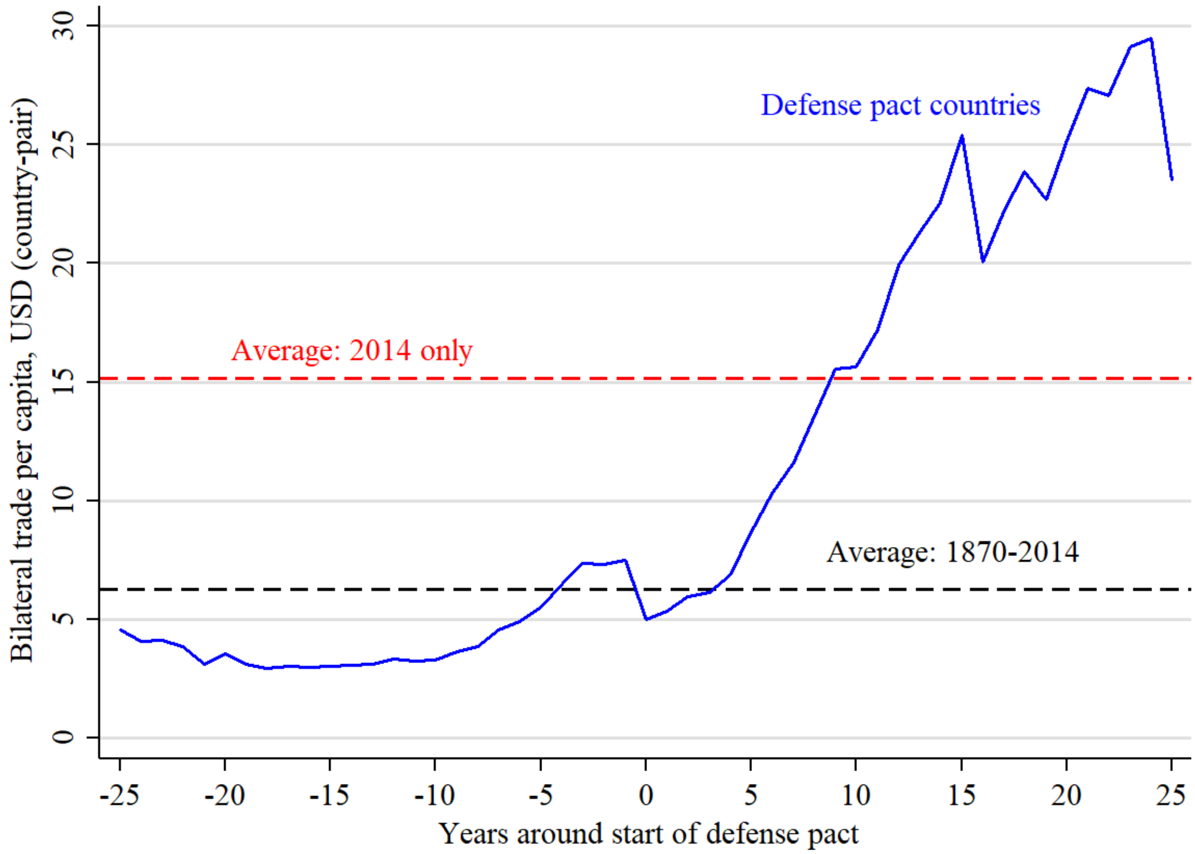
Figures

Figure 2.1: Long-Run Trends: Export-to-GDP Ratio and Formal Alliances



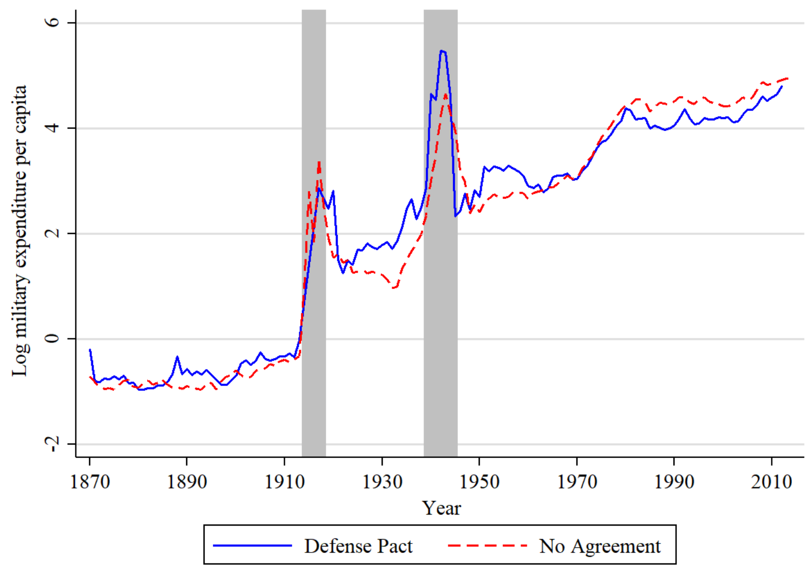
Notes: Data on alliances comes from Correlates of War Formal Alliances database. Export-to-GDP ratio data comes from CEPII TRADEHIST database.

Figure 2.2: Country-Pair Trade Volume Around Defense Agreement

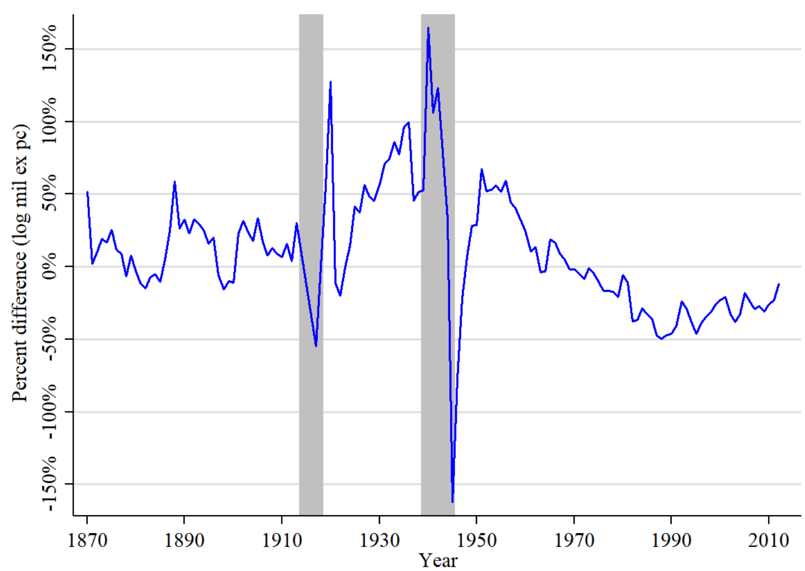


Notes: Bilateral trade in real USD at the country-pair level is plotted with the blue line graph in years around the start of a formal agreement. The red dashed line is the average of bilateral trade volume among all country-pairs in the final year of data, 2014. It is just over $15. The black dashed line is the average bilateral trade volume among all country-pairs for the entirety of the sample and is just over $6.

Figure 2.3: Long-Run Trends: Defense Agreements and Military Spending



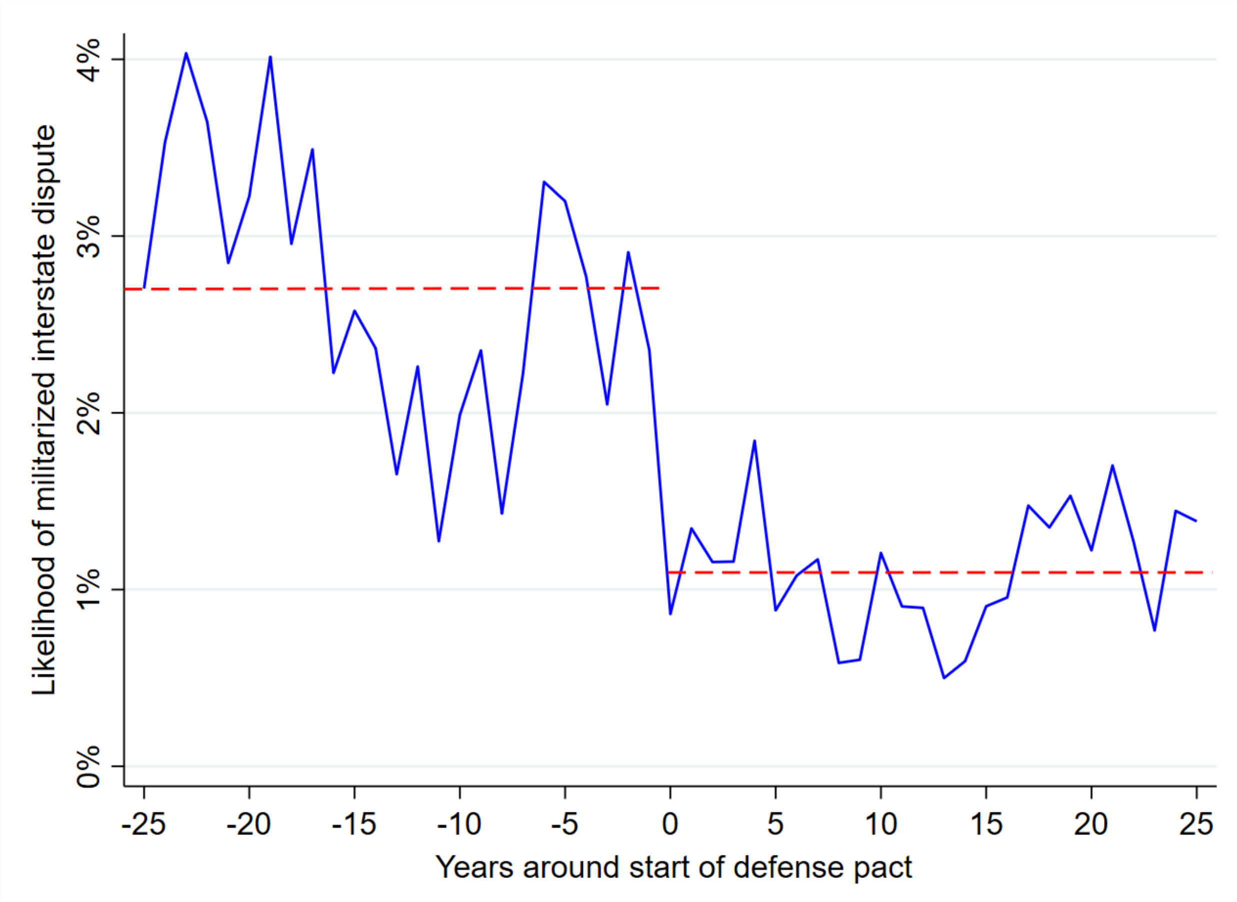
(a) Log military expenditure per capita, raw



(b) Difference in log miltiary expenditure per capita, percent

Notes: Subfigure (a) plots average log military expenditure per capita of country-pairs in and out of defense agreements. The gray shaded areas signify the time periods of WW1 and WW2. Subfigure (b) reports the percent difference between the two line plots in the first figure over the same time horizon.

Figure 2.4: Reduced Likelihood of MIDs Around Defense Agreement



Notes: Blue line plot is likelihood of either member of a country-pair facing a militarized interstate dispute (COW MIDs database) in a given year, plotted around the start of a defense pact between the country-pair. Red dashed lines show the average likelihood before and after the start of the defense agreement.

Chapter 3

The Consequences of Militarization

The negative relationship between militarization and economic development has been a focus of social science researchers for decades. Increasing military expenditure has been shown to lead to lower output due to a misallocation of resources away from economically productive outlets [Dunne and Tian, 2020]. Externally, a country may experience less economic cooperation with other states as a form of punishment for violating international norms around military behavior [Acemoglu and Yared, 2010].

In the modern era of warfare, nuclear weapons are the apex of military power and their proliferation remains one of the major security issues facing the world [Singh and Way, 2004]. However, an understudied aspect of militarization is the effect of nuclear weapon development on economic conditions. Previous work has tended to focus on the value of possessing a nuclear weapon, namely nuclear deterrence [Huth, 1990]. Far less attention has been paid to the economic costs of militarizing with nuclear weapons. Using the nuclear armed country of Pakistan as a case study, I attempt to answer the question: "Does nuclear proliferation lead to a sacrifice in economic development?"

