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The Theory of Lateral Pressure: Highlights of Quantification and Empirical Analysis

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Abstract

The term *lateral pressure* refers to any tendency (or propensity) of states, firms, and other entities to expand their activities and exert influence and control beyond their established boundaries, whether for economic, political, military, scientific, religious, or other purposes. Framed by Robert C. North and Nazli Choucri, the theory addresses the sources and consequences of such a tendency. This chapter presents the core features—assumptions, logic, core variables, and dynamics—and summarizes the quantitative work undertaken to date. Some aspects of the theory analysis are more readily quantifiable than others. Some are consistent with conventional theory in international relations. Others are based on insights and evidence from other areas of knowledge, thus departing from tradition in potentially significant ways.

Initially applied to the causes of war, the theory focuses on the question of: *Who does what, when, how, and with what consequences?* The causal logic in lateral pressure theory runs from the internal drivers (i.e., the master variables that shape the profiles of states) through the intervening variables (i.e., aggregated and articulated demands given prevailing capabilities), and the outcomes often generate added complexities. To the extent that states expand their activities outside territorial boundaries, driven by a wide range of capabilities and motivations, they are likely to encounter other states similarly engaged. The intersection among spheres of influence is the first step in complex dynamics that lead to hostilities, escalation, and eventually conflict and violence.

The quantitative analysis of lateral pressure theory consists of six distinct phases. The first phase began with a large-scale, cross-national, multiple equation econometric investigation of the 45 years leading to World War I, followed by a system of simultaneous equations representing

conflict dynamics among competing powers in the post–World War II era. The second phase is a detailed econometric analysis of Japan over the span of more than a century and two World Wars. The third phase of lateral pressure involves system dynamics modeling of growth and expansion of states from 1970s to the end of the 20th century and explores the use of fuzzy logic in this process. The fourth phase focuses on the state-based sources of anthropogenic greenhouse gases to endogenize the natural environment in the study of international relations. The fifth phase presents a detailed ontology of the driving variables shaping lateral pressure and their critical constituents in order to (a) frame their interconnections, (b) capture knowledge on sustainable development, (c) create knowledge management methods for the search, retrieval, and use of knowledge on sustainable development and (d) examine the use of visualization techniques for knowledge display and analysis. The sixth, and most recent, phase of lateral pressure theory and empirical analysis examines the new realities created by the construction of cyberspace and interactions with the traditional international order.

Keywords

Lateral pressure theory, state profiles, phases of empirical analysis, security, global environment, cyberspace, cyber challenges to the state system, empirical international relations theory.

Subjects

Groups and identities, international political economy, quantitative political methodology, world politics.

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The Theory of Lateral Pressure: Highlights of Quantification and Empirical Analysis

1 Introduction

The term *lateral pressure* refers to any organized tendency (or propensity) of individuals, societies, states, or other entities to expand their activities and exert influence and control beyond their established boundaries whether for economic, political, military, scientific, religious, or other purposes (Choucri & North, [1972](#), [1975](#); Ashley, [1980](#); Choucri & North, [1989](#); North, [1990](#); Lofdahl, [2002](#)). Framed by Robert C. North and Nazli Choucri, the theory addresses the sources and consequences of such a tendency. To the extent that states expand their activities outside territorial boundaries, driven by a wide range of capabilities and motivations, they are likely to encounter other states similarly engaged. The intersection among spheres of influence is the first step in complex dynamics leading to hostilities, escalation, and eventually to conflict and violence. These processes are contingent on the actors' intents, capabilities, and activities.

Lateral pressure is a relatively neutral concept similar to what Sorokin ([1957](#), p. 565) called economic expansion and Kuznets ([1966](#), pp. 334–348) referred to more broadly as outward expansion. The strength of a country's lateral pressure is generally taken to correlate positively with its power as that concept is conventionally understood. The theory draws on the level of analysis or image perspective in international relations (Boulding, [1956](#); Waltz, [1979](#)), largely as an initial framing, and then extends this traditional perspective in specific ways. As such, it addresses the sources and consequences of transformation and change in international relations and provides a basis for analyzing potential feedback dynamics.

The theory seeks to explain the relationships between state profile and patterns of international behavior. The causal logic runs from the internal drivers, the master variables that shape the profiles of states, through the intervening effects of socially aggregated and articulated demands and institutional capabilities and toward modes of external behavior designed to meet demands given the capabilities at hand (Choucri & North, [1989](#)). The attributes and characteristics of states are not fixed. They are subject to a wide range of influence (intended or unintended), most notably as a result of their own external activities.

When Choucri and North ([1972](#), [1975](#)) formulated the theory of lateral pressure in qualitative as well as quantitative terms, they signaled that in general, the strength of a country's lateral pressure correlates positively with its capabilities and power (a concept that is almost universally used but defined with difficulty). Lateral pressure theory provides a more detailed and nuanced

view of the sources of power, the types of leverages used, the behaviors that can be inferred and those that are manifested. It suggests how certain types of international behaviors or activities appear to be more prevalent in some countries than others. Among the notable reviews of lateral pressure theory are Levy (1989), and Pollins and Schweller (1999).

This article proceeds as follows: First we highlight the basic features of lateral pressure theory, its core components, and their interconnections. Some aspects are more readily quantifiable than others. Some are more consistent with conventional theory in international relations than others, and some aspects are based on assumptions that depart from conventional theory by adopting a multidisciplinary perspective, thus drawing on insights and evidence from other areas of knowledge. Second, we summarize six phases of empirical investigations to date and the evolution of theory over time. In so doing, we build on the basics and focus on the refinements of metrics and quantification of the core concepts. All of this pertains to the world as we have known it prior to the construction of the Internet, the core of cyberspace.

We cannot assume the portability of theory and of methods from the kinetic or traditional international arena (hereinafter referred as real domain) to the cyber arena (or cyber domain), a domain of human interaction created by the interconnections of billions of computers by a global network, nor can we assume a one-to-one correspondence of metrics and measures. Accordingly, we also apply lateral pressure theory to the cyber domain and examine empirical evidence of propensity for state expansion in the cyber domain compared to expansion tendencies in the real domain.

Finally, we ask the questions: Where do we go from here? What are the major theoretical and empirical challenges? In today's world, the nation-state remains the dominant, but not the only, significant entity in world politics. How relevant is the theory of lateral pressure for other actors in world politics, both private and public? How is the natural environment endogenized in theoretical, empirical, and policy analysis? What are the generic features of international relations in an increasingly complex world where the cyber and the real arenas are increasingly interlinked?

