Walls, Barriers, Checkpoints, Landmarks, and "No-Man's-Land:" A Quantitative Typology of Border Control Infrastructure

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Fabian Gülzau & Steffen Mau *

Abstract: *»Mauern, Barrieren, Kontrollorte, Grenzsteine und Niemandsland. Eine quantitative Typologie von Grenzkontrollinfrastrukturen«*. This article investigates how states design their border infrastructures. We attempt to link the characteristics of borders to specific socio-political contexts, with a particular focus on borders as material and physical structures that states set up in order to demarcate, control, and seal off their territory. For this purpose, we introduce the "border infrastructure data" that seeks to capture the infrastructure at the border line. Our empirical investigation of all land borders worldwide (N=630) classifies border architecture into five categories – from relatively open to completely closed – that we describe respectively as "no-man's-land" borders, landmark borders, checkpoint borders, barrier borders, and fortified borders. While we find that checkpoint borders are by far the most common type of design, we also observe that barriers and fortified borders are frequently used, particularly on the Asian and European continents. Fortified borders are often put in place by relatively affluent states when there is a significant wealth gap with their neighboring countries. Barrier borders typically are erected by states to separate different political systems. Landmark borders are maintained among a community of equally democratic and affluent states. Lastly, "no-man's-land" borders are found between poor states.

Keywords: Border control, border regime, international border, mobility, cross-border flows.

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1. Introduction

Despite prevailing narratives of a globalized world without walls, border security has forcefully returned as a decisive topic on the political agenda. There is growing concern about international borders that is apparent in discourse, but also evident in material changes on the ground, leading to a hardening of borders (Simmons 2019a). Perhaps, the "return of the wall" (Vallet and David 2012) is best captured in Donald Trump's speeches during his campaign rallies in which he repeatedly called for a physical barrier along the U.S.–Mexican border (Lamont, Park, and Ayala-Hurtado 2017). Even though the former U.S. President is not the only politician whose agenda prominently features border walls, his talks illustrate the complexity of the syndrome of "border anxiety" (Simmons 2019b). A case in point is his "Address to the Nation on the Crisis at the Border," in which he warned of a "growing humanitarian and security crisis" at the U.S.–Mexican border and offered several reasons underlying the need for a border wall, ranging from smuggling and trafficking to crime rates and economic competition (The White House 2019).

Empirical studies indicate that there is indeed a strong emphasis on erecting border walls and fences. Following a mismanaged refugee crisis, Europe, for example, has been caught in a "continuing flurry of wall building" (Brown 2017, 16), but less-researched regions such as Asia also account for the establishment of new border barriers (Jones 2018, 22-3). Research shows that the global trend toward border barriers is accelerating, as most have been built in recent decades (Hassner and Wittenberg 2015; Vallet and David 2012). Border fortifications might be "a first-century solution to 21st-century challenges" (Collins 2018), as a former Mexican ambassador to the U.S. explained, but they are still popular and frequently used. Despite the notable trend toward border fortification and militarization (Vallet and David 2012), recent estimates of the global number of hard physical border barriers indicate that around a fifth of all contiguous land borders include such structures (Vallet 2021). Hence, border walls and fences are just one among several approaches that states use to regulate territorial access. Our article addresses this issue by introducing the "border infrastructure data," which measures – at a global scale – the material infrastructures at the border line for all contiguous land borders (N=630).

Our article asks the question "how do states design their international land borders and which factors are associated with a specific border infrastructure?" In the following, we provide a brief history of border constructions that states have used to demarcate and control their territorial boundary lines. Subsequently, we review studies that analyze the relationship between a state's economic, political, cultural, and security environment and its border design. We then introduce a fivefold typology of border infrastructures that distinguishes "no-man's-land" borders, landmark borders, checkpoint borders, barrier borders, and fortified borders and provide empirical evidence on the global distribution of border designs. Lastly, we analyze how territorial designs are associated with additional factors, discuss our findings, and note the limitations of our approach.

2. The Shifting Nature of Borders

In the contemporary world, states implement various border policies and arrangements in order to manage territorial access and their relationship with neighboring countries. In addition to physical infrastructures at the border line, states rely on remote control through visa requirements, airline liaison officers, and consulates (Zaiotti 2016; Shachar 2020), "smart borders" by the use of digital technologies as well as through third-country involvement or the relocation of border control in the context of regional integration (Mau et al. 2012; Mau 2021). In short, border control has become a complex issue that combines physical infrastructures, legal arrangements, relocation of control, technology, and the involvement of third parties into varying border regimes. In this article, however, we focus on the "physicality of borders" (Hassner and Wittenberg 2015, 162) as the most visible and symbolic display of control efforts. We assume that states choose a "territorial design" (Atzili and Kadercan 2017) – a border infrastructure design – in a complex situation that involves the evaluation of their specific geopolitical, economic, and social environment (Jellissen and Gottheil 2013).

For a large part of history, territorial boundaries were not clearly demarcated and often "natural" topologies such as rivers or mountains provided a rudimentary form of territorial separation. The modern nation state that rests on the idea of a congruency between territory, population, and a sovereign state – the Westphalian model – became reality much later, but even then territories where not "bordered" in terms of a fully established border infrastructure. Throughout the 19th century, the design and function of international borders underwent several shifts. In the interwar period, and even more so after World War II, borders were understood as protective frontiers that states erected to guard their national economies (Anderson and O'Dowd 1999, 601). Many borders, such as the French Maginot Line, were based on the logic of military deterrence (Sterling 2009). These "military borders" (Andreas 2003, 85), however, quickly lost their appeal due to advances in military technology (Donaldson 2005, 174) and the global acceptance of the "territorial integrity norm" (Zacher 2001). Other borders are a legacy of the colonial past and are drawn by external powers ignoring local conditions and interests (Gülzau and Mau 2021). After the Second World War and orchestrated by the hegemonic U.S. through several trade agreements (e.g., the General Agreement on Tariffs and Trade [GATT] and the World Trade Organization [WTO]), international borders became gradually more open to trade. Policymakers hoped that the integration of isolated states into a densely connected network of trading nations would have a pacifying effect (Rudolph 2006, 3-5). This process of de-bordering was accelerated through regional integration (e.g., the European Union) and globalization, which meant that tight borders came to be seen as a hindrance to reaping the benefits of free trade (Anderson and O'Dowd 1999, 601). In addition, rising levels of air traffic and global tourism established airports as important ports of entry (World Tourism Organization [UNWTO] 2019, 7).