There are eight confirmed nuclear-armed states with a ninth, Israel, strongly believed to also have nuclear capabilities. In this paper, I try to understand what would happen to another country's economy if it began developing a nuclear weapon. Because of this, I can rule nearly all nuclear countries out as potential case studies due to the unique circumstances of their proliferation. First, the United States and Russia (previously, Soviet Union) developed nuclear weapons during a surge in military spending and technological advancement throughout World War 2. This proliferation path is not replicable, as it seems highly unlikely that a country today would be among the military superpowers during a time of global war and not already have nuclear weapons. Second, the United Kingdom and France developed nuclear weapons in the 1950s as a result of collaboration with the United States. Scientist from both France and the U.K. were present during the Manhattan project. As such, current nuclear-armed countries are unlikely to share this technology with another country today due to international agreements such as the Treaty on the Non-Proliferation of Nuclear Weapons. Israel's nuclear development is believed to have also been a direct result of collaboration with France. The Chinese nuclear weapons' program received assistance from the Soviet Union prior to the Sino-Soviet split in 1956 and tested its first weapon just a few years later. India received no nuclear cooperation from the United States despite asking on numerous occasions.[28] However, India as a country is not a valuable case study do to its size. India is one of two countries that have over one billion people and accounts for more than 17 percent of the world share of population. No other non-nuclear countries come close.[29] If I want to understand how a country choosing to develop a nuclear weapon tomorrow might impact their economy, India is not a representative example due to its size. This leaves just two countries that have developed nuclear weapons as case studies.[30] North Korea is not feasible simply because of data constraints. Economic data coming out of that country is unreliable and sparsely available. Pakistan, which began nuclear development in 1972 and first tested a weapon in 1998, is the only real choice for a case study for three reasons: (1) long time-series of economic data for analysis, (2) nuclear development with little to no outside collaboration and not during a time of global conflict, and (3) country characteristics more representative of the rest of the world.[31]

From the beginning of a program to the initial nuclear test demonstrating capability, the impact of nuclear weapon development at a national scale is significant. Yildirim and Öcal [2006] find that regional aggression and the subsequent arms race between India and Pakistan slowed economic growth for both countries because of the resources allocated away from economically productive outlets (i.e., opportunity cost of resources). Morrow and Carriere [1999] find that the 1998 U.S. sanctions meant to oppose nuclear testing had negative effects on foreign direct investment, the stock market, and reduced the supply of foreign currency in both countries. Looking at these two studies and the broader literature concerning nuclear weapons and development, it is evident that resource allocation opportunity cost and international economic punishments brought on by nuclear proliferation can be a considerable drag on an economy. However, to the best of my knowledge, there is no existing paper that tries to quantify this negative effect over the long run. In order to help fill this gap in the economic literature, I perform a case study of Pakistan and estimate the effect of pursuing a nuclear weapon on economic development. I utilize the synthetic control method (SCM) pioneered by Abadie and Gardeazabal [2003], Abadie et al. [2010] and Abadie et al. [2015]. I produce a synthetic control group to replicate the economic characteristics of Pakistan before the start of its nuclear program, believed to be 1972, by using a linear convex combination of countries without a relationship to nuclear weaponry. I compare the real per capita GDP of the synthetic Pakistan without a nuclear weapon's program to actual Pakistan with a program for the 1973-1997 time period.[32] In the 25-year period of 1973-1997, I find that Pakistan's actual real per capita GDP underperformed the synthetic by an average of 27.8 percent.

I assess the robustness of my estimation with several checks: (1) Leave-One-Out synthetic control, a repeated estimation of the synthetic, or counterfactual, Pakistan by removing one weight-assigned country for each repetition; (2) placebo test by excluding the treated unit from the control group; (3) alternative pre-nuclear characteristics as predictors of per capita GDP; (4) sparse synthetic controls, reduced pool of control countries to view balance between sparsity and goodness of fit; (5) using non-outcome predictors in the pre-intervention period; (6) alternative matching with respect to international trade and sanctions as barometers of cross-country cooperation.[33]

The rest of the paper is structured as follows: Sub-Section 3.0.1 introduces the existing literature. Section 3.1 provides the theoretical basis for the synthetic control method and establishes rationale for the data set used, as well as donor pool criteria. Section 3.2 shows the primary results and a variety of robustness checks for the validity of my inference. I test the potential of trade disruptions caused by international sanctions as a mechanism driving the negative growth effects and show that resource opportunity cost may not be playing as large of a role in underdevelopment as previously believed. Section 3.3 discusses the results and concludes the study.

3.0.1 Literature

Empirical literature on the economic consequences of nuclear proliferation is limited. Hartley [2006] investigates the fiscal cost of nuclear weapon policies in the United Kingdom, as well as the associated opportunity costs. There are several anecdotal studies and policy papers that ask a similar question. For example, in a 2013 article for the Council on Foreign Relations entitled "The Economics Costs of North Korean Nuclear Development", Scott Snyder wrote that proliferation of nuclear policy was significantly hindering the North Korean economy.[34] He provided analysis which stated nuclear development could cost North Korea over $100 billion in international trade volumes by 2020. The policy paper also suggested that denuclearization could contribute to greater economic prosperity in terms of per capita GDP growth. A similar policy analysis was written by Arthur Katz and Sima Osdoby of the Cato Institute in 1982, called "The Social and Economic Effects of Nuclear War."[35] This paper made largely the same case as Snyder, suggesting the economic and social welfare could be greatly improved by a countries reduction of nuclear capabilities. The nuclear case of Pakistan has received little attention within the field of economics. This may be because North Korea was able to test a nuclear weapon only 8 years later and presents itself as a significantly more hostile international actor than Pakistan.

Perhaps more relevant to this study, existing defense literature describes two major channels through which military behavior (i.e., nuclear proliferation) may affect economic development: inefficient resource allocation and international ramifications.

An active area of economic research looks at whether military expenditure has a positive or negative impact on economic growth [Dunne and Tian, 2020]. Several studies within this literature have argued that military expenditure is an economically inefficient outlet for a country's resources, and a reduction in spending will lead to economic growth [Knight et al., 1996]. An example of a potential channel for this growth would be taking funds used to buy weapons and putting it towards market-oriented research and development to increase total factor productivity. However, the actual impact of military expenditure on economic growth is unclear. Alptekin and Levine [2012] perform a meta-analysis of the existing literature and find that changes to expenditure levels have no effect on developing countries. For developed countries, elevated levels of military expenditure are found to have a positive impact on growth. In a more recent meta-analysis, Yesilyurt and Yesilyurt [2019] find no effect on growth for any country development level. The study also contends that some of the examples of statistically significant results in the literature may be a result of data mining. The economic argument for no significance is one of military keynesianism [Dunne, 2013]. Proponents of this theory suggest that fiscal stimulus in the form of military spending is a positive on the economy. So long as that funding is redistributed to other forms of public expenditure, there is not a fiscal loss. Therefore, if the change in military spending is offset by different fiscal expenditure, then there should be no broader economic effect. Looking at channels for my findings in section 3.2.2, I show that military expenditure in Pakistan declines rapidly after the successful nuclear test in 1998. I also show that economic growth after this period is essentially equal to the synthetic. Meaning, this large decline in spending was not accompanied by any major growth effects.

The breakdown of international economic cooperation is another possible drag on economic growth as a result of military behavior. Acemoglu and Yared [2010] find that as countries become more militarized (i.e., more troops and increased spending), demilitarized countries are less likely to trade with them. This appears to be in part driven by international sanctions meant to deter aggressive military behavior. A contemporary example is the wave of U.S. sanctions being pushed onto Iran as that country continues to push for a nuclear weapon. According to Felbermayr et al. [2020], the U.S., the G8, and other countries and international organizations imposed sanctions on Pakistan during its development of a nuclear weapon. Neuenkirch and Neumeier [2015] conduct a cross-sectional empirical analysis U.S. and United Nations specific sanctions on economic growth in 160 countries from 1976-2012. The authors show a negative and statistically significant relationship between sanctions and per capita GDP growth rates. Interestingly, United Nations sanctions have a larger economic impact than exclusively U.S. sanctions. Dizaji and Farzanegan [2021] observe a similar outcome when looking at sanctions against Iran and the response of that country's military expenditure. This suggests the influence sanctions can have when multiple parties within international organizations are involved, as there might be with nuclear proliferation sanctions. Specific examples of countries afflicted by sanctions include Russia (Simonov et al. [2015]; Nelson [2015]), Iran (Habibi [2008]), Iraq (Alnasrawi [2001]), China/Cuba/Iran (Askari et al. [2003]), South Africa (Levy [1999]) and India/Pakistan (Morrow and Carriere [1999]). Sanctions have been causally identified in a number of these studies to be detrimental to a country's economy. An important study in this literature looks at the lifting of sanctions in Iran following the signing of the JCPOA (Joint comprehensive Plan of Action) in 2015 [Dizaji, 2019]. The author finds that in response to lifted sanctions, military expenditure increased in Iran. My findings differ in section 3.2.2 as I show that for Pakistan, reduced sanctions saw a reduction in military spending and an increase in trade. It is important to note the difference of Iran not acquiring a nuclear weapon as a result of the JCPOA while Pakistan did in 1998. My study contributes to existing literature like Dizaji [2019] by providing an example of behavior once nuclear weapons have been acquired.

There is a small collection of papers that apply the synthetic control method to identify the causal effects of military expenditure, international economic sanctions and armed conflict. For example, Bilgel and Karahasan [2019] estimates that the introduction of terrorism to Turkey by the PKK in the late 1980s reduced the real per capita GDP in the following decades by an average of nearly 14 percent per year. A substantial realization and contribution to the literature of conflict and growth, this paper is an example of sustained interventions in the SCM literature. As my study also deals with a sustained intervention from a nuclear regime, the SCM can show the cumulative weighing down effect created by long-term policies. Bove and Elia [2014] is a similar example that uses American and British involvement in Afghanistan and Iraq for a comparative case study on economic effects. It should be noted that the seminal work of Abadie and Gardeazabal [2003], providing an analysis of economic effects stemming from Basque country terrorism, is the genesis of the literature and gives the econometric foundation for all SCM studies in this style. Gharehgozli [2017] is an example of SCM being used to understand the economic impacts of sanctions. The study shows that sanctions against Iran cost the country 17 percent of real GDP from 2011 to 2014. SCM is the appropriate econometric tool for case studies with considerable data restrictions. I discuss the econometric process in detail in the following section.

3.1 Materials and Methods

The Synthetic Control method has been proven to be a reliable estimation technique for case studies involving singular events/origin points (Abadie and Gardeazabal [2003]; Abadie et al. [2010]; Abadie et al. [2015]). Traditionally, this study would fall under the category of a difference-in-difference model and rely on a two-way fixed effects (TWFE) approach. Recent studies have shown that TWFE may bias results with staggered implementation, a threat to causality in this study given the varied timings of international sanctions [De Chaisemartin and d'Haultfoeuille, 2020]. Matching and synthetic control are alternative techniques to the TWFE and offer an unbiased estimate of the average treatment effect (ATE), provided the underlying assumptions of each model are met [Grier and Grier, 2020]. For these reasons, I choose the Synthetic Control method as the appropriate estimation technique for this study.

3.1.1 Synthetic Control Methodology

If there is a collection of $C+1$ countries, and they are indexed as $i = 1,2,\dots,C+1$ for T time periods, $t = 1,2,\dots,T$, the synthetic control method states that country $i = 1$ has a nuclear weapons' program and the remaining C countries without programs are control units, making up the donor pool. T_0 is the number of pre-nuclear periods and T_1 is the number of post-nuclear periods, meaning that $T_0 + T_1 = T$. The effect of pursuing nuclear armament for unit i at time t is represented by $\theta_{it} = Y_{it}^A - Y_{it}^B$. In this equation, Y_{it}^A is real per capita GDP for unit i at time t if nuclear program begins in $T_0 + 1$ and Y_{it}^B is the same but in the absence of such a program. Because only one country is exposed to the treatment of having a nuclear weapons' program (country $i = 1$), I must estimate $\theta_{1,0},\ldots,\theta_{1,T}$. Y_{it}^{B} is estimated with the following factor model:

$$Y_{it}^{B} = \alpha_t + \beta_t X_i + \delta_t Z_i + \varepsilon_{it} \tag{3.1}$$

Here, α_t is an unknown common factor invariant across units, X_i is a covariate vector not affected by nuclear weapons, β_t is a vector of unknown time-specific parameters, δ_t is a vector of unknown common factors, Z_i is country-specific unobservables and ε_{it} is the error term for zero-mean transitory shocks.

The synthetic control method creates the missing counterfactual, Y_{it}^{B}, from countries in the donor pool that do not participate in nuclear development. Abadie et al. (2010) explains this process in the following way: Let $W = (w_2,\ldots,w_{C+1})'$ be $(C \times 1)$ vector of weights such that $0 \leq w_j \leq 1$ for $j = 2,3,\ldots,C+1$ and $\sum_{j=2}^{C+1} w_j = 1$. I define the linear combination of pre-nuclear real per capita GDP values by $\bar{Y}_j^{K} = \sum_{m=1}^{T_0} k_m Y_{jm}$. Therefore, if the condition:

$$\sum_{j=2}^{S+1} w_j^{*} Z_j \wedge \sum_{j=2}^{S+1} w_j^{*} \bar{Y}_j^{K} = \bar{Y}_1^{k} \tag{3.2}$$

holds[36], then the estimate of the effect for pursuing nuclear weapons in Pakistan, $\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{S+1} W_j^{*} Y_{jt}$, can be considered an unbiased estimator of α_{1t}. With w_j^{*} being the assigned weight for the j^{th} country in the donor pool not participating in nuclear proliferation.

The synthetic control method calls for the minimization of the distance between the vector of pre-nuclear characteristics for Pakistan (X_1) and the weighted matrix of pre-nuclear characteristics for unexposed countries (X_0). W^{*} is the chosen vector to do this, expressed as:

$$\parallel X_1 - X_0 W \parallel = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)} \tag{3.3}$$

with V being a symmetric and positive semidefinite matrix. The constraints of minimization are that the weight assigned for each country in the pool of non-nuclear proliferation must be between zero and one with the sum of those weights bounded by one. Those donor pool countries are assigned their weights by their comparability to pre-nuclear real per capita GDP and GDP influencing covariates of Pakistan before their nuclear program began in 1972. That measure of comparability comes from the minimization of root mean square prediction error (RMSPE) in the pre-nuclear period. The RMSPE is a measure for the lack of fit between the trajectory of the outcome variable and its synthetic counterpart (Abadie et al., 2015). The pre-nuclear RMSPE is $(\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t}-\sum_{j=2}^{S+1}w_j^*Y_{jt})^2)^{\frac{1}{2}}$ and the post-nuclear RMSPE is $(\frac{1}{T_1}\sum_{t=T_0+1}^{T_1}(Y_{1t}-\sum_{j=2}^{S+1}w_j^*Y_{jt})^2)^{\frac{1}{2}}$. The number of pre- and post-nuclear periods are T_0 and T_1. The outcome of the synthetic is $w_j^*Y_{jt}$ and it is created with j^{th}, the unexposed country with weight w^*, and Y_{1t}, the actual outcome of the treated. Section 3.2.2 carries an alternative specification using predictors of GDP that do not involve pre-intervention outcome variables.