2 Basics of Lateral Pressure Theory

Drawing on insights and evidence from the social sciences (as well as natural sciences and, more recently, engineering), lateral pressure theory can be understood in terms of its basic assumptions, its components and their interconnections. The key features, highlighted next, signal some of the most important departures from conventional theory in international relations.

2.1 Systems of Interaction

The theory assumes that all human activity is embedded in three distinct but closely coupled systems; that is, the *social* domain of human interactions, the *natural* environment of life-

supporting properties, and now the human constructed arena (namely, *cyberspace*)—an assumption that holds within and across all levels of analysis, as defined later in this article. While the logic of lateral pressure theory argues for their joint dependence or codependence (or even coevolution), only social entities are characterized by fully articulated decision systems as we understand them. Clearly, humans make decisions that have impacts on life-supporting properties, directly or indirectly, and the feedback effects are subject to the decision mechanisms of nature. The cyber arena, created by human intelligence, assumes properties of its own, which are seldom entirely subject to social decision or control.

Early on, lateral pressure dynamics were considered largely in terms of social interactions in an international context. It gradually became apparent that the propensity to expand is manifested in environmental traces of all human activity and, more recently, in the cyber arena.

2.2 Levels of Analysis

The notion of images or levels of analysis—so fundamental in international relations theory—is an important element of lateral pressure theory, subject to three major departures from tradition. The first is the introduction of a fourth level of analysis (namely, the overarching global system encompassing the individual, the state, and the international levels). The second is the positioning of the levels within three distinct but interconnected systems of interaction. The third relates to the aggregation issue. The conventional practice is to point to the levels of analysis—beginning with the individual and moving up the level of aggregation—a practice that we shall follow in the remainder of this section to illustrate the logic of lateral pressure theory. However, feedback effects may generate reversal effects (that is, from the global system to the international, the state, or the individual level). While not fully articulated, the theory highlights the potentials and possibility of generativity, a feature that remains to be explored in international relations theory.

2.3 Individuals and Aggregates

At the base of the social order are the core activities undertaken by individuals in their efforts to meet their needs and demands. Aggregated at the levels of the state, the international system, and the global context, the most fundamental individual needs and wants are driven by the quest for security and survival. This is consistent with tradition in international relations theory. But the view of the individual differs from that posited by convention as the first level of analysis, also introduced as the First Image by Boulding (1956).

First, lateral pressure theory sees the individual as an information processing and an energy using entity. Second, the theory is anchored in the assumption that *homo individualis*—in contrast to *homo economicus* and *homo politicus*—is situated in an overarching social and natural, and now cyber, environment. Also, it is at odds with the conventional view of the economic human, the isolated individual entering an impersonal market at a particular point in time. Both the market

and the polity are well understood with respect to properties and modes of behaviors, they retain an exclusively social view of humans. Embedded in the interactive social, natural, and cyber arena, *homo individualis* is at once an economic, social, or political person, and even *homo cybericus*, depending on the role and context at any point in time.

2.4 Demands and Capabilities

The concepts of demands and capabilities provide the transition from the individual for aggregation to broader social entities (notably, the state). A *demand* is a determination that derives from a perceived (or felt) need, want, or desire for the purpose of narrowing or closing the gap between a perception of fact (i.e., what is) and a preference or value (i.e., what ought to be). Basic demands are usually for access to resources, better living conditions, physical safety, and security, all of which are generally considered under the rubric of utility by economists. To meet demands—and to close the gap between the *is* and the *ought*, and possibly also to approach or establish a preferred condition—individuals and societies must possess the required capabilities.

Capabilities consist of the set of attributes that enable performance and allow individuals, groups, political systems, and entire societies to manage their demands. Given that states vary extensively in their capabilities, their environmental effects also will vary, as will the attendant pressures on the integrity of social systems or the viability of the natural environment.

2.5 Master Variables

The theory assumes that the critical drivers of social activity—in all contexts and at all levels of development—can be traced to the *interactions* among three master variables—population, resources, and technology. Measurement of the master variables is usually a first step in quantitative analysis and grounds the theory in an empirical context. *Population* refers to the size, distribution, and composition of people, as well as to changes thereof. Each of these variables can be differentiated along a number of subfactors or variables depending on the issues at hand or the interest of the analyst. The same can be said about resources and technology. *Technology* refers to all applications of knowledge and skills in mechanical (equipment, machinery, etc.) as well as organizational (institutional) terms. This concept of technology encompasses both soft and hard dimensions, and often the former is as important as the latter. *Resources* are conventionally defined as elements that are of value to society—not only natural resources critical for human survival (such as space, water, air) but most notably those made available through applications of technology (such as drilling for petroleum, or developing alternative energy sources, enabling access to raw materials and minerals, to note only a few).

2.6 State Profiles

Lateral pressure theory further argues that all states can be characterized by different *combinations* of population, resources, and technology (the master variables) and that different combinations yield different state profiles—and different patterns of international behavior and impacts on the natural environment. Analyses and results from a number of studies (Choucri & North, 1989; North, 1990; Wickboldt & Choucri, 2006; Choucri & North, 1993a) illustrate the empirical aspects of this logic. The formal specification of state profiles is shown in Table 1. For convenience, state profiles are displayed in terms of a technology-driven perspective, indicated by the T-variable along the diagonals. But this particular display is not a necessary feature of the theory or of the concept of profile.

We shall turn to the measurement of profiles later in this article, as well as the empirical basis for this proposition (Choucri, 2012, p. 310). The reorganization of each profile location in this table yields, by definition, a population-driven display, or alternatively, a resource-driven display (each of which has the P- or the R-variable along the diagonals). See Choucri and North (1993b) and Lofdahl (2002) for the original specifications; and Wickboldt and Choucri (2006) for an extension of the logic to differentiating empirically among countries within each profile group.

Table 1. Definition of State Profile

Profile 6	<i>Technology</i>	>	Population	>	Resources
Profile 5	<i>Technology</i>	>	Resources	>	Population
Profile 4	Resources	>	<i>Technology</i>	>	Population
Profile 3	Population	>	<i>Technology</i>	>	Resources
Profile 2	Population	>	Resources	>	<i>Technology</i>
Profile 1	Resources	>	Population	>	<i>Technology</i>

Source: Choucri (2012, p. 32).