Yet even though hardened and physical borders lost much of their appeal as military installations, they are far from being obsolete. Scholars argue that the terrorist attacks of 9/11 and the following global war on terrorism as well as migratory movements made fortifications at the border line be seen as an attractive solution, whereas "open borders" were perceived as a security threat (Jones 2012; Rosière and Jones 2012). International borders and national security subsequently became increasingly intertwined and many states entered a period of re-bordering (Vallet and David 2012). However, bordering was hardly about full territorial closure. Governments in today's world are confronted with different cross-border flows: those which they like and try to attract, and those which they want to keep outside. Trade and foreign investments, for instance, mostly constitute desired cross-border flows, while contraband and unauthorized migrants are examples of undesired mobility. Transnational terrorism and crime are even more serious challenges to security. Therefore, states are eager to deploy territorial measures and forms of infrastructure in order to protect their territory, serve their security interests, and control and regulate cross-border flows. As bordering remains an important and constitutive issue for statehood, we are interested in the specific border designs that states consider and deploy.

3. What Shapes Border Infrastructures?

We know from previous studies that "border walls" have increased substantially, particularly since the dawn of the millennium (Vallet 2021, 9). Several studies have scrutinized the motives and determinants underlying the current surge of wall building (Avdan 2019; Hassner and Wittenberg 2015; Carter and Poast 2017; Jellissen and Gottheil 2013; Vallet 2021). A number of studies have investigated the association between a state's economic position and the likelihood of it having border walls. States that install physical barriers along their border line incur direct costs for the construction and maintenance. In this regard, Rosière and Jones (2012, 225) argue that border walls are more likely to be found in developed countries, while less-permanent border fences are more often used in less-developed nations. Research has corroborated a positive and robust effect of a state's economic capacity on the likelihood to build a physical barrier (Avdan 2019). It has also been found that high economic inequalities across a border line increase the likelihood of a wealthier state building a barrier at the border with its less affluent neighbor (Carter and Poast 2017; Avdan 2019; Hassner and Wittenberg 2015; Vallet 2021). Accordingly, border barriers have been described as "discontinuity lines" (Rosière and Jones 2012, 217) between relatively unequal societies. In this regard, Vallet (2021, 12) found that wealthier states justify their wall building by alleged threats of migration, terrorism, and smuggling. Bilateral trade between states, however, decreases the likelihood of a barrier being erected at a shared border (Avdan 2019), as states may fear a detrimental effect on trade (Carter and Poast 2020).

Research also suggests that autocratic states have a greater preference for tight and physically robust borders, while democracies are bound by liberal principles and thus cannot impose closed borders without compromising their basic norms (Anderson 2000, 24). In addition, democratic peace theory hypothesizes that democracies are less likely to wage war against each other, though they are not hesitant to use force against non-democracies (Rousseau et al. 1996). Following this argument, one might ask whether democracies are also less likely to erect walls against each other. Even though established democracies such as the U.S., Israel, and India have demonstrated that democracies are not necessarily reluctant to erect walls against neighboring states (Jones 2012; Vallet 2021), scholars assume that hardened borders are less likely where there are democratic dyads (Avdan 2019). By contrast, Carter and Poast (2017) report that democracies are more likely to build border barriers, albeit on borders with autocratic states.

Security considerations or politically perceived "security threats" are another main driver of territorial designs. Avdan (2019) underlines that transnational terrorism is the main factor that pushes states toward harder borders. In particular, directed terrorism – i.e., causing victims among a state's population or on its territory – increases the likelihood of hardened borders, while global terrorism has less influence. She also explores whether refugee flows, which have been framed as security risk in the public discourse, affect border regimes. However, her analysis does not corroborate such an effect. Another security related explanation posits that territorial disputes may motivate a state to secure a disputed territory by erecting a border barrier (Carter and Poast 2017).

Lastly, scholars have also tested the assumption that a "cultural clash" may be conducive to wall building. In this perspective, border walls are erected to differentiate between a dominant in-group and "the Other," whereby negative qualities are "mapped onto the entire populations of neighboring countries" (Jones 2012, 15). Such narratives are based on cultural affiliations and frequently used to justify border fortifications. In this regard, Hassner and Wittenberg (2015) show that states with a Muslim-majority population are more likely to be targeted by fortified borders. However, they also report that these barriers are mostly erected by fellow Muslim states, though other than religious factors may be decisive here.

In sum, scholars assume that specific socio-economic and political environments affect a state's border control infrastructure. In particular, harder borders are thought to reaffirm existing discontinuity lines, which persist across borders. Accordingly, we can expect that affluent states erect obstacles at borders that are characterized by a large wealth differential. We also assume that autocratic states have a greater desire to tighten and physically strengthen borders than democratic states, and that security threats by terrorist groups may drive states to erect fortified barriers. Lastly, scholars hypothesize that cultural tensions or disparities across borders can lead to tighter borders. While these findings apply to border walls, much less is known about other types of border infrastructures. In the following, we introduce a more fine-grained border typology that captures the different physical infrastructures states maintain at their borders. We will give a descriptive account of the share and global distribution of these different border types and scrutinize the economic, political, cultural, and security factors that may influence border infrastructures.