3.1.2 Economic Data

I use country-level panel data on real per capita GDP from the Penn World Tables v9.1 [Summers and Heston, 1991].[37]. The data set has coverage for 182 countries from 1950-2017. Similar studies have made use of three other GDP panel data sets, those being the Maddison Project (Bolt and van Zanden [2020], the World Bank Global Financial Development indicators and the United Nations Conference on Trade and Development (UNCTAD). The selection of data is based on the availability of pre/post-treatment periods and potential control units. The UNCTAD database, beginning in 1970, has a large collection of potential control countries with 170, but lacks pre-treatment data to form a sufficient counterfactual. The World Bank data set has more than 200 countries, but data only goes back as far as 1960, meaning that there are only 12 pre-treatment years. This is a relatively limited amount for a proper synthetic control. The Maddison Project database is a potentially genuine alternative to the PWT. With 169 countries and data going back much further than even PWT, there is a full set of pre-treatment periods and a similarly large collection of controls. However, I choose the PWT because it combines a large pre-treatment period with a substantial set of potential control countries. Given the somewhat limited nature of nuclear weapons and programs globally, which will be discussed in the following section concerning the donor pool, I chose to place less value on greater than 22 available pre-treatment years (which Maddison offers) and more on the amount of control units. This is to ensure that there is appropriate weighting of control units through possible year to year variance and a significant understanding of GDP trends in the long run.

3.1.3 Synthetic Control Sample Selection

In order to produce a relevant counterfactual with SCM, the impact of developing a nuclear weapon on a nation's real per capita GDP must be isolated by determining control units that have not been affected in a significant way by nuclear activities. To do this, I consulted information from the Institute for Science and International Security, the Arms Control Association and the International Atomic Energy Agency (IAEA) to identify countries which had or currently have a relationship to nuclear weapons and nuclear technology. My exclusion criteria for the donor pool include whether countries currently or have ever possessed nuclear weapons[38], developed nuclear weapon technology, expressed intent or internally advocated for such weapon development, successfully tested a nuclear weapon or have been widely suspected of any of the above. Table 3.1 lists the 36 countries excluded from the initial set of PWT control countries, as well as an indicator for the reason of exclusion on the grounds of nuclear activity.

To ensure the SCM is well-functioning, it is necessary to select control units which have have enough pre-treatment period observations to reproduce the desired country (Abadie et al. [2015]; Kuruc [2018]; Dhungana [2011]). If donor pool countries lack a significant pre-treatment, then the ability to produce a credible match diminishes (Grier and Maynard [2016]; Billmeier and Nannicini [2013]). I thus exclude all countries within the PWT data set which do not have observations of real gdp for the entire pre-treatment period. The entire pre-treatment being all the years of available data on Pakistan prior to 1972, which in this case is 22 years (1950-1971). With this two-step process of building the SCM donor pool, I arrive have 26 countries with which to develop a synthetic Pakistan before and after nuclear development.[39] This allotment of control countries should provide a reasonable interpretation of what Pakistan would be like without a nuclear weapon. All control countries have never had nuclear weapons or nuclear ambitions, and they have sufficient data to assess trends over a long period of time.

3.2 Results

Figure 3.1 is a plot of real per capita GDP for Pakistan and the synthetic Pakistan from 1950 to 1998, including a 22-year pre-nuclear period. The synthetic Pakistan trend is produced with the convex combination of control countries in the donor pool matching closely to Pakistan before the country began a program to develop a nuclear weapon in 1972. Weights for the value of each country based on this pre-intervention resemblance are displayed in table 3.2.

Based on the goodness-of-fit for the synthetic replication, an RMSPE of 42.57, it is fair to say the real per capita GDP trajectory is reproduced accurately in the pre-nuclear period. Figure 3.1 depicts the negative divergence of economic development for Pakistan immediately following the start of the country's nuclear program in 1972.

Between 1973 and 1989, the first 17 years following the start of Pakistan's program, the synthetic and actual real per capita GDP is consistent. The average difference between the two is \$371.10.[40] For the next 8 years, when Pakistan was under substantial financial, military, and trade related sanctions by the United States and later the G8 and other countries, the average difference between synthetic and actual Pakistan is \$1457.03. For the entirety of the 25 years following the initiation of the Pakistani nuclear program, the average difference between Pakistan and synthetic Pakistan is \$718.60. At no point in the post-treatment observation period does actual Pakistan outperform the synthetic counterfactual economically. Overall, I find that synthetic Pakistan is 27.8 percent higher on average. This equates to greater than 2 percentage points higher annual growth over the course of 25 years. A large portion of this underdevelopment narrative seems to be taking place during the sanctioned years of 1990-1997. According to the Global Sanctions Database, the United States had strict international sanctions on Pakistan for arms, military support, and financial cooperation [Felbermayr et al., 2020]. This 8-year period alone saw synthetic Pakistan outperform actual Pakistan by an average of 33.7 percent, in terms of per capita GDP.

3.2.1 Inference

In-Space Placebo Tests

To confirm that the synthetic controls in the donor pool make good predictors for the path of real per capita GDP in the pre-nuclear period, I conduct an in-space placebo test (Abadie et al. [2010]) featured in figure 3.2. For this test, the 26 control countries which were not involved in nuclear development are artificially reassigned as if they had an active nuclear program, beginning in 1972. Pakistan is also moved into the donor pool for each of these new synthetics. The expectation is that these countries, which did not pursue nuclear weapons, should be unaffected when the policy is enacted artificially. In other words, these non-nuclear countries should not see divergence of real per capita GDP between synthetic and actual trajectories in the post-nuclear period. For the in-space placebos, if similar or larger estimated GDP gaps are found for the non-nuclear countries, the causality of the effect of nuclear proliferation on economic development would be severely undermined (Abadie et al. [2010]).[41]

To assess the validity of inference for the estimated effect, I estimate in-space placebo GDP gaps with the synthetic control method for every country in the donor pool. This method allows for the identification of significance levels of the effect. If the effect from the development of nuclear weapons was found to be inside the distribution of the placebos, that would imply a random occurrence and not a causal effect. To do this, I look at the ratio of post-nuclear to pre-nuclear Pakistan RMSPE and how that compares to the ratio of the other country placebos. The ratio created is the p-value which can be seen as the probability of having a post/pre-nuclear RMSPE that is at least as large as Pakistan. The implication being that if the effect is causal, the ratio for a country which has been given nuclear activity artificially should not be larger than that of actual nuclear activity in Pakistan.

The RMSPE post/pre-nuclear ratios for all placebos and Pakistan are featured in figure 3.2.

Because the real per capita GDP gap is outside all the of placebo gap, a country that is randomly assigned distribution from the sample has a probability of having a post/pre-nuclear RMSPE ratio higher than Pakistan of $1/27 = 0.0370$. As shown in figure 3.2, none of the donor pool countries reach this ratio. The reader can interpret this as having greater than 96% confidence in the findings of figure 3.1.

Leave-One-Out Distribution

In order to assess the sensitivity of my results to changes in synthetic weights created by the removal of any one donor country, I create a series of 'Leave-One-Out' distributions. Based on the synthetic constructed in figure 3.1 and the weights as described in table 3.2, the synthetic of Pakistan without nuclear weapons is comprised of 6 countries: Bolivia, Cyprus, Ethiopia, Honduras, Thailand, and Uganda. To determine if and by how much the results are influenced by any one country, I repeatedly remove one country at time and re-run the model to build a new synthetic Pakistan. Figure 3.3 shows the results of this process with light grey lines for the various leave-one-out estimations.

To determine the effects of any one country on the outcome, I took the average difference between the actual GDP of Pakistan and the 6 leave-one-out distributions in the pre-treatment period. I found that actual GDP was on average 0.002 percent lower than the average of all leave-one-out synthetics in the pre-treatment period, a relatively small difference that suggests the leave-one-out estimations return a good fit to the model. For the post-treatment period, the difference between average leave-one-out synthetic estimations and actual GDP of Pakistan is 24.24 percent on average. Given that the difference between the synthetic with all donor countries and actual GDP was 27.8 percent, I can reasonably conclude these two are close matches. However, the most important part of this distribution is the difference between the leave-one-out and original synthetics in the post-treatment period. This difference is an indicator of whether the measurable effect of nuclear weapons' development is robust to country exclusion. To that end, I find that the average of the 6 leave-one-out synthetics was on average 0.28 percent smaller than the original full donor pool synthetic. A relatively small difference that suggests the leave-one-out estimates are robust in the face of iterative country removal.

Sparse Synthetic Controls

In the literature of synthetic counterfactuals, the trade-off between sparsity of controls and goodness of fit is a necessary check for robustness (Abadie et al. [2010]; Bilgel and Karahasan [2019]). To check the worthiness of my synthetic, I systematically reduce the number of control countries from the donor pool which contribute weight to the synthetic of Pakistan. This process leads to an effective measurement with a smaller number of comparison countries so that the trade-off of sparsity and goodness of fit may be evaluated. I construct a set of synthetic controls for Pakistan by allowing sequential combinations of control countries, from six to one. At each level of removing another country, the resulting synthetic is the one that minimizes the corresponding RMSPE. Table 3.4 lists the countries and their corresponding weights, as well as the goodness of fit based on the compromise of sparsity for each control country removed. The set of 6 control countries are those which are given weights from the original synthetic control created by the 26-country donor pool. Looking at the original RMSPE of 42.57, there is very little loss to goodness of fit moving from 6 control countries to 3. The average percentage difference between the average of sparse synthetic's for Pakistan and actual Pakistan for l = 5, 4, and 3 controls is a negative 28.18 percent. This is larger than the 27.8 percent gap found in the original synthetic, but relatively close to the amount of lost growth associated with developing a nuclear weapon. For the extremely sparse controls of 2 and 1, the goodness of fit was very poor. In these cases, the gap between actual and synthetic dissipated and was difficult to interpret. This suggests that estimated effect of nuclear development may be slightly exaggerated, and the actual effect could be a smaller negative than the vast differences I have been reporting. However, I don't think there should be too much concern for this as the extremely sparse synthetics are limited to two and one controls, respectively. This would be like saying that the interpretation of the effect of nuclear development on Pakistan is entirely determined by Honduras. Obviously, that is inefficient and why the most realistic interpretation comes from the full set of controls.

Figure 3.4 is the real per capita GDP for Pakistan with the original synthetic of 6 weighted control countries and a range of sparse control synthetics from 5 controls to 1. The set of sparsely populated synthetics resemble the original synthetic Pakistan with full controls (figure 3.1) in the pre-treatment period and for most of the post-treatment period. These reduced control scenarios mimic the original synthetic in the post-treatment period as well. Looking at the average of these synthetics, there is a relatively insignificant gap between treatment and synthetically estimated Pakistan. Again, the extremely sparse synthetics ($l = 2$ and 1) fail to capture the effect and show a greater resemblance to the actual Pakistan. Given this, it is still reasonable to say that nuclear development predicts worsening economic outcomes.

Non-Outcome Pre-Nuclear Characteristics

Kaul et al. [2015] suggests that the creation of a synthetic counterfactual with the synthetic control method should not be made of entirely pre-intervention outcome observations as economic predictors. The reason being that non-outcome predictors may become irrelevant when 'all' pre-treatment outcomes are included, with the chance of bringing biasedness on the treatment effect. My reasoning for using all pre-treatment outcome variables is that they are unlikely to bias my estimate because with a sufficient pre-intervention set of GDP data, I can control for heterogeneous responses to multiple observed factors (Abadie et al. [2015]; Bilgel and Karahasan [2019]).

To robustly confirm this assertion, I create another synthetic Pakistan that uses non-outcome pre-nuclear predictors rather than solely outcome predictors. Taking from the extensive selection of literature concerning cross-country determinants of economic performance by way of GDP, I use a set of predictors from 1950-1971. These predictors include inflation rate, population growth rate, imports and exports (% of GDP), life expectancy at birth, fertility rate, and net incoming foreign direct investment flows (% of GDP). Data comes exclusively from the World Development Indicators database at the World Bank. The data pool of potential synthetic control countries is the same as the main results with a set of excluded countries due to lack of additional predictor data.

These are Venezuela, Ethiopia, Trinidad and Tobago, Luxembourg, Uganda, Cyprus, Mauritius, and the Democratic Republic of the Congo. This leaves a total of 18 potential control countries from the original 26. There is also a need to control for initial levels of GDP and GDP at the treatment cutoff date. To do this, I include real per capita GDP observations for 1950, 1961, and 1971.