2.7 Governance and Government

In this context, the term *governance* refers to legitimate structures and processes through which societies are managed. *Government* refers to the specific mechanisms for management and serves as the lead entity of decision, policy, and enforcement. Simple as this might seem, we shall note later in this discussion how important these concepts are for interactions in the cyber domain. Initially framed in the context of the sovereign state, these definitions are generic in form and

applicable to all countries, at all levels of development, and during all periods of time. By analogy, similar mechanisms operate in other contexts and entities, such as corporations and nonprofit entities.

At this point, we return to the notion of *capabilities* introduced previously. Especially relevant are the contributions of Almond, Powell, and the Rogers D. Spotswood Collection (1966), who defined government capabilities for extraction, distribution, responsiveness and regulation, as well as symbolic capacity. It is not difficult to see the connection between this view of capabilities and most of the variables in the state's national budget. Less obvious, however, is the connection to one of the most fundamental functions of government, namely, provision of national security.

In this context, the management of demands and capabilities is the intervening process relating state profiles and their characteristic features to propensities for external behavior. Efforts to meet demand—or to expand capacity in order to meet demands—often create unintended consequences that may undermine the very objective at hand. The generic governance challenge is how best to manage two countervailing processes: (a) pressures emanating from societal demand, creating loads on the system; and (b) capacities of government to manage the loads and respond to pressures while avoiding any conflict and large-scale disruption.

2.8 Expansion and Intersection

In the management of loads and capabilities, and/or in the protection of its national interests, the state may find it necessary (or it may have the capacity) to extend its behavior outside territorial boundaries. To the extent that states extend their behavior outside territorial boundaries, they are likely to encounter other states similarly engaged. The theory of lateral pressure signals the *intersection of spheres of influence* as a significant point at which interactions are likely to evolve into competition, which in turn shapes hostilities set in place that can rapidly evolve into spiraling conflicts, leading to military competition and eventually to violence and warfare—usually triggered by an overt act that is perceived as a provocation.

Clearly, not all expansions lead to intersections of interests, nor do all intersections of interests harness a conflict spiral. This stylistic sketch is remarkably consistent with the historical record of the industrial West and the narratives developed over time to explain the outbreak of World War I and World War II. The quantitative investigations of lateral pressure theory, highlighted later in this article, signal the challenges and the opportunities and contentions inherent in, and surrounding, quantitative empirical analyses.

2.9 High-Level Causal Logic

While the master variables are the core building blocks of theory, lateral pressure stipulates that the causal logic runs from the internal drivers (that is, the master variables that shape the profiles

of states) through the *intervening* variables (namely, aggregated and articulated demands given prevailing capabilities) to *external* behavior and international outcomes. Throughout this process, states may experience changes in profile type. Here, we can only briefly present the causal logic, not a detailed statement or the various forms of nonlinear interactions among the three master variables.

The high-level view in Figure 1 reminds us that, at one point in time, the type of state profile contributes to propensities for external expansion—and eventually to international behavior. When this happens, states may intersect with others similarly engaged. This is the first stage in what usually becomes a complex dynamic process. At the same time, however, all states are experiencing *differential* rates of change in their master variables—foundations for unequal rates of growth and development—shaping *differential* rates and types of international activities. Whatever takes place from this point on, countries can pursue different strategies; they can engage in different forms of interactions; they can make friends and make enemies. All of this generates different outcomes. For example, if intersections are conflict oriented, and when violence results, there are usually winners and losers. In each case, there could be a gain or loss in the master variable metrics, thereby potentially altering the profile of the state. On balance, then, the state profile is shaped by the state’s own situation, as well as by the situations of all other states in the international system. Each state accounts for a “share” of the global total for each of the individual master variables. The inequalities in Table 1 apply to the individual shares for each state relative to the global aggregate.

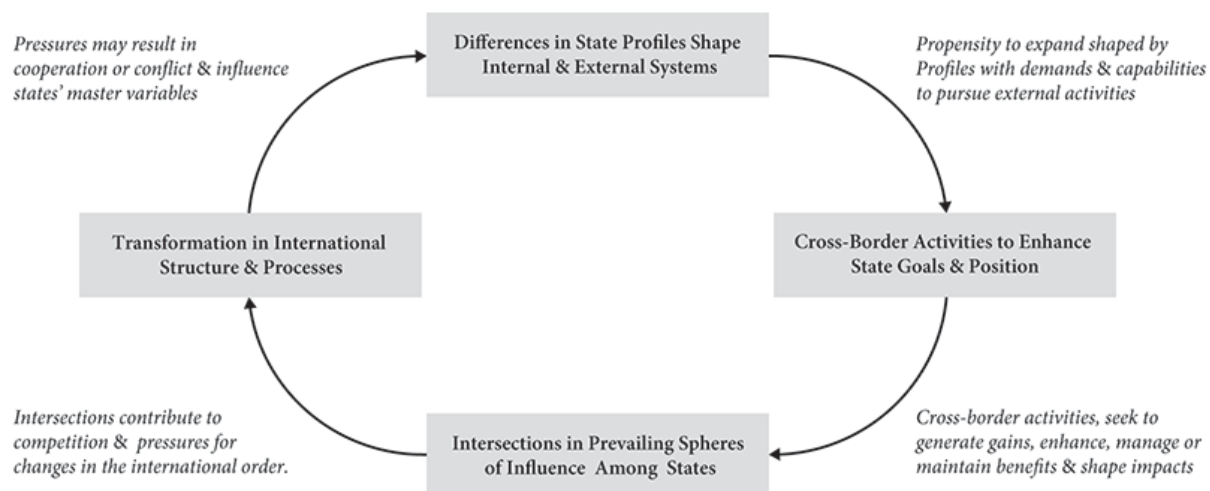


Figure 1. Simplified causal logic of lateral pressure theory.

Source: Revised from Choucri and Mistree (2010).

Note: This is a highly-simplified view. It obscures the feedback dynamics that at each stage and modify, alter, or reinforce the illustrated pathways. None of this is inevitable. These are contingencies with associated probabilities.

2.10 International Relations

By definition, international relations consist of interactions among sovereign entities, intergovernmental organizations, nonstate for-profit and not-for-profit entities, nongovernmental organizations, and many others. As a result, the state is embedded into a wide range of networks, formal and informal. Given that competition for power and influence is a generic feature of politics among nations, lateral pressure theory points to intersections among spheres of influence as a mechanism for creating hostilities, potentially setting in place the dynamics of military competition that lead to the well-known phenomenon of the arms race.