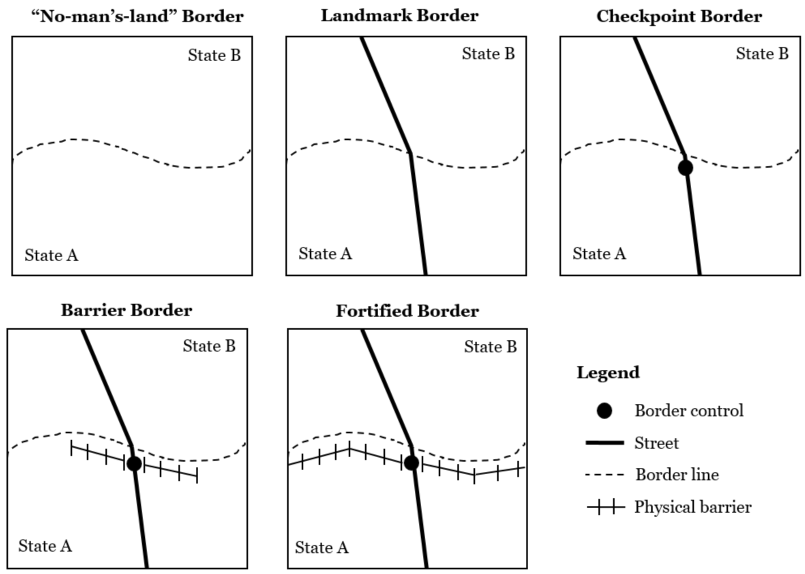
4. A Typology of Border Infrastructure

Following the research on border infrastructures, we propose a typology that measures how states equip their borders in order to control territory and to regulate territorial access. We acknowledge that state borders have multiple purposes and are designed to combine openness and closure. However, the physical infrastructure that states put in place to manage their boundaries still signals the exercise of control, territorial separation, and whether a state is interested in deterrence or the facilitation of specific cross-border flows (Gavrilis 2010, 6). One could say that the material configuration of borders "form[s] the backbone" (Baud and Van Schendel 1997, 226) of borderlands.

Though every classification has some blurriness and not every border infrastructure shares the same features along the border, we classify border infrastructures into five categories: "no-man's-land," landmark borders, checkpoint borders, barrier borders, and fortified borders. These categories distinguish five border infrastructures according to their strength and physical characteristics. Figure 1 provides a visual illustration of the categories. We term boundaries that are largely disconnected from state activities as *"no-man's-land" borders*. They are peripheral in the sense that no government infrastructure is put in place to control cross-border movements. "No-man's-land" borders are often found in remote regions such as deserts or jungles, which are difficult to access by state agents. In many instances, poor road networks and connections also limit the economic exploitation of the border. At first sight, *landmark borders* are reasonably similar to the previous category. However, landmark borders feature little state infrastructure because states have agreed to abolish regular controls in order to boost the cross-border flows of goods and people. An example is the zone of free movement that has been established by the European Union through the Schengen Agreement. Such borders regularly feature a dense road network, frequent cross-border travel, and integrated economic zones. Often, they have border and control infrastructures that have been dismantled.[1] The most common type of border control infrastructure is *checkpoint borders*. This category is characterized by border posts at major border crossing points with the purpose of stopping and controlling travelers. Typically, checkpoint borders feature a major road that splits into several lanes before it runs into a border inspection post. *Barrier borders* also feature border posts, but in contrast to checkpoint borders, states install additional barriers at specific border crossing points that make it difficult to avoid inspections. In particular, physical obstacles such as barriers or fences are put in place to channel mobility into checkpoints. Lastly, *fortified borders* consist of obstacles that are meant to prevent unauthorized mobility along the total length of a border line. States that maintain fortified borders install obstacles such as fences and walls in order to deter cross-border flows. In some cases, the barriers are even built to prevent all physical exchange across the border (Korte 2021, in this special issue). The following section provides information on the empirical data that was used to classify international borders into these five categories. In addition, it discusses the limitations and drawbacks of our approach.

[1] However, border enforcement was never completely abolished but relocated to the external borders of the European Union. In addition, Schengen member states introduced so-called "flanking measures" such as a harmonized visa policy, common asylum procedures, and police cooperation to compensate for the absence of intra-Schengen border controls. Finally, states might reintroduce temporary border controls in the case of serious threats to public policy or internal security (Cornelisse 2014).

Figure 1 Typology of border infrastructures



5. Data and Method

The data on border infrastructures were collected between April 2018 and October 2019.[2] Our starting point was the "Direct Contiguity 3.2" data from the Correlates of War Project that we used to identify all contiguous land borders between nation states ($N_{country}$=158/N_{border}=630; Stinnett et al. 2002).[3] For each country, we created a single document and gathered information on all the land borders. In general, we relied on visual cues and additional evidence from newspapers and digital sources. We looked for case studies in scientific databases (e.g., Scopus) and conducted searches in digitized media archives. We also examined satellite images of border crossing points using the Google Maps API. In some cases, the image quality was too low, forcing us to use alternative services such as Bing Maps. In addition to the visual information

[2] Accordingly, the impact of the global COVID-19 pandemic on borders lies beyond the scope of this study (but see Kenwick and Simmons 2020).

[3] The COW dataset was adjusted by adding the border dyad between Nigeria and Chad, which became a land border due to the progressing aridification of Lake Chad. In addition, two erroneous entries were corrected (United Arab Emirates–Qatar, and Myanmar–Pakistan). Lastly, we excluded French overseas territories such as French Guyana.

included in satellite imagery, images of border posts were added where possible. Lastly, we compared and enriched our coding with existing studies on fortified borders (Avdan 2019; Hassner and Wittenberg 2015; Carter and Poast 2017; Jones 2012; Jellissen and Gottheil 2013).

We followed a dyadic conceptualization of international borders by measuring the infrastructure on each side of a mutual border line. Accordingly, a shared border line that creates a "state couple" (Vallet and David 2014a) is separated into two distinct observations. In this way, we account for borders that are managed cooperatively as "*bi-national* institutions" (Longo 2017, 2) and for borders that are places of conflict, which might be the case when incompatible territorial designs meet. For instance, a state that is affected by a fortified border could enter a race toward tighter borders by also installing barriers or could de-escalate the situation by maintaining conventional checkpoints. In addition, a dyadic approach enables us to include measurements that capture the relationship between bordering countries such as differences in the economic output or political system.

The typology enables us to map border infrastructures on a global scale, addressing questions regarding the worldwide distribution of physical markers. Nevertheless, our typology is not without limitations. First, borders and their territorial designs have a history, but our typology only provides a cross-sectional view of current border infrastructures, as it was not possible to trace the origin of each checkpoint. A case in point concerns African borders that were drawn by colonial powers during the scramble for the continent and securing colonial exploitation. Even today, the colonial past fuels border conflicts and several border fences have been inherited from this past (Gülzau and Mau 2021). Second, states maintain multiple border crossing points that do not necessarily have the same material infrastructure along the whole border line. Our measurement uses the highest level of border infrastructure at a specific border line to characterize its entirety. For example, the Kenyan government planned a border fence that was meant to cover the whole border with Somalia. However, only one section at the border crossing point of Mandera was eventually fenced (Galvin 2018). Accordingly, the border between Kenya and Somalia is classified as a "barrier border," although some parts of the border are less protected. Lastly, our typology is limited to the measurement of the physical infrastructure at a border line. However, border infrastructures only regulate mobility when sufficiently monitored by personnel. This is illustrated by former secretary of the U.S. Department of Homeland Security, Janet Napolitano, who questioned the efficiency of border walls saying "You show me a 50-foot wall and I'll show you a 51-foot ladder at the border" (Lacey 2011).