In figure 3.5, the trends in real per capita GDP for both actual and synthetic Pakistan based on non-outcome predictors are plotted. Given the new predictors and altered donor pool, synthetic Pakistan has a new set of controls that are given weight to create the synthetic: Bolivia (0.064), Ecuador (0.031), Morocco (0.154), and Thailand (0.751). Using the 7 non-outcome predictors previously listed, the synthetic control approach still returns an acceptable goodness of fit of 211.0855 in the pre-nuclear period as well as demonstrating a negative effect on the economy of Pakistan in the post-nuclear period. Figure 3.5 shows that the synthetic Pakistan outpaces actual Pakistan in per capita GDP by an average of $2179.90 for the entirety of the 25-year post-nuclear period. This is quite a bit larger than what was found in figure 3.1, but the direction and movement of the graph are close to the same. There is a noticeable jump in the gap between synthetic and actual Pakistan around the start of new sanctions in 1990. The takeaway from this figure should be that relying on strictly outcome variables as predictors may be under-selling the development drag created by seeking a nuclear weapon. Using non-outcome predictors captures a greater number of heterogeneous effects on growth, perhaps preventing an ecological fallacy. Either way, the implication of a negative effect on development is clear and corresponds once again with international sanctions being placed on Pakistan.

Alternative Exogenous Shock: 1988 Unexpected Leader Death

A recent referee report pointed out that there might be other exogenous events driving under-development, potentially confounding the results from my original synthetic control. One such event was the unexpected death of former 4-star general and President of Pakistan Muhammad Zia-ul-Haq in a 1988 plane crash. Jones and Olken [2005] is a seminal study on the impact of national leaders and economic development. In that paper, Jones and Olken causally identify a significant effect of leaders based on exogenous shifts in who was in power. The mechanism they use is random or otherwise unexpected deaths of leaders. Using the death of General Zia in 1988, I perform a synthetic control analysis to see if this event has a statistically significant impact on development.

In figure 3.6, I present the findings of this synthetic control case study. I find that between 1988 and 1998, the death of General Zia did not have a statistically significant impact on development. The graph depicts a slight jump in economic performance for Pakistan in the years around the event, but then returns to be in line with the synthetic. This result is not significantly different from zero, so I rule out the possibility of this alternative exogenous shock being the driver of economic underdevelopment.

3.2.2 Potential Mechanisms

Economic Sanctions and International Trade

The United States, other countries, and international organizations tried for decades to contain the Pakistani nuclear program. The primary tool at the hands of these entities was and still is sanctions. Throughout the 1970s, after the initiation of the program by Pakistan, the U.S. and Canada put military, financial, and trade sanctions on Pakistan with varying degrees of success (Felbermayr et al. [2020]). Pakistan was then left relatively alone by the international sanction's regime throughout the 1980s, presumably due to its cooperation with western nations in supporting the Mujahideen against the Soviet Union during its intervention in the Afghan Civil War (1979-1989). Sanctions then returned in force against Pakistan in the 1990s as the country became increasingly adversarial with nuclear armed India. The culmination of this standoff would be the dual testing of nuclear weapons by both countries in 1998, thus demonstrating the nuclear capability of Pakistan to the world. The 1990s saw all forms of international sanctions placed on Pakistan, including trade-based sanctions, by the U.S., the G8, Japan, Canada, the Netherlands, the United Kingdom, Australia, Germany, and the Commonwealth. As noted in figure 3.1, the 1990s saw the greatest loss in economic development for Pakistan when compared to the synthetic. A loss of trade correlated with the international sanction's regime of the 1990s against Pakistan could be the answer to why that period of time was so devastating economically, with respect to the nuclear program. A list of sanctions placed on Pakistan is shown in table 3.4. The sanctions fall under two classification types. The first is 'Policy Change' which are sanctions meant to deter Pakistan from nuclear proliferation. Sanctions of the type 'Prevent War' are sanctions meant to deter the escalation of conflict and the potential use of nuclear weapons.

To examine trade as a potential mechanism for the lackluster economic development seen throughout the 1990s, I perform an additional synthetic control analysis with trade as the dependent variable. The analysis uses trade data from Fouquin et al. [2016], as it provides observations covering 1950. This is not as common as one might think in trade data sets. The World Bank Development Indicators suffer from only covering as far back as 1960. I once again use a combination of outcome and non-outcome predictors to perform the synthetic control analysis. These include the total bilateral flow of trade in million British pounds (2014) and the non-outcome predictors found in 3.2.1.[42] Therefore, the set of control countries are the same 18 used in 3.2.1 to maintain continuity. The year for the synthetic break also remains the same, 1972, for the origin of Pakistan's nuclear program.

Figure 3.7 shows the results of the described synthetic with the trends in total bilateral trade from 1950-1997. Once again, the synthetic matches well in the pre-treatment period with a RMSPE value of 44.26627. The control countries are different than the previous figures and are as follows: Bolivia (0.149), Colombia (0.774), Kenya (0.022), and Mexico (0.056). From the beginning of the nuclear program, Pakistan's actual bilateral trade flow under-performs its synthetic counterpart. Over the 25-year post-treatment period, actual Pakistan averages 1339.20 million British pounds (2014 level) less than the synthetic counterfactual. After 1989, when the international sanctions began hitting Pakistan in force, the average expands to 2256.75 and eventually reaches 4583.77 in 1997. This graph clearly demonstrates the devastating economic effects an international sanctions regime had on Pakistan's global trade as a result of its nuclear activities. This can be seen as a significant contributing factor to the under-performance of economic development for Pakistan in comparison to the synthetic counterfactual.

Military Expenditure: Resource Reallocation

There has been for several decades an active debate over the impact of military expenditure on economic growth. One side argues that military expenditure is an economically unproductive outlet for resources and the redistribution of those resources leads to economic growth [Knight et al., 1996]. The opposite is argued by others due to security related spillovers or a view that military spending is simply another form of fiscal spending to stimulate the economy [Dunne, 2013]. In figure 3.8, I show the evolution of Pakistan's military burden (military spending as a percentage of GDP per capita) over time. The graph shows that the military burden in Pakistan was elevated during the period of nuclear development and peaked at nearly 7 percent. However, by the early 1990s when it was believed that Pakistan had created a functioning nuclear weapon, the burden began to fall. This decrease in military spending accelerated following the 1998 nuclear test and has continued to remain below 4 percent ever since.

Therefore, it is important to ask whether this decrease in funding after nuclear development had an impact on growth. In figure 3.9, I plot synthetic and actual Pakistan but include the post-1998 trends. The reason I use the existing synthetic make-up and not a new one for the post-nuclear period is because of the changing counterfactual dynamic. Prior to 1998, the counterfactual to Pakistan having a nuclear program but not a demonstrated capability was a country without a nuclear program entirely. Post-1998, the counterfactual would be a country with a nuclear program but no weapon. This is an incredibly limited number of countries after the 1970 Test Ban Treaty and there currently are not any being added. The lack of countries to produce a credible counterfactual means I must keep with the existing synthetic.

Figure 3.9 shows the evolution in Pakistan and the synthetic. I find that the gap between Pakistan and the synthetic continues to expand in the post-1998 period. During the initial few years after the 1998 test, Pakistan continued to be impacted by international sanctions. The same is not true for military expenditure which is clearly show in figure 3.8. If military expenditure had a serious impact on the underdevelopment of Pakistan during the countries pre-test proliferation period, then we might expect some convergence of the synthetic and actual output. The fact that the gap between the two countries continues to grow is evidence to support the theory of Yesilyurt and Yesilyurt [2019] that military expenditure may have little impact on growth. It is also an interesting comparison to Dizaji [2019] which shows that military expenditure went up for Iran even after nuclear sanctions were lifted in 2015. The key difference is that Iran did not have a demonstrated nuclear capability when Pakistan did. Having a nuclear weapon perhaps relieved some of the pressure to spend more on the military. However, this did not translate to more economic growth due to the crippling international sanctions that remained on the country for years after.

3.3 Conclusion

Using the synthetic control method and a country-level panel data set of real per capita GDP for the time frame of 1950-1997, I was able to determine the economic effect of nuclear weapon development in Pakistan. This analytical framework produces the economic development of Pakistan had the country not pursued a nuclear weapon beginning in 1972. For a 25-year period following the first successful nuclear weapon's test (1973-1997), I find that Pakistan experienced an average of 27.8 percent lower real per capita GDP as a result of the country's nuclear actions. Based on 2011 U.S. dollars (measurement used by PWT data set), this difference accounts for an average of $718 over the 25-year period. Since Pakistan began seeking a nuclear weapon, the annual GDP growth rate of the country has decreased by an average of 2.04 percent compared to the expected rate predicted by the synthetic. This estimated effect is shown to be caused by the declaration of nuclear capabilities by Pakistan through in-space placebo distributions. The results are also shown to be extremely robust against iterative removal of control countries and non-outcome characteristics as predictors in the pre-treatment period. The results are highly correlated with the implementation of international sanctions. From the beginning of 1972, the actual and synthetic

Pakistan GDP trends diverge. However, in 1990 when the U.S. and other countries began imposing significant sanctions targeting Pakistan and its nuclear program, the country began massively following behind its predicted development.

The past 70 years have seen 9 countries officially rise to the level of nuclear armament with others suspected. Even more countries have attempted to or are actively researching the capabilities necessary to produce a functioning nuclear weapon. These actions will have lasting effects on the economies of the countries in question, as well as others around the world based on their relationship to said countries. My study is one of the first to estimate a significant effect on the economic outcomes and to point out the annual and overall size of economic disruptions caused by the pursuit of nuclear weapons in a statistically transparent way. The findings in this study suggest that there is a sizable economic loss associated with nuclear development, and this can be largely attributed to the penalty of sanctions from international organizations and individual countries. In conclusion, this study serves as a benchmark in the cost-benefit analysis countries must undertake when deciding if it is worth pursuing the most destructive weapon on planet Earth.

Notes

[28]The date of the earliest confirmed Indian nuclear test was May 18th, 1974. The weapon, a Pokhran-1 12 kiloton (1 kiloton equals the explosive energy created by one metric ton of TNT) nuclear warhead, was nicknamed the ”Smiling Buddha”.

[29]Pakistan has around 2.8 of the world population share. Pakistan also is in the 33rd percentile of GDP per capita so it is not considered an economic superpower like other countries with nuclear weapons.

[30]For more information on the development of nuclear weapons in Pakistan, see Kapur [1987]

[31]Information on the technical details of Pakistan's nuclear development is from the Federation of American Scientists (FAS). The organization was originally founded in 1945 as the Federation of Atomic Scientists by former members of the Manhattan Project. Today, the FAS works to curtail the spread of nuclear weapons, prevent nuclear terrorism, promote high standards of security and safety, as well as illuminating government secrecy practices around nuclear devices.

[32]1998 was the year Pakistan first tested a nuclear weapon, thus moving the country from the development to armed status.

[33]These robustness methods follow directly from Abadie et al. [2010] and employ a similar style to Bilgel and Karahasan [2019].

[34]Senior Fellow for Korea Studies and Director or the Program on U.S.-Korea Policy at the Council on Foreign Relations.

[35]https://www.cato.org/publications/policy-analysis/social-economic-effects-nuclear-war

[36]$\wedge$ is a symbol for logical AND, meaning both conditions must be satisfied.

[37]Data from Penn World Tables 9.1, and I use the variable expenditure-side real GDP at chained PPPs (in mil. 2011 U.S. dollars) *rgdpe*. This is divided by the population variable within the Penn World Tables data set to create the dependent variable.

[38]This includes through nuclear sharing programs. NATO currently hosts U.S. nuclear weapons in a number of countries including Turkey and Italy.

[39]Donor Pool Countries: Austria, Bolivia, Colombia, Costa Rica, Cyprus, Democratic Republic of the Congo, Denmark, Ecuador, El Salvador, Ethiopia, Finland, Honduras, Iceland, Kenya, Luxembourg, Mauritius, Mexico, Morocco, New Zealand, Portugal, Sri Lanka, Thailand, Trinidad and Tobago, Uganda, Uruguay, and Venezuela.

[40]Calculated by taking the ratio of the difference between averages of synthetic and actual Pakistan in the post-nuclear period.

[41]RMSPE: Root Mean Square Percentage Error. $RMSPE = \sqrt{\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{n}}$

[42]Unfortunately, the trade data from Fouquin et al. [2016] is only available in British pounds.

Tables

Table 3.1: Nuclear Activity, Excluded From Donor Pool

Country	Armed (Includes Sharing)	Program, not Armed	Previous Program	Previously Armed (Sharing)	Suspected/ Advocated
Algeria					x
Argentina					x
Australia			x		
Belarus				x	
Belgium	x				
Brazil			x		
Canada				x	
China	x				
Egypt			x		
France	x				
Germany	x				
India	x				
Indonesia					x
Iran		x			
Iraq			x		
Israel	Likely				
Italy	x				
Japan					x
Kazakhstan				x	
Libya			x		
Netherlands	x				
North Korea	x				
Norway					x
Russia	x				
South Africa				x	
South Korea			x		
Spain					x
Sweden			x		
Switzerland			x		
Syria					x
Taiwan			x		
Turkey	x				
Ukraine				x	
United Kingdom	x				
United States	x				
Yugoslavia			x		

Table 3.2: Synthetic Control Country Weights

Country	Weight
Bolivia	0.198
Cyprus	0.016
Ethiopia	0.218
Honduras	0.176
Thailand	0.340
Uganda	0.052

Author's calculations.