Here, the theory draws on four important concepts in international relations theory. These are (a) the *conflict spiral* (Holsti, [1967](#)); (b) *arms race* dynamics (pioneered by Richardson, [1960](#)); (c) the *security dilemma* (notably Herz, [1950](#); Jervis, [1997](#)); and (d) the *peace paradox* (Choucri & North, [1975](#))—namely, when initiatives by one adversary to reduce hostilities and deescalate violence are considered by the other as a sign of weakness, and thus an opportunity for taking the offensive and making a move to gain advantage in the conflict in question. In this connection, while everyone acknowledges the importance of deterrence and deterrence theory, there is less agreement about the underlying conditions that enable deterrence or the relevance of deterrence in the 21st century cyber arena—which we shall turn to later in this article.

Less fully developed in lateral pressure theory are the dynamics of international cooperation, which we shall refer to later in this discussion in the context of global accord on the environment (Choucri, [1993](#)). In this context, the theory draws upon concepts of multilateralism as a form of coordinated behavior among states that is designed to reduce disorder and anarchy in the international system. Stated differently, as coordinated action among sovereign states, multilateralism emerged as a means of protecting the interests and activities of states in the international system in their pursuit of core goals—namely, wealth and power (Gilpin, [1987](#)). Much of the foregoing is applicable at other levels of analysis, however defined, and is relevant to any delineation or aggregation of entities.

2.11 Businesses, Firms, and Nonstate Actors

Lateral pressure theory argues that the relationship between corporate actors and the sovereign state is framed by the characteristic features of the state's profile on the one hand, and the dynamics of corporate expansion of investments and related activities, on the other. For example, in early phases of development, a country generates neither outward nor inward organizational capability. Over time, as a country increases its capabilities and its private organizations become more effective, it generates a range of cross-border activities and may even become a net outward investor.

Eventually, the capabilities of corporate entities, rather than the power and the profile of the home country, become more significant. In this process, the firm's strategies are increasingly

decoupled from the home state and its profile. Corporate policy is now framed largely within the firm's *organizational field* (Fligstein, 1990), a concept that carries much of the expansionist core of lateral pressure.

The *horizontal* reach of the traditional commercial private sector is well known, as are the various transformations in response to changing market and other conditions. These features are embedded in emergent *vertical linkages*—connecting global and local—for information, communication, and knowledge building to and from the grass roots. By definition, these actors assume a physical presence in different jurisdictions, the nature of which depends on the nature of products, processes, and services. Unless closely held, these entities are controlled by *stockholders*—at least in principle. Again, all of this is part of traditional international relations. The same cannot be said of the private sector for the cyber arena, largely due to the salience of the not-for-profit segment and the consolidation of *stakeholders* interested in the new arena of interaction.

2.12 The Global System

Recall that lateral pressure theory extends the traditional levels by positing the global system as an overarching concept that encompasses its constitutive features—the individual, the state, and the international system—within the social system and the natural environment and, more recently, in the cyber domain. The theory also views globalization in overarching terms—as fundamental transformations in economic and social structures and processes worldwide, shaped by the large-scale movements of people, resources, and technologies across boundaries and all the attendant by-products.

Such cross-border mobility influence the nature of national societies and economies and, under certain circumstances, may even alter them in fundamental ways. Inevitably, they also shape and reshape international exchanges and interactions. To the extent that these processes are sufficiently pervasive and call for changes in dominant policy thrusts, it is reasonable to argue that the essence of globalization lies in the forging of common and overlapping policy spaces.

The globalization process generally leads to new areas and modes of interaction. Earlier globalizations, which had created new spaces of interaction due to control or conquest (e.g., colonies, the polar regions, and outer space), provided opportunities for the few and the powerful. Over time, the globalization processes became more complex and assumed new properties of unprecedented scale and scope. Later in this article, we shall turn to the cyber domain and illustrate the ways in which lateral pressure theory addresses and helps analyze the actors and activities in, and of, cyberspace.

Among the many challenges associated with understanding the global system and the globalization process, at least four are especially compelling (Choucri, 1993). First, the basic biogeochemical characteristics of the global environment are broadly recognized, but uncertainties

about *feedback effects* on both the geophysical and social processes remain daunting. Second, the social, environmental, and cyber-based processes operate at unequal and sometimes overlapping *time frames*, thus complicating the notion of temporality and the role of time. Third, the *intergenerational impact* of environmental change, whereby future generations incur environmental burdens created by the actions of past and present generations, are associated with long lead times. Fourth are the uncertainties due to *irreversibility* signal that patterns of environmental alterations cannot readily be undone, nor can root sources be easily controlled or eliminated on short order, if at all. Needless to say, the construction of cyberspace creates its own pervasive challenges—as we shall show later on.

3 Empirical Analysis and Theory Development

Lateral pressure theory assumes that each statistic is an indicator of—and a consequence of—a discrete decision by an individual human being, governed by his or her preferences. The larger the size of the community, the greater are the demands, wants, and needs. Population growth, for example, is in fact the outcome of a large number of private decisions (due to volition or to coercion), over which policymakers or national governments are not likely to have direct control. In this connection, if there is any determinism in this logic, it is driven by individual decisions. Indicators of technology, like those of population, are also the observed outcomes of a number of widely dispersed decisions by individual actors, such as developers, inventors, scientists, investors, or manufacturers. The same holds for resource access and use. Statistics involve descriptions of and generalizations about aggregates. Empirical analyses of lateral pressure theory have gone through several phases, with each one providing grounds for added developments in theory and new challenges for quantitative analysis.

The earliest studies were completed during the 1970s. Until very recently, the theory dwelt in the physical realm of traditional world politics, along with all other theoretical and empirical analyses in international relations. The construction of cyberspace created new challenges pertaining to quantification of the master variables, state profiles, and patterns of behavior. This section focuses on empirical theory and analysis in the conventional realm—a necessary prerequisite for understanding measures and metrics for the cyber domain.

In retrospect, we now appreciate how our quantitative work and empirically based inferences have evolved over time. We can now point to six distinct phases to date, each with its theoretical and methodological features, which will be discussed next.

3.1 Major Power Interactions, 1870–1914: Econometrics

The first phase is a large-scale econometric analysis based on a cross-national system of simultaneous equations for the period leading up to World War I (Choucri & North, [1975](#)). The quantitative work includes a set modeling and simulations that yield empirical connections

between the master variables and the behavior of states. Choucri and North (1975) developed an econometric simulation model of six major powers during the 45 years leading to World War I. In each case, they found the causal connections between the master variables and the overt international behavior. The traditionally dominant power during this period, Great Britain, viewed any significant growth in other powers as a source of threat, and these perceptions were translated into specific policies intended to retain an advantage over the other powers, most notably a rapidly growing and newly unified Germany. The discussion of each of the equations in the overall model of jointly estimated dependent variables is contextualized in a historical narrative that enriches the analysis, the results, and the inferences drawn.