Notwithstanding these limitations, our study is able to map international borders according to the presence of different types of physical infrastructures. The border typology thus enables us to analyze where states rely on border obstacles such as barriers and fences to block territorial access. In addition, the typology captures more open regimes that are based on checkpoints or de-institutionalized borders. It also grasps "no-man's-land" borders that are peripheral to state control.

In the next step, we proceed by investigating the global distribution of border designs across world regions. In addition, we scrutinize the relationship between the border typology and state and context characteristics. For this purpose, we compiled a dataset of variables that capture the economic, political, security, and cultural situation of states. In particular, we measure a state's economic capability by GDP per capita (in 2020 USD, logged; The World Bank 2020). This variable is also used to compute the cross-border ratio of economic capabilities within a state dyad. We rely on the PolityIV dataset to measure political regime characteristics (Marshall, Gurr, and Jaggers 2019). The polity2 score ranges from -10 to 10. It distinguishes autocratic (scores between -10 and -6), "anocratic" (-5 to 5), and democratic (6 to 10) political systems. We also use this indicator to compute the political difference between neighboring states. A state's security situation is captured by three variables. First, the military orientation is measured by military expenditure as a proportion of the GDP (The World Bank 2020). Second, we investigate how states' border designs are affected by terrorist incidents on their territory (as the logged annual number). The data is described in LaFree and Dugan (2007). Third, we examine whether militarized interstate disputes between neighboring countries affect border regimes. We constructed a binary measure that indicates whether states had a militarized interstate dispute between 2000 and 2014 (Palmer et al. 2015).

As it has been argued that a state's majority religion impacts territorial designs (Hassner and Wittenberg 2015), we evaluate this claim by using a measurement for majority religions (Maoz and Henderson 2013). We condensed religions into three broad categories (Christianity, Islam, and other religions, which includes Buddhism, Hinduism, Judaism, Syncretism, and nonreligion). In addition, we include a measure on religious proximity to evaluate whether differences in states' religious composition affect border infrastructure. The continuous variable is bounded between zero and one. The indicator comes from the CEPII Gravity database (Head, Mayer, and Ries 2010; Head and Meyer 2014). Lastly, we control for cultural similarities among countries. In particular, we use a binary variable to measure whether states share an official language. We also include a variable that indicates whether neighboring states have ever had a shared colonial history. Both binary variables have been taken from the CEPII Gravity database. With a few exceptions, all the variables were gathered for 2017. However, data on majority religions was only available up to 2010. In addition, the binary indicator of dyadic militarized interstate disputes uses data from 2000 to 2014. Finally, the variables from the CEPII database are used in their latest revision.[4]

In the following, we provide information on the global distribution of border designs. We also describe the bivariate relationship between our indicator and state and context characteristics. Lastly, we use a multinomial logistic regression model to scrutinize how the independent variables are associated with border infrastructures. The multinomial logistic regression is used to model unordered outcome variables. This approach is akin to fitting multiple binary logistic regressions for all possible comparisons among the categories (Long and Freese 2014). Missing values were imputed using multiple imputation by chained equations (MICE; van Buuren 2012). All model variables were included in the imputation. We followed best practice recommendations by creating 50 imputed datasets (Johnson and Young 2011). In the multiple regression model, we cluster the standard errors (SE) by state and border dyad to account for the nested structure of the data.

6. Analysis

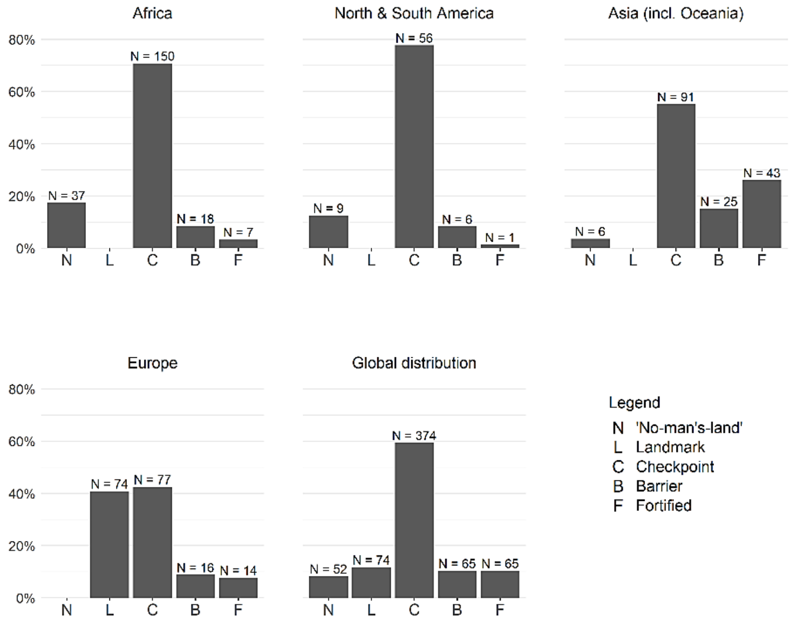
Our analysis proceeds by examining the characteristics and global distribution of border infrastructures. Subsequently, we describe the relationship between a state's territorial design and its economic, political, cultural, and security context. Lastly, we conduct a multinomial logistic regression to evaluate the relative importance of these factors in a single model. Figure 2 shows how the five categories of border typologies are distributed across continents. In addition, the last panel in the second row provides information about the global distribution. We find – fairly similar to Vallet (2021) – that barrier and fortified borders account for a fifth of all borders (10 percent each), indicating that walls, fences, and barriers are widespread features of contemporary border designs. However, it also becomes evident that checkpoint borders are by far the most common type of border structure (59 percent). Landmark borders characterize only 12 percent of all land borders. Uncontrolled "no-man's-land" borders are the least common type (8 percent).

The global distribution nevertheless obscures large regional variations. For instance, barrier and fortified borders account for nearly half of all borders in Asia (41 percent). After the collapse of the USSR, many emergent states struggled to demarcate their newly created international borders, which suddenly divided communities and disrupted existing trade connections (Lewington 2010). This issue is exacerbated by the complicated geography of many

[4] The variables are time-invariant and revisions mostly reflect missing data (Conte, Cotterlaz, and Mayer 2021).