Table 3.3: Synthetic Weights with Varied (Sparse) Control Combinations, Pakistan

Synthetic Combination	RMSPE	Honduras	Ethiopia	Thailand	Bolivia	Cyprus	Uganda
6 Controls	42.57	0.176	0.218	0.340	0.198	0.016	0.052
5 Controls	46.24	0.159	0.229	0.325	0.276	0.008	
4 Controls	44.32	0.190	0.190	0.408	0.212		
3 Controls	56.75	0.340	0.250	0.411			
2 Controls	168.4533	0.490	0.510				
1 Control	907.68	1.000					

Notes: Countries and weight constructed from best fitting sequential combination.

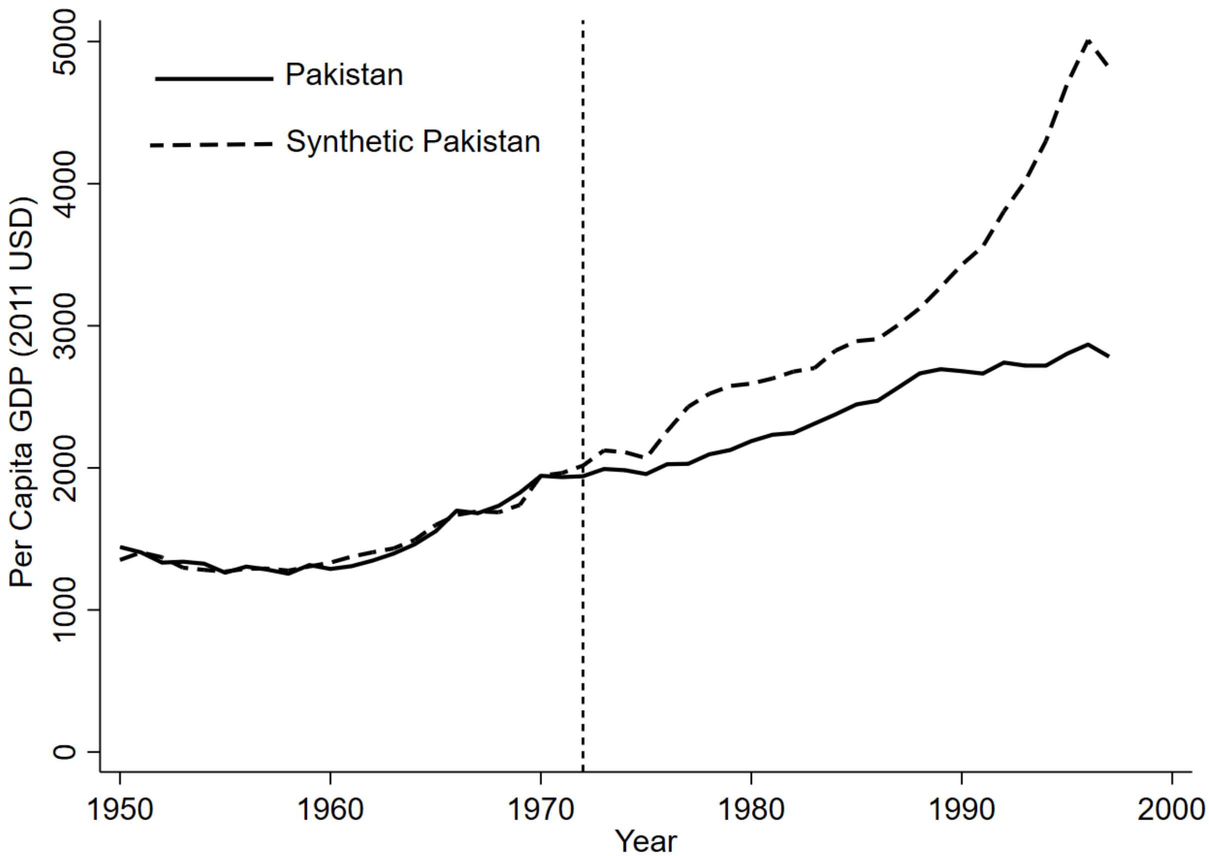
Table 3.4: International Sanctions Against Pakistan by Year

Sanctioning State	Years	Trade Sanctions	Financial Sanctions	Objective
Canada	1974-1976	1	0	Prevent War
United States	1979-1981	0	1	Prevent War
United States	1990-2001	0	1	Policy Change
United States	1993-1995	1	0	Policy Change
G8	1998-1999	0	1	Prevent War
Japan	1998-2001	0	1	Prevent War
United States	1998-2001	0	1	Prevent War
Netherlands	1998-2008	0	1	Prevent War
Canada, Germany	1998-2001	0	1	Prevent War
Australia	1998-2001	0	1	Prevent War
Commonwealth	1999-2004	1	0	Prevent War
United Kingdom	1999-2000	0	1	Prevent War
United States	1999-2001	0	1	Prevent War
Commonwealth	2007-2008	1	0	Prevent War

Notes: Data comes from the Global Sanctions Database [Felbermayr et al., 2020]. For the trade and financial sections variable, 1 indicates that the sanctions fell into the category in question. A 0 indicates that the sanctions were not of this type. Under objective, policy change indicates that the sanctions were intended to persuade Pakistan not to develop/test nuclear weapons. The prevent war objective indicates that sanctions were meant to deter Pakistan from escalating conflict with India, another nuclear armed country.

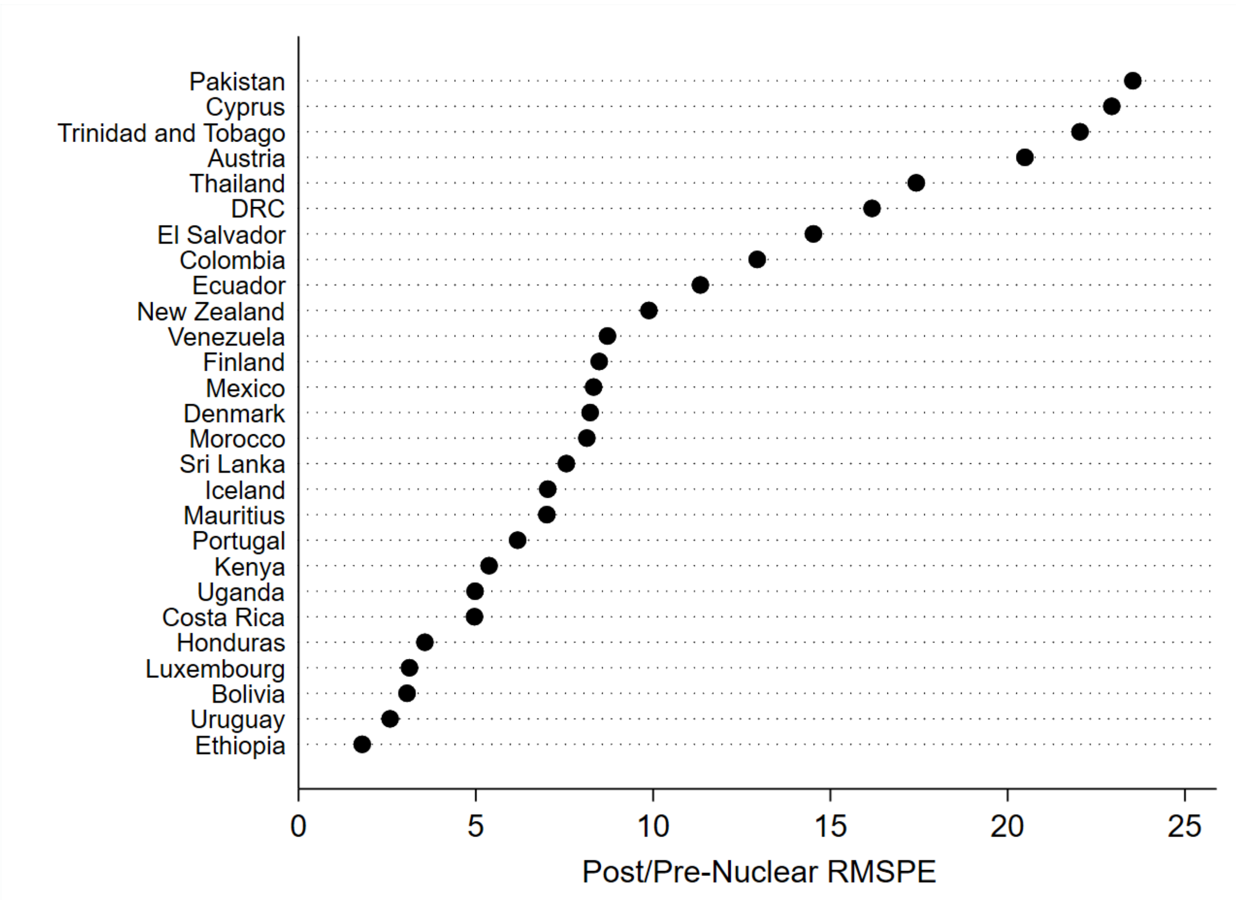
Figures

Figure 3.1: Trends in per capita GDP: Pakistan vs. Synthetic Pakistan



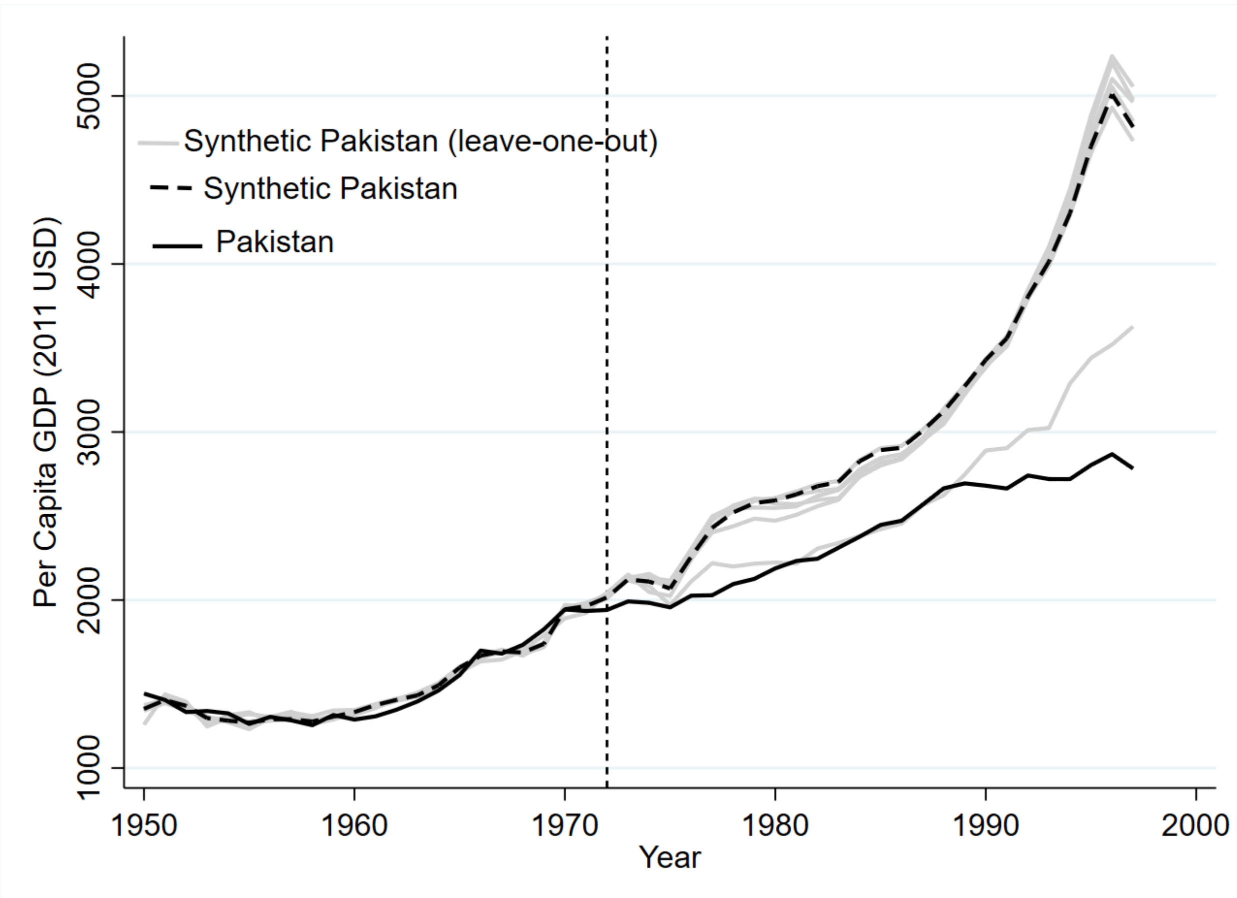
Notes: Main results. Reference line signals 1972, the year Pakistan's nuclear weapons' program began. Dotted line is the composed synthetic version of Pakistan during this time period (up to 1998–year of first nuclear test). Solid line is actual performance of GDP per capita for Pakistan. The difference between actual and synthetic Pakistan widens throughout the 1990s. This time period coincides with massive economic sanctions placed on Pakistan while the rest of the world experienced unprecedented economic growth.