The theory of lateral pressure, then in its infancy, was readily mapped onto a set of variables and processes that represented growth, expansion, intersection of interests, conflict, and violence. Choucri and North (1975) show the logic of empirical investigation at that time. All variables, dependent and independent, other than the ultimate dependent variable, *violence*, were derived from the existing statistical record, adjusted appropriately for comparison across countries and over time. The final dependent variable was constructed based on a 15-point international interaction scale developed for that purpose. This was long before measuring the intensity of hostilities in world politics became common practice in the field. In retrospect, this study clearly preceded the development of formally framed state profiles, as it did the quantitative articulation of the propensities for expansion rather than the actual behavior.

Shortly thereafter, *The Political Economy of War and Peace* (Ashley, 1980) extends the lateral pressure logic, as well as the measures and metrics, into a system of simultaneous equations representing conflict dynamics among competing powers in the post–World War II era. Ashley focused on the interactions generated by differentials in population growth, resource access, and technology levels, focusing on the United States, the Soviet Union, and China. The study demonstrates the close interconnections among national growth, bilateral rivalry, and multilateral balance of power. It is also the first quantitative analysis of these three powers in world politics.

Ashley (1980) shows how the dynamics of insecurity and the antagonizing processes contribute to the globalization of military competition, which in turn creates serious impediments to the collective management of many dimensions of growth itself. Careful model development, empirical grounding, and parameter estimation, as well as simulation of sensitivity analysis, revealed the overall security problematic surrounding major power interactions. Despite changes in world politics since 1914, as well as the processes modeled by Choucri and North (1975), some fundamental features of lateral pressure retained powerful resonance during the post–World War II period.

In retrospect, despite the end of communism and the dissolution of the Soviet Union, the analysis and results shed important light on the emergent challenges to global and national security in the 21st century. The unquestionable dominance of the United States in world politics does little to dampen perceptions of threat due to China's growth, given its rapid expansion in the global

economy, nor perceptions of Russian threat, given its period encroachment on the sovereignty of select neighbors.

3.2 Japan Growth and Expansion, 1868–1970: Econometrics

The second phase of empirical analysis of lateral pressure consists of a detailed analysis of Japan over the span of more than a century (Choucrist, North, & Yamakage, 1992). Focusing on growth, development, competition, warfare, and reconstruction, this case illustrated the ways in which Japan sought to manage its resource constraints, adopt internal and external policies to meet its core demands, and find itself competing with other states, leading to conflicts that it viewed as essential for its survival. The concept of the state profile, introduced in an earlier study (Choucrist & North, 1989), was operationalized and put to the empirical test in Japan across three historical periods—before World War I, during the decades between the World Wars, and following World War II. Aptly titled *The Growth of Japan Before World War II and After*, this empirical study grappled the before and after dynamics created by sharp system breaks due to war (that is, after World War I and after World War II), as well as the subsequent transformations in the 1950s, 1960s, 1970s, and the early 1980s. The book was completed long before analysts recognized the declining birth rate of Japan and the leveling of its population growth—both of which potentially affected the country’s profile.

The case of Japan indicates how a country’s profile can change over time and how these changes are associated with different patterns of international behavior. Each period demonstrated different structural features and alternative pathways for adjustments to internal and external constraints. Nonetheless, Japan’s profile continued to demonstrate powerful resource scarcities, and thus a necessary dependence on external trade. The demand for imports could be met only by the supply of exports, thus shaping a vicious cycle of reliance on external resources. Japan was caught between a rock (invariant resource levels) and a hard place (external constraints on resource access). In the decades preceding major international conflicts, Japan fostered its eventual technology-dominant profile, enabling it to engage in a wide range of expansionist activities to reduce its resource constraints.

3.3 Highlighting Complexity: System Dynamics and Fuzzy Logic

The third phase of lateral pressure empirical analysis builds on exploratory system dynamics modeling for the period from the 1970s onward, and introduces investigations based on fuzzy logic. Early system dynamics models of lateral pressure such as that of Choucrist, Laird, and Meadows (1972) addressed the interconnections among the master variables that create internal sources of external conflict. Extending this work, Choucrist and Bousefield (1978) developed a model of the economy anchored in the master variables, and then they located sources of lateral pressure and propensities toward modes of external behavior.

Later, in a comparative analysis of 20 countries (industrial and developing), Wils, Kamiya, and Choucri (1998) extended the analysis of internal sources of international conflict and examined the nature of the feedback effects—namely, how international conflict in turn influences and even alters the master variables of the state and changes the internal sources of conflict, as well as propensities for particular modes of external behavior. This phase concentrates on basic changes in the master variables across states and over time, as well as the implications for international relations. Introducing the use of fuzzy logic, the analysis generated empirically based distributions of states both within and across profile groups (Wickbolt & Choucri, 2006). The use of fuzzy logic facilitates more systematic and accurate specifications of the distribution of states throughout the international system. This could be an important step in visualizing shifts in state location over time and, to some extent, helping to anticipate conflict-prone behavior.

3.4 Global Environmental Change: Statistics

All these investigations were undertaken with reference to the kinetic, traditional international arena (the real domain or arena). Incorporating the natural environment is an important development in empirical analysis of lateral pressure theory, as well as in quantitative analysis generally. These studies are all informative in their own right. Each one provides important insights and evidence about the internal dynamics, state attributes, external behavior, and antagonizing processes that lead to system-threatening dynamics and, in some cases, to overt conflict, violence, and war. Also, they all focus on the real domain.

The fourth phase in empirical analysis of lateral pressure theory seeks to endogenize the natural environment. By necessity, Choucri and North (1993c) selected first principles (i.e., to focus on anthropogenic sources of greenhouse gases) to examine the specific activities that are most dominant in generating specific greenhouse gases and to take note of the salient properties of these gases, followed by identification of states that are most engaged in the activities in question. This provided a mapping of social impacts on nature. Greenhouse gases generated in the course of creating human products and processes can be viewed as environmental lateral pressure, or lateral pressure in the environment mode.

This is a propensity intimately tied to and created by the characteristic features of products and processes—without explicit consideration of nature's life-supporting properties (Choucri & North, 1993a, 1993b). Subsequently, Lofdahl (2002) modeled the relationship between internal dynamics of growth and development rooted in the master variables on the one hand, and propensities toward particular patterns of international trade and their environmental impacts on the other. Lofdahl's work departed from previous investigations by adopting a worldwide perspective and positing the all-encompassing global system.