Central Asian states, where territories can be intertwined like "interlocked fingers" (Lewington 2010, 222) and several enclaves amplify border disputes. As a result, autocracies such as Uzbekistan use border fences among other measures to maintain their illiberal rule (Lewis 2015). Border fences are also common in the Middle East and notably on the Arabian Peninsula, where Saudi Arabia contracted the European Aeronautic Defence and Space Company (EADS) to build a high-technology fence along all of its borders (Vallet and David 2014b, 148; Saddiki 2018).

Figure 2 Relative Distribution of Border Typology by Continent



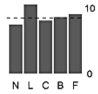
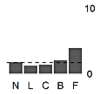
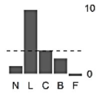
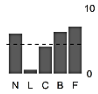
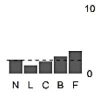
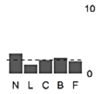
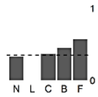
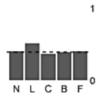
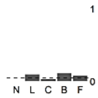
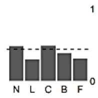
Fortified and barrier borders are less prevalent in other parts of the world. They account for less than 10 percent of borders in the Americas and 12 percent in Africa. However, such infrastructures characterize 17 percent of Europe's borders. In Europe, these hardened boundaries are a result of the "recent and continuing flurry of wall building" (Brown 2017, 16) that ensued after the refugee crisis of 2015-2016. Cases in point include the Hungarian border fences, which have been erected at the borders with Croatia and Serbia (Kallius, Monterescu, and Rajaram 2016). At the same time, landmark borders are only found in Europe, where they make up 41 percent of all borders. This contradictory image – free movement and hardened borders – can be explained by the creation of the "borderless" Schengen Area. Member states abolished internal controls by pushing border enforcement outward, thus creating sharp edges at Europe's outer margins. Lastly, "no-man's-land" borders are more common in Africa (18 percent) and the Americas (13 percent) than in other regions. Such borders can be found along the Sahel, in Central Africa, and in Caribbean South America.

In the next step, we turn to the bivariate relationship between territorial designs and economic, political, and cultural factors, as well as the situation of states in terms of security. We evaluate claims that we derived from the existing body of research. As already mentioned, we expect that affluent states will erect barriers at borders that are characterized by a large wealth differential. It is also assumed that autocracies are more likely to build fences than democratic states. We further test whether cultural tensions – measured as religious differences – between neighboring states may lead to tighter borders. In addition, we evaluate whether security threats by terrorist groups might drive states to erect fortified barriers. Lastly, we evaluate whether cultural (dis-)similarities affect border regimes.

Table 1 shows summary statistics of the independent variables. In addition, the relationships between border design and the various factors is displayed in small multiples. In these plots, a horizontal dashed line shows the overall mean value of the respective variable, while the bars display the mean value within each category of the border typology (abbreviated as N: "no-man's-land" border, L: landmark border, C: checkpoint border, B: barrier border, F: fortified border). In the following, we focus on the small multiples to provide an overview of the relationship between border regimes and the various factors.

In line with previous research, we find that fortified borders are mainly erected by affluent states (mean: 9.1, i.e., $8,639). Among these fortifications, we find several borders that are regularly in the spotlight such as the U.S.–Mexican border wall, the Israeli fortifications, the high-tech fence erected by the United Arab Emirates, and the Spanish fences in Ceuta and Melilla. Yet we also find that landmark borders are, on average, built by even more affluent states, although this is mainly explained by the role they play in the Schengen Area (mean: 10.5, i.e., $36,298).

Table 1 Bivariate Relationships, Means by Border Typology

Variable	Mean	SD	Max	Min	Observations	Plot	Source
GDP per capita (in 2020 USD), log	8.49	1.40	12.06	5.68	607		World Bank (2017)
GDP per capita (in 2020 USD), ratio	1.69	2.27	21.66	0.05	584		World Bank (2017)
Political regime	3.46	6.21	10.00	-10.00	618		PolityIV (2017)
Difference in political regimes	4.45	4.68	18.00	0.00	606		PolityIV (2017)
Military expenditure (as % of GDP)	2.02	1.62	10.22	0.00	565		World Bank (2017)
Terrorist incidents (annual), log	2.08	2.04	7.83	0.00	630		Global Terrorism Database (2017)
Militarized disputes	0.35	0.48	1.00	0.00	630		COW: DyadMID (2000-2014)
Religious proximity	0.39	0.35	0.99	0.00	572		CEPII Gravity Database
Shared colonial history	0.05	0.21	1.00	0.00	630		CEPII Gravity Database
Common official language	0.44	0.50	1.00	0.00	624		CEPII Gravity Database

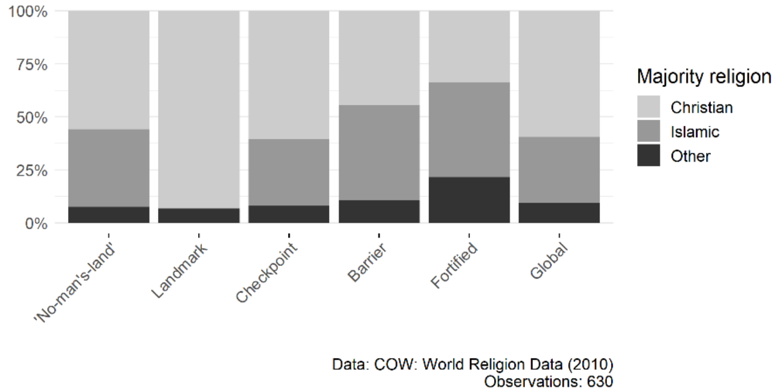
Abbreviations: N: "no-man's-land" border, L: landmark border, C: checkpoint border, B: barrier border, F: fortified border.

Looking at wealth gaps, we find that fortified borders are often discontinuity lines marking and sustaining substantial economic differentials. The figure provides the average ratio of the GDP per capita within border dyads, showing that states with fortified borders are nearly four times as wealthy as their neighbors. Considerable wealth gaps are also apparent at borders that are characterized by barrier borders (GDP_{ratio}=2). Checkpoint and landmark borders are found in border dyads that are more similar in their economic capabilities. Lastly, wealth differentials are also apparent across "no-man's-land" borders (GDP_{ratio}=1.75). This is partly explained by the fact that such borders are typically found in poor regions such as along the Sahel. For example, even though crisis stricken itself, Libya still has a much higher economic output than its neighboring countries of Niger, Chad, and Sudan.