Figure 3.2: In-Space Placebo Distributions



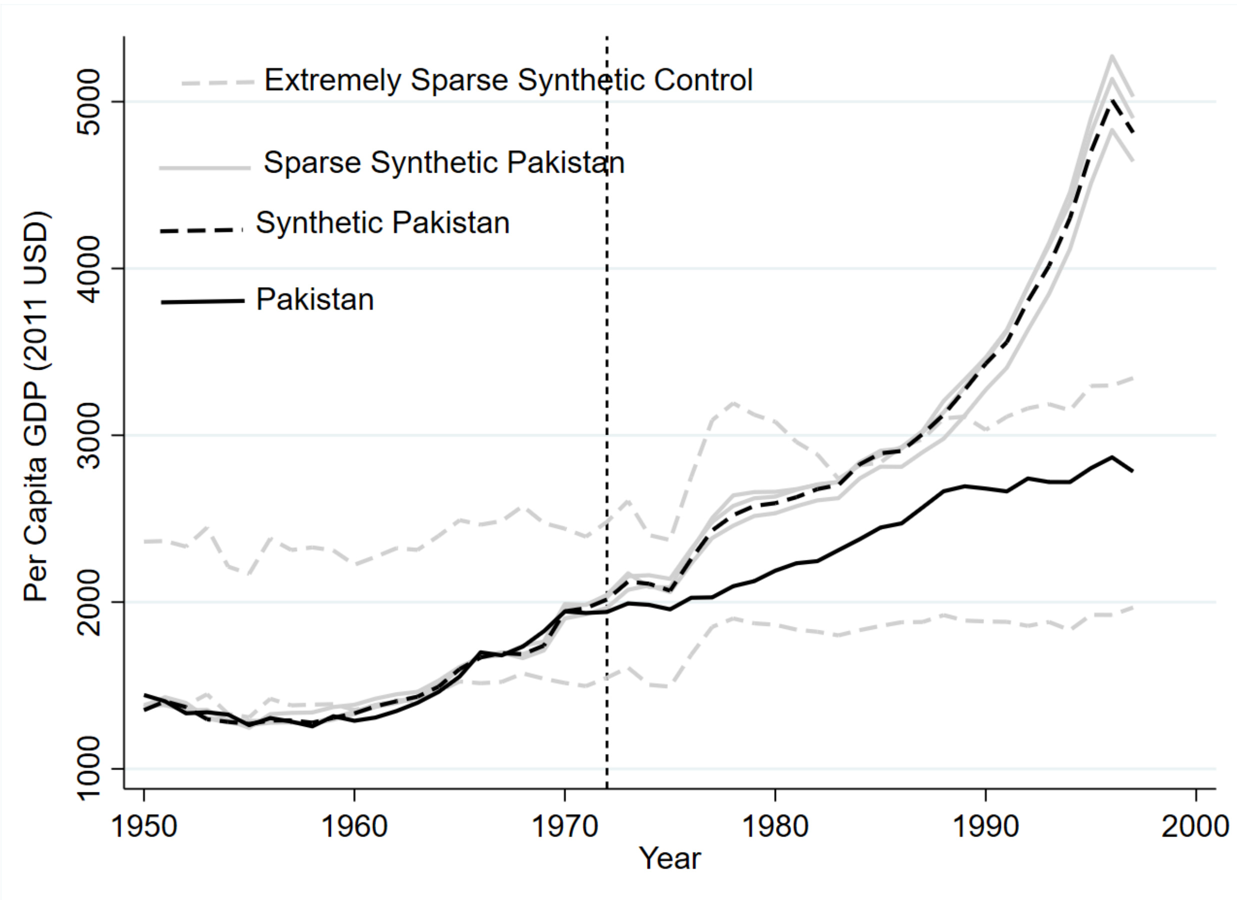
Notes: Ratio of Post-Nuclear to Pre-Nuclear RMSPE. Pakistan is the largest, signifying an inference of 1/27 = 0.037. Giving a p-value for figure 3.1 of greater than 96%.

Figure 3.3: Leave-One-Out Distribution of the Synthetic Control



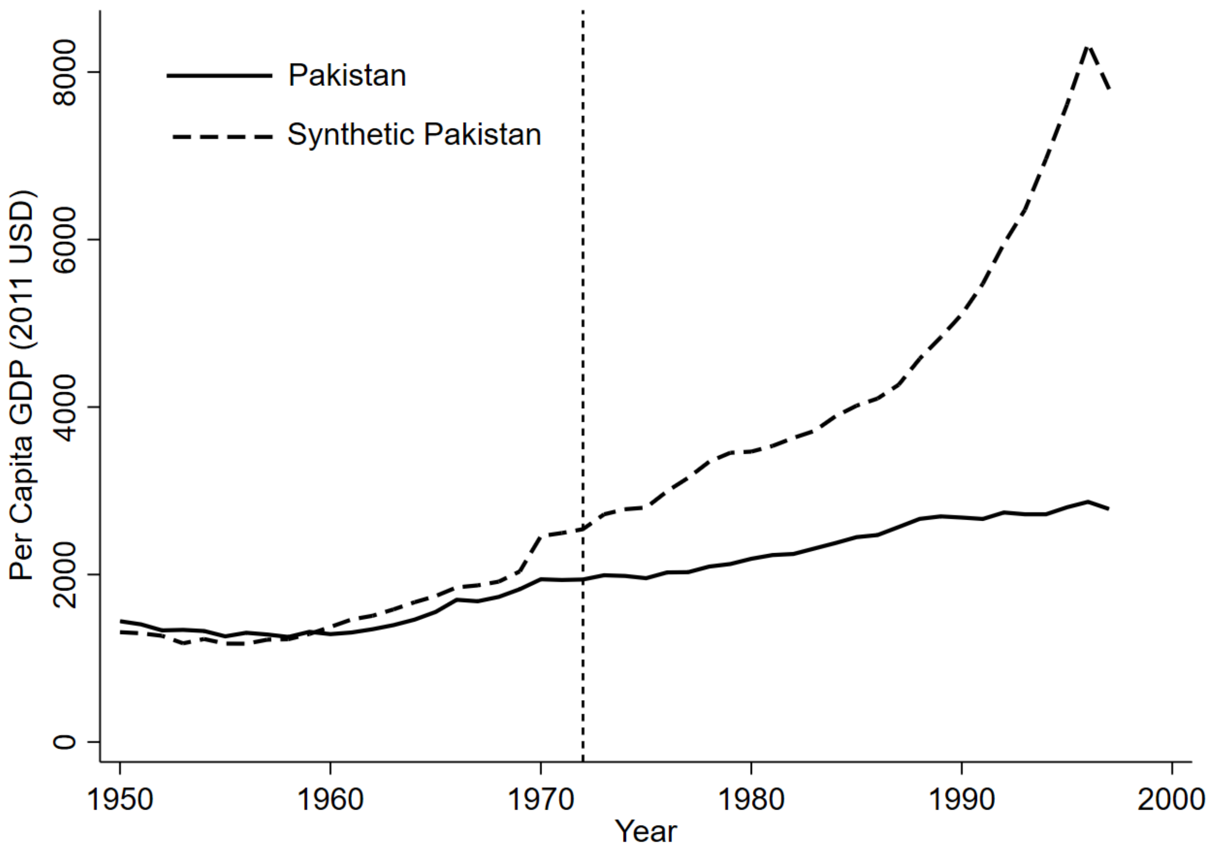
Notes: Light grey lines are the analysis of the original synthetic with one of the control countries removed. All else is the same from figure 3.1.

Figure 3.4: Per Capita GDP: Pakistan and Sparse Synthetic Controls



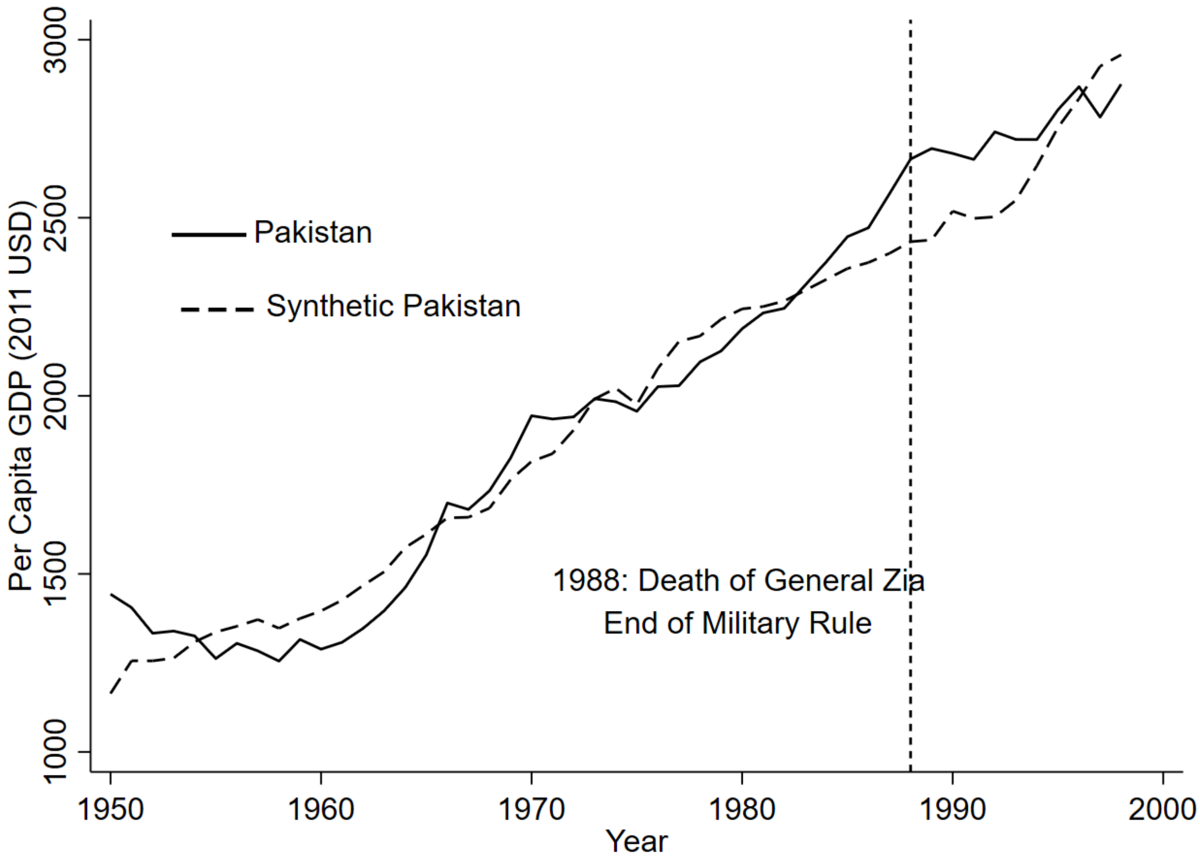
Notes: Sparse synthetic control lines are those with 1-4 controls removed. The extremely sparse synthetic controls have only 1 or 2 control countries. All else the same as from figure 3.1.

Figure 3.5: Trends in per capita GDP: Non-Outcome Predictors



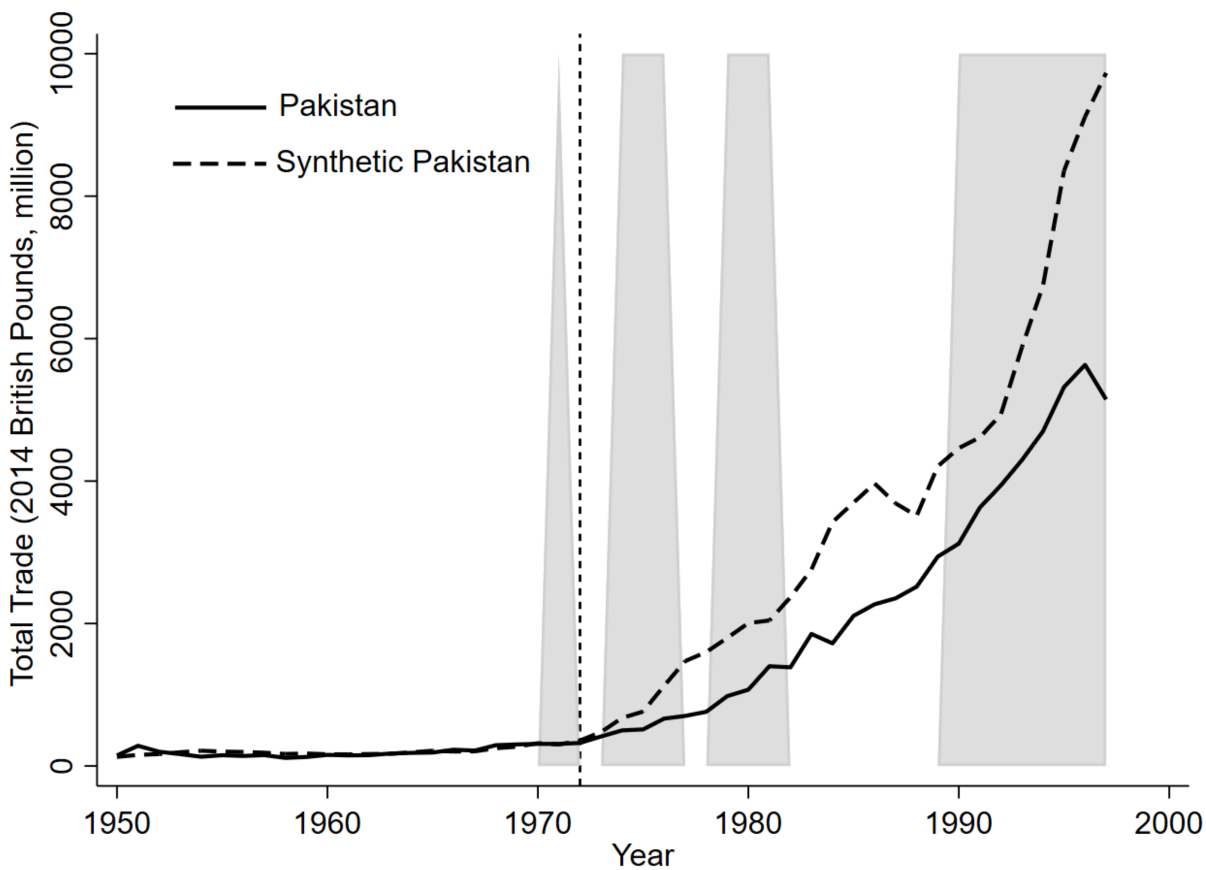
Notes: Identical specifications as figure 3.1 except I use non-outcome predictors listed in the **??** to create the synthetic. Figure 3.1 uses the full set of available GDP data as primary predictors instead.