3.5 Sustainability: Knowledge System, Ontology, and Networking

In many ways, we have found the concept of sustainable development, sustainability for short, to be an important addition to international relations theory, policy, and practice, and to lateral pressure logic by helping to provide system boundaries for framing the problems at hand. Focusing on the master variables as critical drivers of lateral pressure, the fifth phase addresses the framing challenge of constructing a detailed ontology of the master variables and their critical constituents in order to (a) better understand the various facets thereof and their interconnections, (b) capture knowledge materials central to sustainable development, and (c) create knowledge management methods for search, retrieval, and addition to the stock of evolving knowledge on sustainable development. The result is the *Global System for Sustainable Development* (GSSD). For more information on consult the website (<http://gssd.mit.edu>).

The basic advances made in this phase are presented in *Mapping Sustainability* (Choucri et al., 2007). Drawing on the work of Marvin Minsky, the founding director of the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology (MIT), it provides the details of the ontology for representing the domain of sustainable development and for organizing relevant knowledge. It is useful to think of an ontology as “a sort of skeleton, something like an application form with many blanks or slots to be filled” (Minsky, 1986, p. 245).

The methods used include various forms of visualization technologies. Among these is the use of geographical information systems (GIS) technology (Ortiz, 2007) to show the distribution of state profile types in two- and three-dimensional maps of the global system. These maps show the global patterns of greenhouse gas emissions, as well as the emissions by profile type. Ortiz illustrates the geographic distribution, temporal evolution, and cross-sectional interrelationships of relevant variables; the categorical proxy of country profiles; and related variables of growth and development across all countries over a time frame of decades. These maps visually convey the basic message embodied in large data sets with complex interrelationships between variables across a geographic space. Visualization contributes to our overall understanding of the lateral pressure dynamics in ways that transcend the econometric or system dynamics methodologies. In many ways, visualization can expedite the process of hypothesis generation and testing.

4 Lateral Pressure and Cyberspace

The sixth, and most recent, phase of lateral pressure theory and empirical analysis focuses on the new realities created by the construction of cyberspace and the interactions with the traditional international order. With the billions of computers that it connects, its management, and the experiences that it enables, the Internet has become a central feature of the 21st century, creating a fundamentally new reality for almost everyone in the developed world, as well as for rapidly growing numbers of people in the developing world. Clearly, construction of the cyber arena was

not anticipated early in the development of lateral pressure theory. But the logic still stands, and its robustness enables us to address these new realities.

4.1 Cyberspace and International Relations

Lateral pressure theory views *cyberspace* as a global domain of human interactions created by the worldwide interconnections of billions of computers, known as the Internet. Built as a layered construct where physical elements provide a logical framework of interconnection, the Internet permits the processing, manipulation, exploitation, augmentation of information, and the interaction of people and information. Enabled by institutional intermediation and organization, it is characterized by decentralization and interplay among actors, constituencies, and interests.

Until recently, cyberspace was considered largely a matter of *low politics*—a term used to denote background conditions and routine decisions and processes. By contrast, *high politics* is about national security, core institutions, and decision systems that are critical to the state, its interests, and its underlying values. Nationalism, political participation, political contentions, conflict, violence, and war are among the most-cited aspects of high politics. But low politics does not always remain as such. If the cumulative effects of normal activities shift the established dynamics of interaction, then the seemingly routine becomes increasingly politicized. Cyberspace is now a matter of high politics.

This new domain of interaction is a source of vulnerability, a potential threat to national security, and a disruptor of the familiar international order. Currently, the influence of cyberspace is evident in all aspects of contemporary society, in almost all parts of the world. The result is a powerful disconnect between 20th-century international relations and the realities of the 21st century. It goes without saying that all of this force us to reassess the conventional perspectives on security as threats to cybersecurity become more and more salient. But this is only one side of the proverbial coin when seen in an international perspective. The other side of the equally proverbial coin is about cooperation and the challenges associated with international governance, especially governance of cyberspace.

Framed in this broad context, two books exploring the interconnections of cyberspace and world politics provided a solid basis for articulating the lateral pressure perspective on the cyber domain in international relations. The first, entitled *Cyberpolitics in International Relations* (Choucri, 2012), concentrates largely on the impacts of cyberspace at different levels of analysis in international relations and points to some ways in which traditional theory and practice require reassessments and reframing. The second, *International Relations in the Cyber Age* (Choucri & Clark, *in press*), takes the position that the ubiquity of cyberspace calls for a meta-analysis, an overarching investigation of the *contours and interconnections of cyberspace and international relations* in order to identify the linkages between the international system (and international

relations) on the one hand, and technological change (and cyberspace), on the other, in analytical, empirical, and observable terms.

Each of these two domains—the cyber and the international—is defined by core principles and characterized by specific features of structure and process; these enable, and are enabled by, a wide range of actors and activities. The increasing interconnections between the cyber and the real domains are shown by the development of practices surrounding *e-government* (to cite just one example), as well as by evidence of state expansion in the cyber arena (addressed next).

4.2 Cyber Challenges to the State

If we take into account the salience of cyberspace—given expansion of cyber access in all parts of the world providing new venues for action and expression—then we can appreciate the fundamental departures from tradition in international structures and processes, and the fact that the world is now much more complex.

A central feature of cyberspace is that it does not readily accommodate jurisdiction in international relations (a corollary of sovereignty)—a concept tied to location-centric rules that depend on the nature of the actors and the issues, as well as the willingness of sovereign states to accommodate differences in the internal laws for managing the private sector while conforming to the practice that external activities are governed by the rules of jurisdiction in public international law. The territorial principle dominates in international relations with the attendant distinction between territoriality of the country of origin versus territoriality of the country of destination.

Such simple rendering notwithstanding, it is clear to see the potential disconnects between these basic principles and the character and ubiquity of cyberspace. There are inherent tensions that are yet to be addressed. If there is international law for cyberspace, it is still in the making. One analyst argues that there is a “simple choice”—between “[m]ore global law and a less global internet” (Kohl, 2007, pp. 28–30).

Especially important here is that characteristic features of cyberspace stand in sharp contrast to our traditional conceptions of social systems generally, and to the state system in particular. Efforts to extend, or apply, international law to cyberspace—notably Tallinn Manual 2.0 (Schmitt, 2017)—reflect the view of international legal experts with all the assumptions of state and territoriality.