Political regime characteristics are also hypothesized to influence territorial designs. Our bivariate analysis indicates a clear preference for fortified borders shown by autocracies such as North Korea, Saudi Arabia, Uzbekistan, and the United Arab Emirates. Countries that organize border controls by using checkpoint or barrier borders are, on average, characterized by a more democratic nature. Landmark borders are only used by democratic member states of the European Union. Lastly, "no-man's-land" borders are found in less democratic political systems such as Eritrea, Cameroon, and the Congo. Looking at absolute differences in the political systems, we find that states erect hardened borders to separate their more autocratic regime from more open political systems. Cases in point are the border wall that divides North and South Korea, as well as several structures that China has installed along its borders. This relationship also characterizes "no-man's-land" borders. In contrast, landmark borders are maintained among equally democratic societies.

Turning to characteristics that are supposed to capture a state's security concerns, we find that military expenditure is strongly associated with hardened boundaries. States that fortify their borders also spend a large proportion of their budget on the military. This association is particularly strong in Central Asia and the Arab Peninsula. With regard to terrorist incidents, the pattern is less clear and straightforward. Terrorist incidents are highest in states that have "no-man's-land" borders, thus re-affirming that such border designs are found in societies that suffer from multiple issues such as poverty and restrictive political regimes. Terrorist incidents also affect states that maintain barrier borders. Finally, militarized interstate disputes are most common among states that erect fortified borders but also affect states with barrier borders.

Figure 3 Relative Distribution of Majority Religion by Border Typology



Though we do not assume a direct causal relationship here in Figure 3, we examine whether border barriers are associated with specific majority religions. For instance, Hassner and Wittenberg (2015) report that "more than half of the barrier builders [...] are Muslim-majority states" (168), and we find that 45 percent of all fortified borders are built by Muslim-majority nations. Hence, given their proportion of 31 percent of the global total, states with a Muslim majority are overrepresented by 14 percentage points among fortification builders. However, this also holds for states with religions other than Christian or Muslim majority, as they exceed their global proportion of 10 percent by 12 percentage points. This pattern is repeated among states that maintain barrier borders. Checkpoint borders are equally distributed along the global proportion of majority religions. Being specific to the European Schengen Area, landmark borders are predominantly found among states with a Christian majority. Finally, Muslim-majority states are also slightly overrepresented among states with "no-man's-land" borders. Table 1 also includes a variable that measures religious proximity between states. We find that most categories of our typology are close to the overall mean value of religious proximity. However, landmark borders are mainly found between states that share a majority religion.

Finally, Table 1 investigates whether shared colonial history or common official languages have an effect on a states' border infrastructure. At five percent, the overall mean value of shared colonial history is rather low and there are only modest variations across border designs. However, a tenth of all landmark and barrier borders separates societies that have a shared colonial history. In contrast, "no-man's-land" borders never share a colonial history. Lastly, we also consider whether a common official language mitigates the risk of wall building. The descriptive analysis shows that only a third of fortified borders are installed between societies that share an official language.

Accordingly, they mostly separate societies with different official languages. This also holds for barrier borders. By contrast, landmark borders show that differences in official languages do not necessarily inhibit open borders.

Lastly, we ran multinomial logistic regressions to investigate the effects of the abovementioned state and border characteristics combined. Figure 4 displays the coefficients from a multinomial logistic regression model, indicating the average marginal effects (AME) including the 95 percent confidence intervals (CI). Coefficients that are significant at the $p \leq 0.05$ level are marked in black. The category of "checkpoint borders" was used as the baseline category.[5]

Fortified borders are predominantly associated with economic factors. States that maintain such structures at their borders are relatively affluent, as indicated by the positive coefficient for the logged GDP per capita ($p \leq 0.01$). On average, an increase in the standard deviation from one unit below the mean value of economic output to one unit above it (i.e., from roughly $1,202 to $19,844), increases the probability of observing a fortified border by 11 percentage points. Further, the positive coefficient for the GDP per capita ratio ($p \leq 0.01$) confirms that fences and walls are more likely to be erected at boundaries that are characterized by large wealth differentials. In regard to differences in the political systems, we observe that such differences are positively associated with fortified borders ($p \leq 0.05$). Distinct political regimes have no significant effect on fortified borders, suggesting that other factors account for wall building. In addition, military expenditure is associated with fortified borders ($p \leq 0.05$). On average, an increase in the standard deviation from one unit below the mean value of military expenditure (as percentage of the GDP) to one unit above it (i.e., from roughly 0.4 percent to 3.6 percent), increases the probability of observing a fortified border by 5.4 percentage points. Terrorist incidents are negatively associated with fortified borders ($p \leq 0.05$). Further, having undergone a previous militarized interstate dispute with the neighboring country increases the probability of observing a fortified border ($p \leq 0.01$). Lastly, states are less likely to erect fortified borders against neighboring states when they share a common official language ($p \leq 0.05$).