Figure 3.6: Trends in per capita GDP: 1988 Death of General Zia



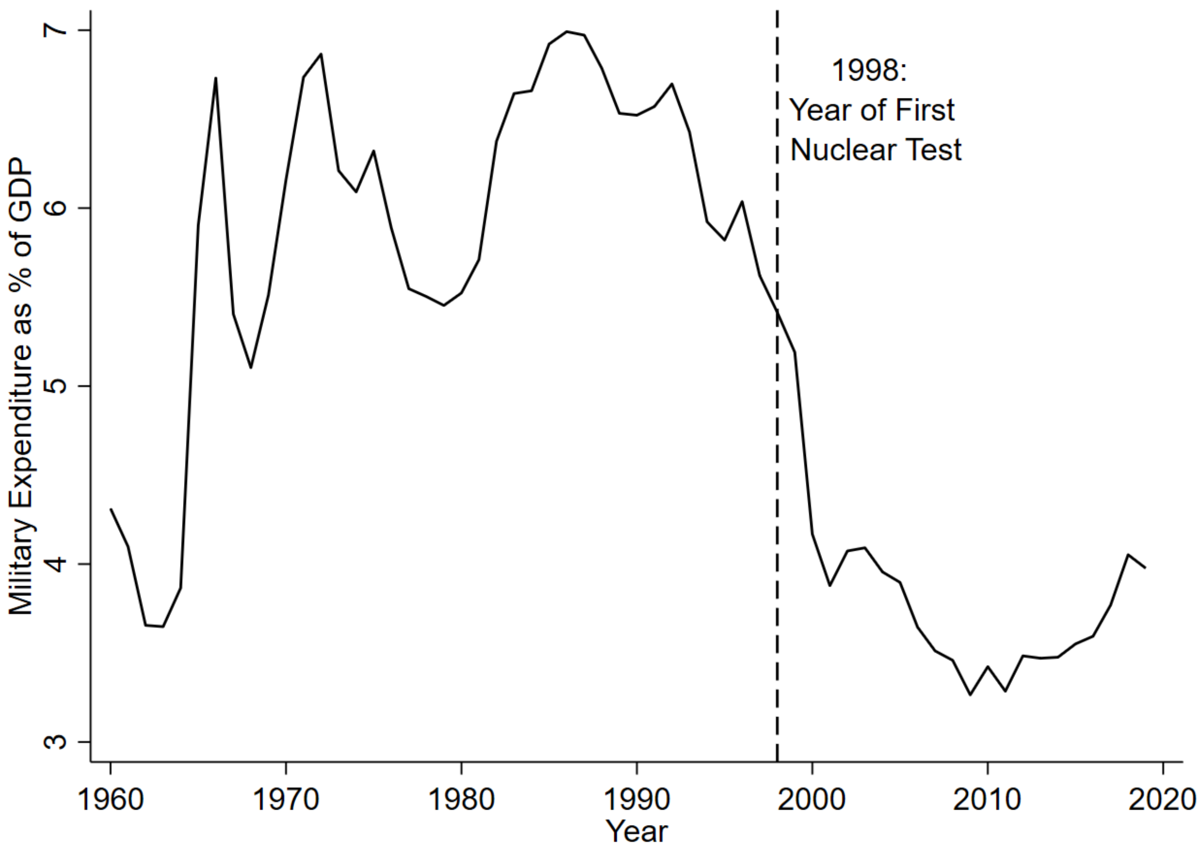
Notes: I use 1988 (the unexpected, plane crash death of Pakistan's leader: General Zia) as the point of treatment rather than the 1998 nuclear test. I observe very little difference between synthetic and actual Pakistan. This confirms that my growth pattern in figure 3.1 are unaffected by this exogenous event.

Figure 3.7: Trends in Bilateral Trade Flow, total



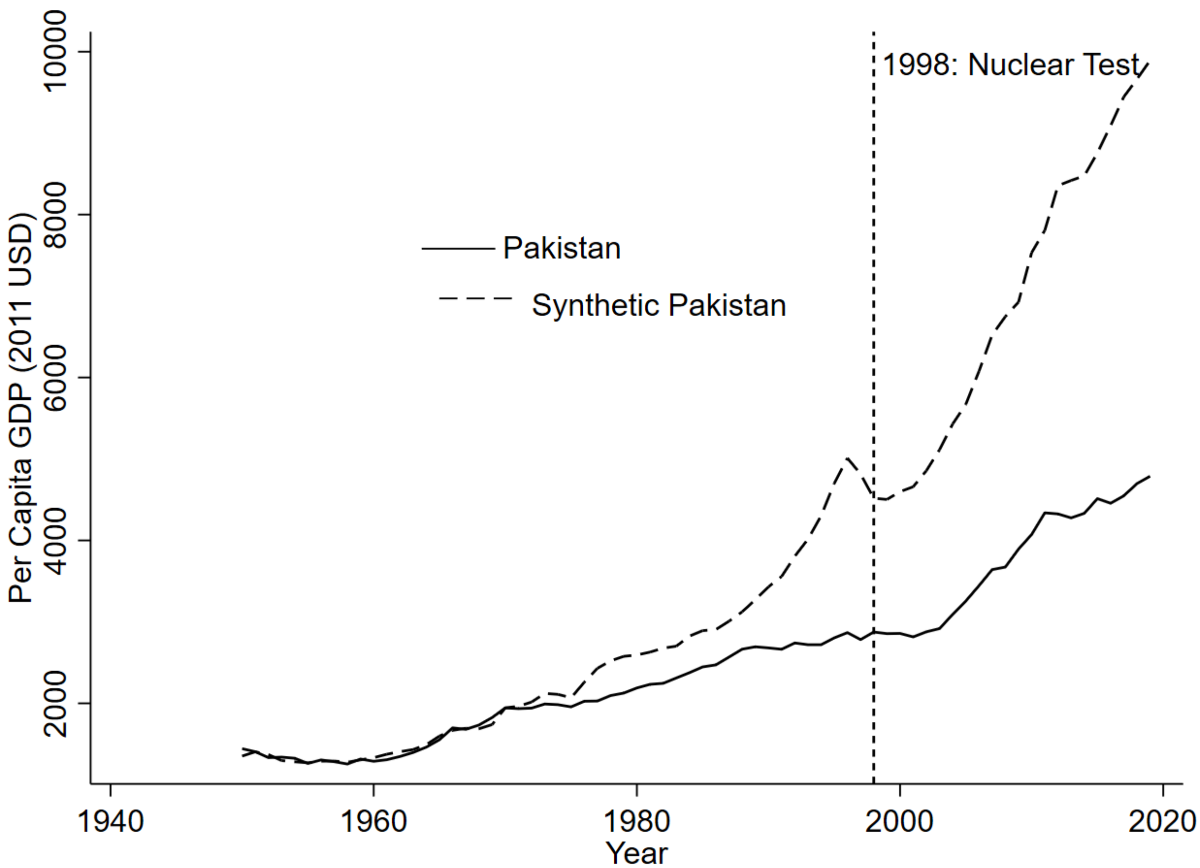
Notes: Graph shows the trends in trade volume measured in million 2014 British Pounds. All other specifications are the same as figure 3.1, with the exception of those variables used to predict the synthetic. In this case I use a combination of pre-treatment outcome variables and a variety of development indicators, also featured in figure 3.5. The gray shaded area represents time periods when Pakistan was under economic sanctions with respect to international trade [Felbermayr et al., 2020].

Figure 3.8: Military Burden in Pakistan



Notes: Graph shows the trend in military expenditure as a percentage of GDP per capita (commonly referred to as military burden in the literature) for Pakistan. Note the sustained period of higher burden during the pursuit of a nuclear weapon followed by a sharp decline once nuclear capabilities were demonstrated. Military burden data comes from the SIPRI military expenditure database.

Figure 3.9: Post-Nuclear Test: Pakistan vs. Synthetic



Notes: Graph shows the trend in GDP per capita of Pakistan vs. Synthetic Pakistan. This includes data following the 1998 nuclear test by Pakistan. This graph shows that the gap between synthetic and actual Pakistan continues to grow following the test and subsequent drop in military burden shown in figure 3.6. Reference line is 1998, year of first nuclear test.

Authors' Notes

Opinions expressed in this essay are solely the author's responsibility and do not reflect the view of any agency.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author acknowledge funding from the NASA Land-Cover and Land-Use Change Program, Grant Number: 18-LCLUC18-2-0004, as well as the University of Oklahoma.

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Appendices

A1 Other Data Sources

Table A1: Data Sources

Data Type	Location	Sources
GDP	Penn World Tables 10.0	Feenstra et al., 2015
Population	Penn World Tables 10.0	Feenstra et al., 2015
Capital stock/services	Penn World Tables 10.0	Feenstra et al., 2015
Terrorist attacks	Global Terrorism Database	LaFree/Dugan, 2007
Democracy scores	Polity IV Project	Marshall et al., 2002
Total factor productivity (TFP)	Penn World Tables 10.1	Feenstra et al., 2015
Foreign direct investment	World Bank Development Indicators	
Bilateral trade	World Bank Development Indicators	
Infant mortality rate	World Bank Development Indicators	
Healthcare spending share of GDP	World Bank Development Indicators	
Education spending share of GDP	World Bank Development Indicators	

A2 Distribution of Military Capabilities Dataset, *rDMC*

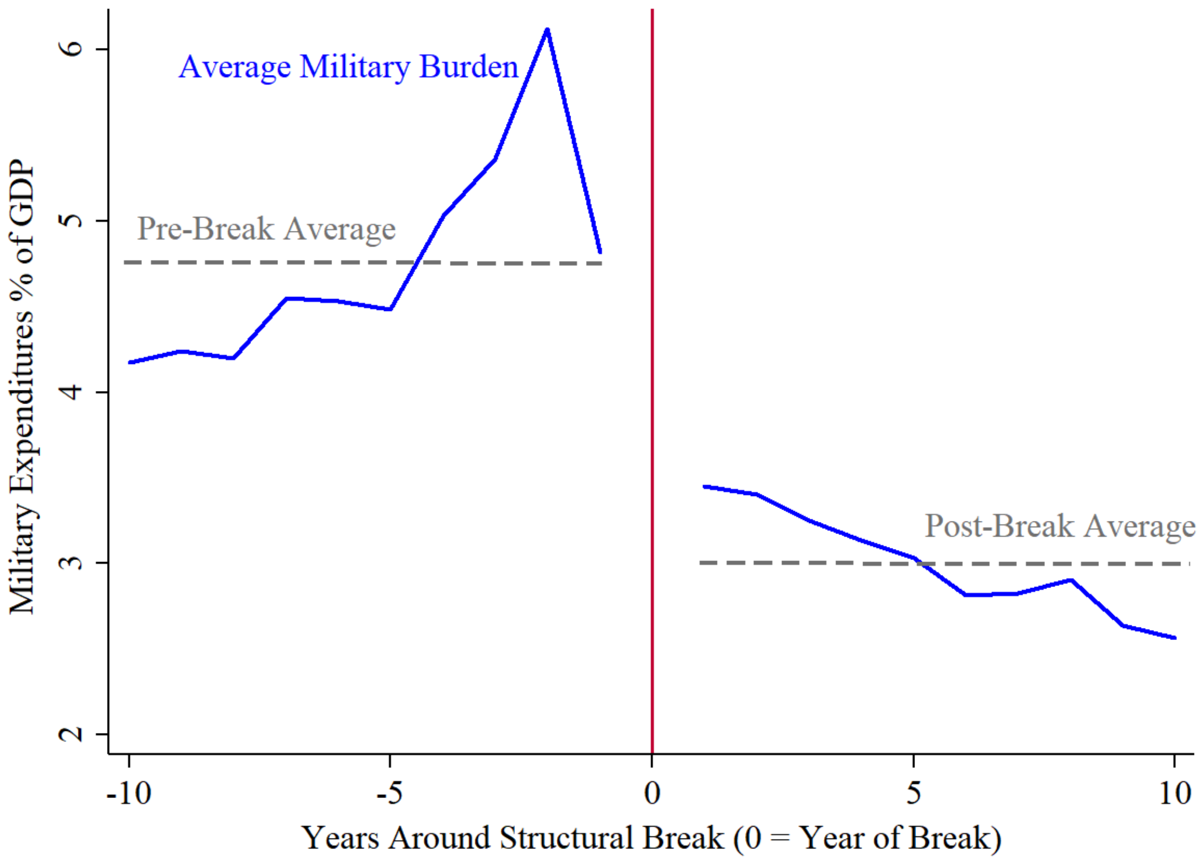
A new data set created by J Andrés Gannon is making a major contribution to the understanding of military capabilities around the world and over time. The stated goal of the project is to "disaggregate military capabilities into military equipment portfolios for each country in a given year" [Gannon, 2021]. Gannon consolidates data from the International Institute for Strategic Studies (IISS) Military Balance. To express the capabilities of each country across time and space, the rDMC counts the amount of military equipment each year for each country.