We now turn to critical disconnects between the key features of interactions in cyberspace and the traditional features of the international system. Shown in Table 2 are properties of the cyber domain that are particularly vexing for the state system (Choucri, 2012).

All of this becomes increasingly important because *who gets what, when, and how* is influenced by cyber access, as well as by the growth and diversity of actors, each endowed with differential levels and distributions of traditional power and capability. By definition, all entities

generate *demands* (that they seek to meet) and are endowed with *capabilities* (that they chose to deploy). They all are able to participate in one way or another in international deliberations, and all seek venues for shaping the evolving international political agenda—but only nation-states have the right to vote.

Table 2. Characteristic Features of Cyberspace

<i>Temporality</i>	Introduces near-instantaneousness into high politics
<i>Physicality</i>	Transcends physical constraints
<i>Permeation</i>	Penetrates boundaries and jurisdictions
<i>Fluidity</i>	Sustains shifts and reconfigurations
<i>Participation</i>	Reduces barriers to political expression
<i>Attribution</i>	Obscures actor identity and links to action
<i>Accountability</i>	Bypasses established mechanisms

Source: Choucri (2012, p. 4).

Early in the 21st century, it was already apparent that the cyber domain shaped new parameters of international relations and new dimensions of international politics. The “new normal” for world politics in the cyber age includes the state system, to be sure, it also includes a wide range of nonstate entities—known and unknown—all of whom operate in a highly dynamic and volatile international context.

4.3 Complexity of Security

Interactions in cyberspace have shifted the balance of power among different actors, including the traditional state powers, and enabled weaker actors to influence or even threaten stronger actors (such as reflected in press reports about incidents of anonymous penetrations of the U.S. government’s computer systems). This sort of shift has little precedence in world politics. We might view this situation as the emergence of new symmetries. However they are framed, we are witnessing potentially powerful changes in the nature of the game. The increased number of nonstate actors may well undermine the sanctity of sovereignty as the operational principle in the international system.

The traditional view of national security—protection of the state borders and territoriality—is no longer sufficient to reflect the complexity of security at all levels of analysis. Also important for all states everywhere, and at all levels of development, is protection of the natural environment and its life-supporting properties. To this, we now add the importance of cybersecurity: that is, security in and of a new arena of interaction characterized by its own distinctive dynamics, as well as the spillover effects of and on the traditional geopolitical (social) and the environmental (nature and its life-supporting properties) arenas.

Figure 2 illustrates in stylistic but realistic fashion the three trajectories of human security and examples of spillover effects across the trajectories. The graphic representation signals some notional conditions, but the record to date would readily support many of these observations. It posits a near-obvious proposition—namely, that human security and security of the state cannot be reduced to parameters of the traditional geopolitical arena, but must invariably span the constructed cyber domain and the natural environment with its life supporting properties. At this point, we shall focus on cyberspace and the traditional geopolitical arena.

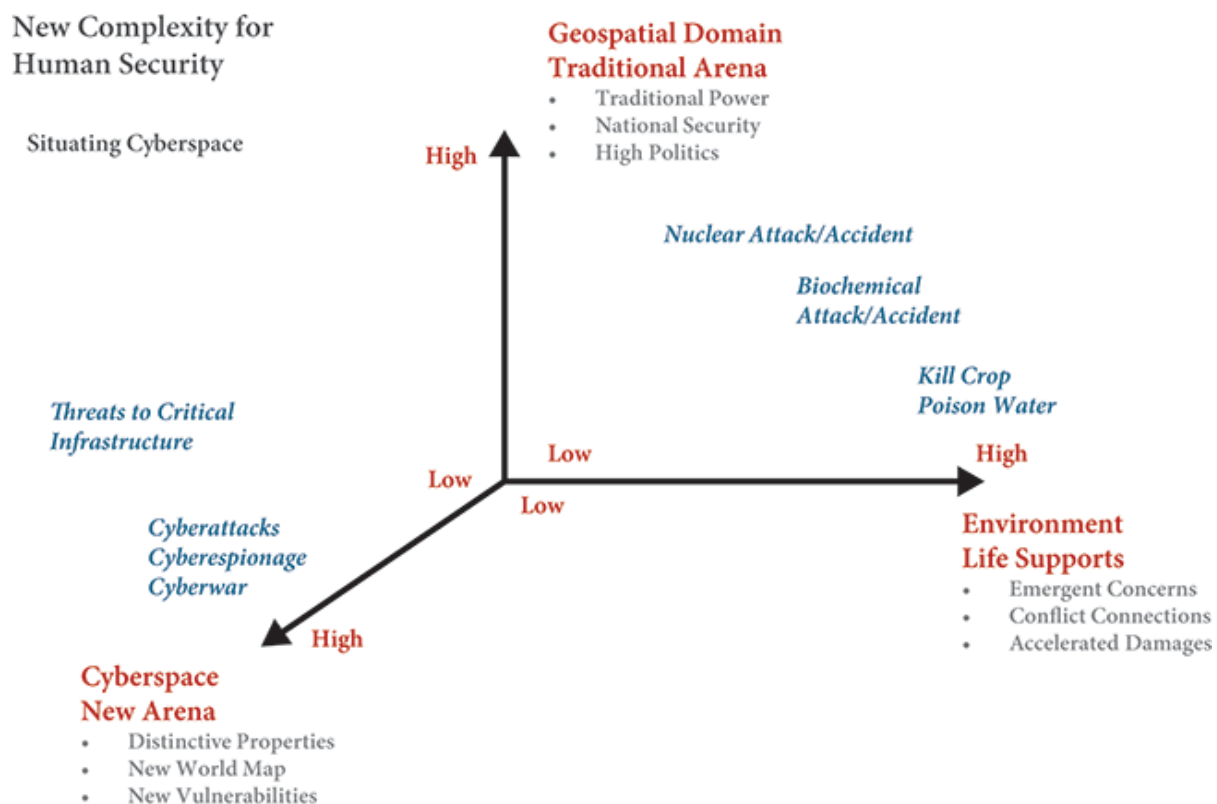


Figure 2. Dimensions of security and spillover effects.

Source: Choucri (2015).

Threats to cybersecurity is a new reality of the 21st century. The features of cyberspace itself may limit the portability of traditional notions of deterrence—the concept and the practice—that assume knowledge of the identity of the adversary. This is not always the case in cyberspace especially when actors seek to hide their identity. In short, the “new normal” is hardly consistent with the standard textbook of international politics, anchored in a system of states with known identities, endowed with a monopoly over the use of force, where force is defined in kinetic terms.