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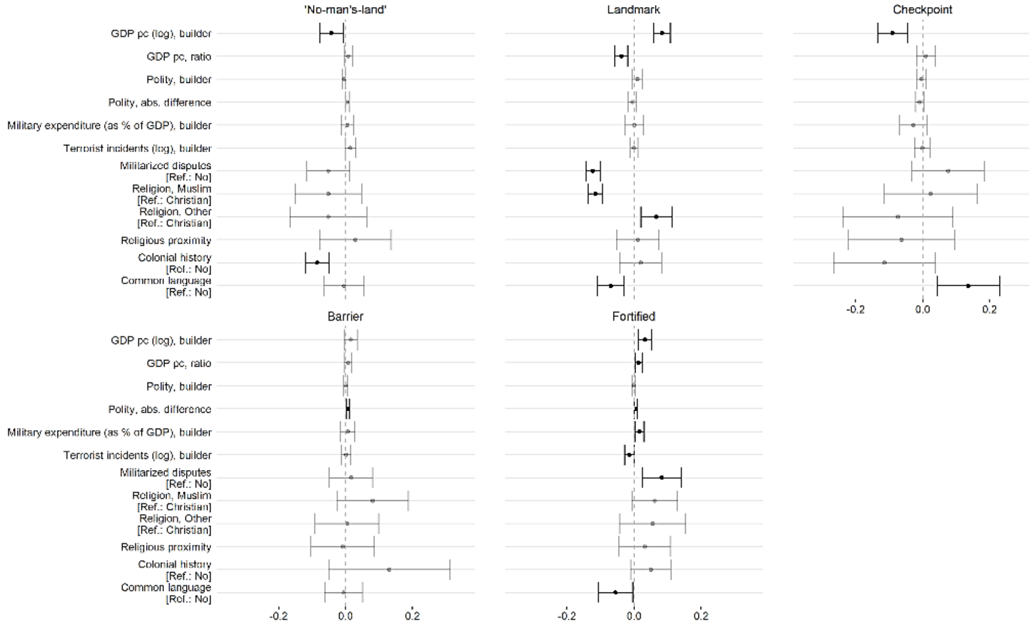
[5] The literature recommends the interpretation of discrete changes instead of overall summary measures such as AMEs, which can change their sign across the range of a predictor (Long and Freese 2014, 415-6). Accordingly, we discuss marginal effect at representative values (MERs) below and provide graphical representations of the effects in Figure A in the appendix.

Figure 4 Multinomial Logistic Regression on Border Typology, AME with 95% CI (50 imputations, clustered SE)



Border barriers in the form of obstacles at specific border crossing points are different from fortified borders. Holding other variables at their observed values, increasing the absolute difference of political systems by one standard deviation below to one standard deviation above its mean value (i.e., from no difference to a difference of nine points) increases the probability of observing a barrier border by six percentage points ($p \leq 0.05$).

As aforementioned, checkpoint borders are the most prevalent border design. They are also associated with economic factors. On average, an increase in the standard deviation from one unit below the mean value of economic output to one unit above it (i.e., from roughly $1,202 to $19,844), decreases the probability of observing a checkpoint border by 20 percentage points ($p \leq 0.001$). However, the effect size increases for more affluent states (see figure A). In addition, checkpoint borders are installed at border crossings that connect societies that share a common official language ($p \leq 0.01$).

Landmark borders are unique to the Schengen Area, and the respective member states are relatively affluent. This is also indicated by the large and positive coefficient for the logged GDP per capita ($p \leq 0.001$). However, in contrast to fortified borders, states that maintain landmark borders are more equal in their economic position. This is shown by the negative coefficient for the GDP per capita ratio ($p \leq 0.001$). Previous militarized interstate disputes (i.e., between 2000 and 2014) decrease the probability of observing a landmark border ($p \leq 0.001$). What is more, there are no Muslim-majority states that maintain landmark borders, as indicated by the large and highly significant coefficient for this category ($p \leq 0.001$). Still, having a different majority religion across the border line increases the probability of a landmark border by 6.6 percentage points ($p \leq 0.01$). The negative coefficient for shared official languages indicates that potential language barriers do not inhibit open borders ($p \leq 0.001$). In the multinomial model, the relationship between political regimes and landmark borders is not significant, which indicates that other factors such as the economic output account for this border design.

Lastly, our typology categorizes "no-man's-land" borders. Here, we find a negative coefficient for the economic output ($p \leq 0.05$). As already seen in the bivariate analysis, states with "no-man's-land" borders are relatively poor. Albeit only at the $p \leq 0.05$ significance level, a standard deviation increase from one unit below the mean value of the GDP per capita variable to one unit above it (i.e., from roughly $1,202 to $19,844) decreases the probability of observing a "no-man's-land" border by 11.3 percentage points. "No-man's-land" borders rarely occur at border lines that previously separated states with a shared colonial history ($p \leq 0.001$).

Overall, we find that border designs are strongly associated with economic factors. Based on our analysis, it is apparent that affluent states choose to install either open and weakly protected or closed and relatively fortified borders. This choice is clearly influenced by the wealth differential between a country and its neighbor. Large wealth gaps seem to motivate states to use fortified borders in order to protect their economic interests, whereas if the neighbor is equally affluent, a deinstitutionalization of strong borders becomes more likely. Border barriers are associated with cross-border differences in political regimes. We also find that "no-man's-land" borders that are not equipped with any discernible border infrastructure are mainly found at borders of poor states that lack the basic capacity to control their borderlands. They are also negatively associated with shared colonial histories. Lastly, checkpoint borders, which serve as our baseline category, are the most prevalent border design. They are also used by less affluent states. Hence, we are neither living in a "walled world" nor in a world where most states respond to global mobility flows by dismantling border posts and checkpoints.

7. Discussion

Our article dealt with the question of which border infrastructures states deploy at their land borders. In addition, we investigated how border designs are associated with economic, political, cultural, and security environments. While most of the scholarship focused exclusively on "border walls" and neglected the variety of border designs, we proposed a fivefold typology that classifies boundaries as "no-man's-land," landmark, checkpoint, barrier, and fortified borders. The empirical analysis of the border typology revealed that all border types make up a significant share of the overall border infrastructures, but that there also is substantial regional variation. Fortified borders are found predominantly in Asia and Europe. After the fall of the Iron Curtain, several newly emerging states were suddenly confronted with the need to demarcate and control vast borderlands. This process was complicated by territorial disputes and the intricate geography of the former Soviet Union region. In this situation, strong border fences were used to establish "facts on the ground" to demonstrate sovereignty. In South Asia, religious conflicts and territorial disputes created a political climate that was conducive to the use of border walls as boundary markers and for military strategy. In Europe, border fortifications remain mainly used to restrict unwanted mobility across the EU's external borders. This process was accelerated by the migration and refugee crisis of 2015-2016, which led to a mushrooming of new border fortifications and fences. At the same time, deinstitutionalized border infrastructures are also specific to the Schengen Area. "No-man's-land" borders are found in less developed regions along the Sahel, in Central Africa, and in Caribbean

South America. Lastly, checkpoint borders are the most prevalent border design across all continents.

Scholars have argued that economic, political, and cultural factors as well as security concerns affect a state's choice between territorial designs. Our descriptive analysis shows that border designs are primarily ordered along economic aspects. A multivariate regression analysis has shown that a state's economic situation is the predominant factor that affects the type of border put in place. Our analysis thus confirms that states erect "hard borders" primarily to reaffirm "discontinuity lines" between affluent and poor societies (Rosière and Jones 2012). In other words, rich states tend to use border fortifications to protect themselves from poorer neighbors and alleged threats like migration, smuggling, or security issues. However, we also show that economic factors are not only responsible for wall building, but also for the choice of more open border designs. This is the case when equally affluent democracies share a border. In particular, we found landmark borders only in the context of the comparatively wealthy European Union.