The data set sorts out major groups of weaponry. These are put into categories, which comes from Gannon [2021]. I then separate these units into two categories: offensive and defensive. Broadly, offensive units are those that might be used in an external attack. Defensive units are those that are used for non-combat roles or defend against external attacks.

The offensive units are the summed by year and matched to the contiguous countries of each country. Contiguity is based on the definition from the Correlates of War: "Land contiguity is defined as the intersection of the homeland territory of the two states in the dyad, either through a land boundary or a river (such as the Rio Grande in the case of the US-Mexico border). Water contiguity is divided into four categories, based on a separation by water of 12, 24, 150, and 400 miles" [Douglas et al., 2002]. The resulting number is my instrumental variable. It is the sum of all offensive military units that are contiguous to any given state. In the opinion of this study, this gives an approximation of the external threat a country faces from its most immediate potential adversaries.

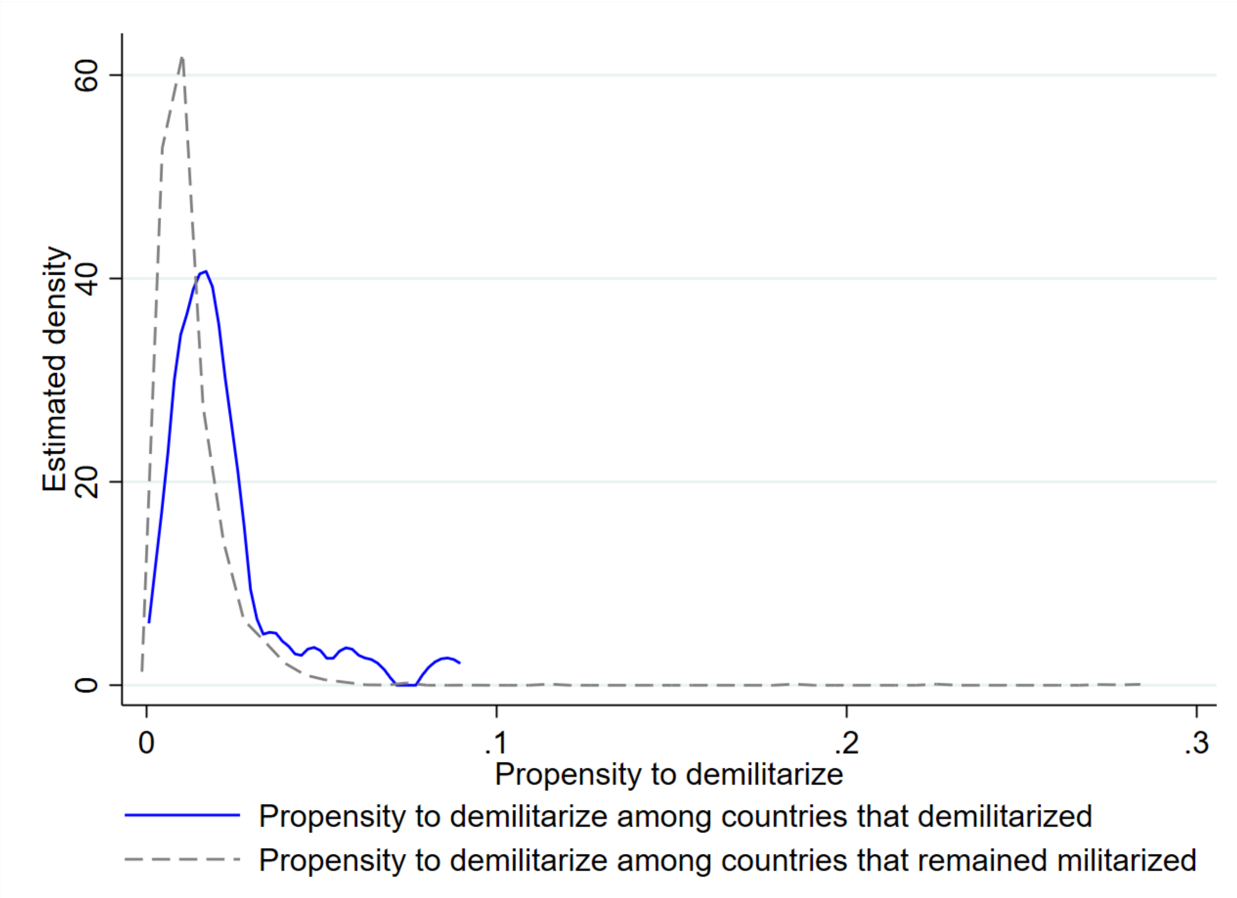
A3 Supplementary Figures

Figure A1: Structural Breaks and Military Expenditure



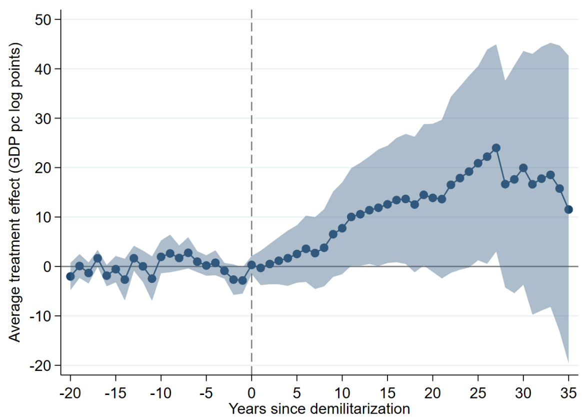
Notes: Structural breaks. This figure plots the average military burden (mil ex as percent of GDP) relative to year of structural break for negative impacts. These are countries which saw the average of their military burden reduced after the break, indicating some sort of policy shift. The blue solid line is the average of all outcomes. The gray dotted line is the pre- and post-break average of all countries (not based on timing).

Figure A2: Propensity to Demilitarize–Common Support Assumption

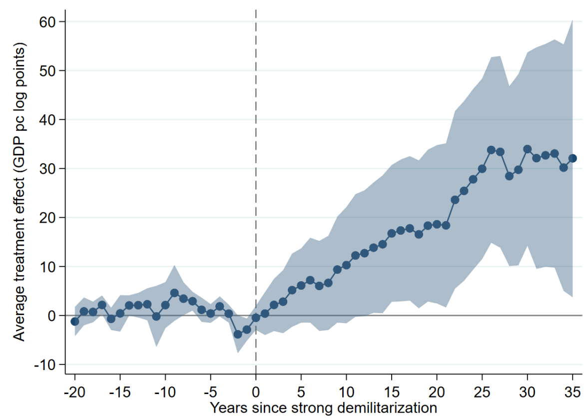


Notes: This figures plot the smoothed density of the estimated propensity to demilitarize. The blue line plots the density for demilitarizing countries while the gray line plots the density for the control countries in each case, which experienced no regime change. I smooth the densities using a standard Epanechnikov kernel.

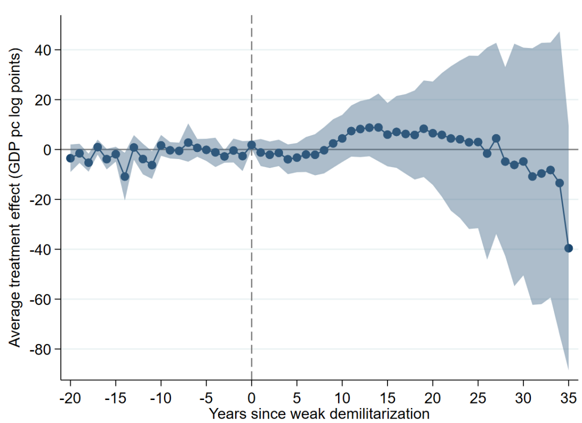
Figure A3: Never Treated Controls: Effect of transition episodes on GDP per capita



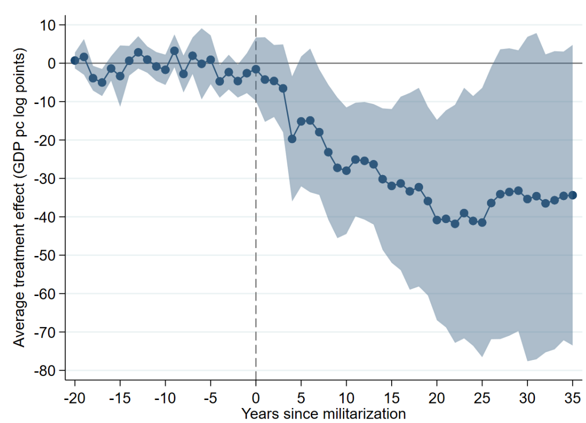
(a) All demilitarizations



(b) Strong demilitarizations



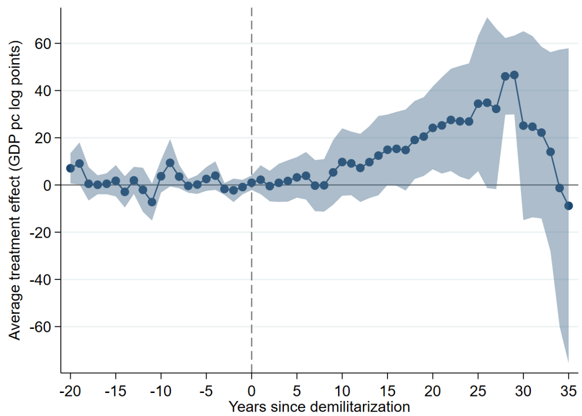
(c) Weak demilitarization



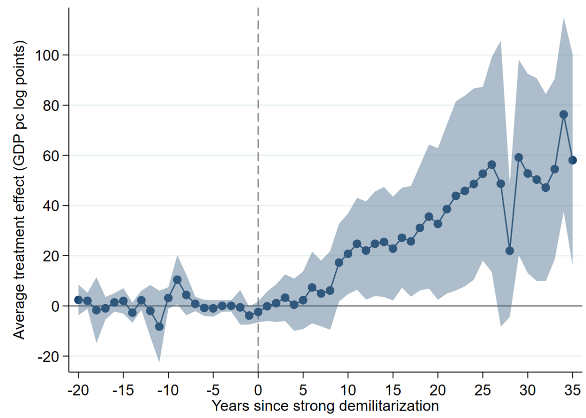
(d) Militarizations

Notes: CSDiD group-time estimates of the over-time effects of all, strong, and weak demilitarization episodes as well as militarization episodes on log of GDP; doubly robust estimate with never treated comparison units. This figure plots CSDID estimates of the effect of demilitarization/militarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that demilitarized/militarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization/militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations/militarizations based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust. Subplot (a) shows all cases of all demilitarizations. Subplot (b) shows all cases of strong demilitarization. Subplot (c) shows all cases of weak demilitarization. Subplot (d) shows all cases of militarization.

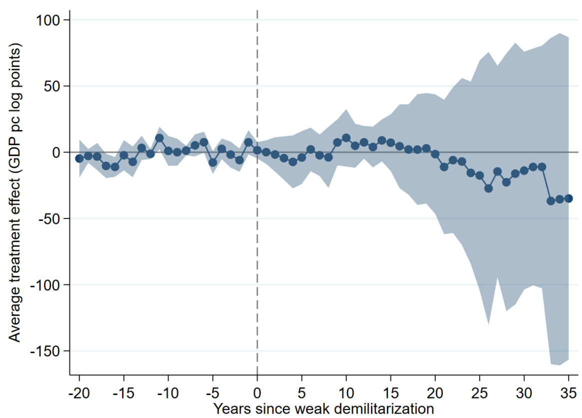
Figure A4: Alternative Covariates: Effect of transition episodes on GDP per capita



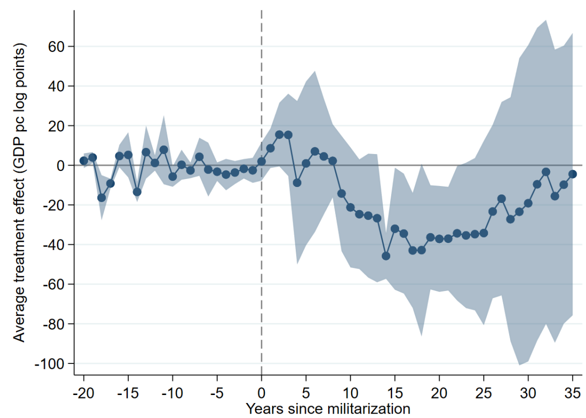
(a) All demilitarizations



(b) Strong demilitarizations



(c) Weak demilitarization



(d) Militarizations

Notes: CSDiD group-time estimates of the over-time effects of all, strong, and weak demilitarization episodes as well as militarization episodes on log of GDP; doubly robust estimate with alternative endogenous covariate comparison units. This figure plots CSDID estimates of the effect of demilitarization/militarization on GDP per capita in log points. The blue, connected line plot estimates average effect on GDP per capita on countries that demilitarized/militarized (in log points), with a 95 percent confidence interval shown by the grey, shaded area plot. Time (in years) relative to the year of demilitarization/militarization runs on the horizontal axis. The estimates are obtained by assuming and estimating a probit model for demilitarizations/militarizations based on GDP lags of the time-cohorts, which I use to estimate the propensity score and re-weight the data. In addition, I partial out lags of GDP linearly, making this approach doubly robust. Subplot (a) shows all cases of all demilitarizations. Subplot (b) shows all cases of strong demilitarization. Subplot (c) shows all cases of weak demilitarization. Subplot (d) shows all cases of militarization.