By contrast, "no-man's-land" borders are mainly found in poor states that lack the capacity to control their borderlands. In the absence of territorial conflicts, poor states might see their borderlands neither as a potential resource nor a threat. Accordingly, even though border posts and checkpoints help to levy duties, infrastructure and border officials also produce costs that these states might not prioritize. Lastly, we have considered states that buffered specific border posts using obstacles such as barriers and fences. Our analysis indicates that states use barriers to separate different political regime.

The proposed border typology has enabled us to map the regional variation of border infrastructures across the world. In addition, we were able to shed light on state characteristics that are associated with specific border designs. Even though the analysis has expanded our knowledge about territorial designs and associated factors, it also highlights directions for prospective research. First, future research should further disentangle checkpoint borders (the most prevalent form of border control), as our indicator groups together different types of checkpoints. These could be as varied as dust roads equipped with basic tollgates and elaborate border infrastructures with multi-lane traffic. Second, studies often rely on extreme points such as entirely open borders or massive border walls for theory building. Accordingly, less extreme border designs are not only under-researched but also rarely theorized. Third, our cross-sectional study design made it impossible to account for historical processes that influence borders. However, many boundary designs are the outcome of historical processes. Accordingly, longitudinal data is needed to account for historical factors that are known to affect the formation of specific border designs.

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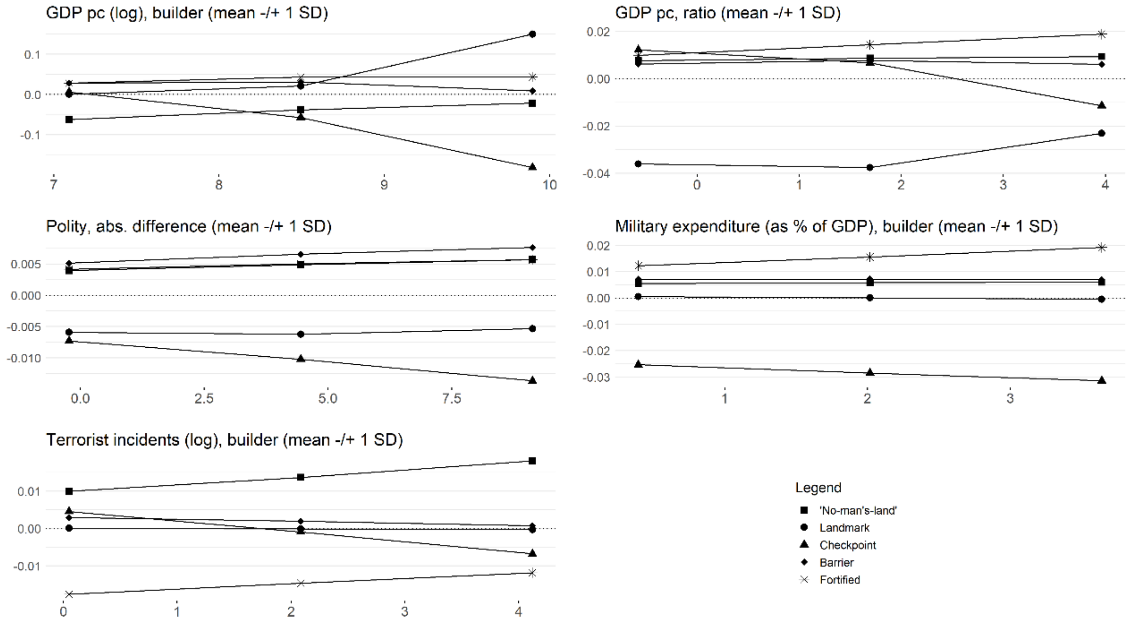
Appendix

Table A1 Multinomial Logistic Regression on Border Typology, AME (50 imputations, clustered SE in parentheses)

Independent variables	"No-man's-land"	Landmark	Checkpoint	Barrier	Fortified
GDP pc (log), builder	**-0.042*** (0.018)	**0.084***** (0.013)	**-0.09***** (0.023)	0.015 (0.01)	**0.032**** (0.01)
GDP pc, ratio	0.008 (0.006)	**-0.039***** (0.01)	0.009 (0.014)	0.007 (0.006)	**0.014**** (0.005)
Polity, builder	-0.004 (0.002)	0.009 (0.008)	-0.004 (0.007)	0 (0.003)	-0.002 (0.002)
Polity, abs. difference	0.005 (0.003)	-0.006 (0.006)	-0.009 (0.006)	**0.006*** (0.002)	**0.004*** (0.002)
Military expenditure (as % of GDP), builder	0.006 (0.009)	0 (0.014)	-0.028 (0.021)	0.007 (0.011)	**0.016*** (0.007)
Terrorist incidents (log), builder	0.014 (0.008)	0 (0.006)	-0.001 (0.012)	0.002 (0.007)	**-0.015*** (0.007)
Militarized disputes [Ref.: No]	-0.052 (0.033)	**-0.123***** (0.011)	0.076 (0.055)	0.017 (0.033)	**0.082**** (0.029)
Religion, Muslim [Ref.: Christian]	-0.051 (0.051)	**-0.115***** (0.011)	0.024 (0.071)	0.081 (0.054)	0.061 (0.035)
Religion, Other [Ref.: Christian]	-0.052 (0.059)	**0.066**** (0.024)	-0.074 (0.084)	0.004 (0.048)	0.055 (0.039)
Religious proximity	0.029 (0.055)	0.011 (0.032)	-0.063 (0.081)	-0.009 (0.048)	0.032 (0.039)
Colonial history [Ref.: No]	**-0.085***** (0.018)	0.019 (0.032)	-0.114 (0.077)	0.131 (0.092)	0.05 (0.03)
Common language [Ref.: No]	-0.004 (0.03)	**-0.07***** (0.021)	**0.136**** (0.048)	-0.006 (0.029)	**-0.055*** (0.026)
Observations	630	630	630	630	630

Notes: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

Figure A AME across Predictor Range (mean -/+ one standard deviation)



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