It may well be that changes in one domain—cyberspace or the international system—induce changes in the other. It is unlikely that any change can be attributed entirely to system-specific or to endogenous factors. It goes without saying that *rates of change* are foundational in any consideration of coevolution. This is taken for granted as we explore methods for measuring the implications of such differences. We neither anticipate nor hypothesize mirror-image dynamics across the physical and the cyber domain, nor can we even consider the possibility of identical adjustments over time. But temporal differences go a long way toward shaping the nature of leads and lags, feedback, and other critical features that shape systems at any point in time. The complexities at hand are exacerbated by *differences* in rates of change: cyberspace is evolving much faster than do the tools used by the state to regulate it. Also important is the nature of the coevolutionary drivers—in both the real and the cyber domain.

4.4 Dilemmas for Quantitative Theory

All of the previous material creates an overarching and inescapable challenge for the state, the state system, international relations, and the global system. The issue is how to manage the entire security complex, given the emergence of unprecedented forms of threat to security (i.e., cyber threats) that signal new vulnerabilities (i.e., undermining all forms of security) and—most vexing of all—those emanating from unknown sources (a feature that we refer to as the *attribution problem*). It inevitably reinforces the politicization of cyberspace and its salience in emergent policy discourses.

Of the many dilemmas for quantitative analysis of lateral pressure theory, three emerge as singularly powerful at this state of our investigations. The first pertains to empirical identification of *state profile* in the traditional international system as well as in the cyber arena, since we cannot assume a condition of profile congruence. The second is measuring propensity for expansion, that is, lateral pressure, in the real world and in cyberspace. And the third is about the matter of congruence for state profiles and for lateral pressure with respect to these two very different arenas of interactions.

We can now consider two questions central to investigations of lateral pressure and cyberspace. First, do state profiles in the cyber domain mirror those in the real domain? Second, is state propensity to extend its behavior in the cyber domain congruent with its propensity for expansion in the real domain? These questions require *metrics* for identifying state profile in traditional

international relations as well as cyberspace. These questions also require *measures* of the propensity for expansion in each of the traditional system as well as in cyberspace.

We now turn to the first question.

4.5 State Profiles—Real and Cyber

In lateral pressure theory, the master variables—*population*, *resource* and *technology*—constitute the basis for identifying the state profile and to calculate a state’s profile type. The concept of profile was first developed early on with respect to the real world, as defined in Table 1. But it was not entirely clear how to move from concept to measurement. Recognizing that at each point in time, a state is characterized by one set of “master variables” that define the empirical parameters of the polity and provide the basis for policy agenda as well (Choucri & North, 1987, pp. 205–208), it soon became evident that normalizing each master variable to a share of the global total for that variable provides a simple and replicable approach to understanding not only the position of an individual state, but to shifts in the global total for any variable. Accordingly, the normalization technique used is the fractional share of a state *s* in the global aggregate value of the indicator in year *t*.

Thus, we define the master variables as follows:

$$Master\ Variable_s^t = \frac{Indicator_s^t}{Indicator_{world}^t}$$

where

$Master\ Variable_s^t$ is the value of a master variable of state *s* at time *t*; and

$Indicator_s^t$ is the value of an individual indicator of a state *s* in year *t*;

$Indicator_{world}^t$ is the global aggregate value (the “world” total) of the indicator in year *t*.

In short, normalization allows the master variables to have the same order of magnitude and are independent of their units of measure. This step ensures that the profiles of different states are comparable and meaningful. Appendix 1 lists the indicators used for calculating master variables in cyber and real domain. Table 3 provides evidence to answer the first question. It shows states with *different* profiles in the real and the cyber arenas, and identifies, in each case, the profile group within which they belong. This is a long list compared to the states with *similar* profiles, real and cyber, in Appendix 2, that is, states that *retain* their profile type across the real and cyber arenas. Countries with missing data are listed in Appendix 3.

Table 3. Countries with Different Cyber and Real Profiles

Cyber State Profile Type					
Real profile type noted by roman numeral in parenthesis.					
R>P>T (I)	P>R>T (II)	P>T>R (III)	R>T>P (IV)	T>R>P (V)	T>P>R (VI)
Australia (IV)	Antigua and Barbuda ¹ (VI)	Kuwait (VI)	Italy (VI)	Austria (VI)	Latvia (IV)
Bangladesh (III)	Argentina (IV)	Swaziland (II)	Japan (VI)	Barbados ¹ (VI)	Mexico (III)
Benin (II)	Azerbaijan (III)		Macao SAR, China (VI)	Belgium (VI)	Norway (V)
Brazil (IV)	Bahamas (V)		Namibia (I)	Bermuda ¹ (VI ^b)	
Bulgaria (II)	Bahrain (VI)		Portugal (VI)	Canada (IV)	
Burkina Faso (II)	Belize (I)		Spain (VI)	Denmark (VI)	
Burundi (II)	Bhutan (I)		United States (V)	Estonia (IV)	
Cambodia (II)	Bolivia (I)			France (VI)	
China (III)	Brunei Darussalam (VI)			Germany (VI)	
Costa Rica (III)	Chile (IV)			Hong Kong SAR, China (VI)	
Cote d'Ivoire ¹ (II)	Colombia (I)			Iceland (IV)	
Croatia (VI)	Cyprus (VI)			Ireland (VI)	
El Salvador (III)	Djibouti (I)			Israel (VI)	

Cyber State Profile Type

Real profile type noted by roman numeral in parenthesis.

R>P>T (I)	P>R>T (II)	P>T>R (III)	R>T>P (IV)	T>R>P (V)	T>P>R (VI)
Ethiopia ² (II)	Dominica ¹ (III)			Luxembourg (VI)	
Ghana ¹ (II)	Dominican Republic (III)			Malta (VI)	
Greece (VI)	Fiji (I)			Mauritius (III)	
Grenada ¹ (III)	Guyana (I)			Netherlands (VI)	
Guatemala (II)	India (III)			Poland (VI)	
Honduras (II)	Jamaica (III)			Republic of Korea (VI)	
Indonesia (II)	Kazakhstan (IV)			Singapore (VI)	
Iraq ² (II)	Oman (IV)			Slovenia (VI)	
Lesotho (II)	Panama (V)			Switzerland (VI)	
Lithuania (V)	Paraguay (I)			Thailand (III)	
Malawi (II)	Peru (I)			United Kingdom (VI)	
Moldova (II)	Qatar (VI)				
Nepal (II)	Russian Federation (IV)				
New Zealand (V)	Saudi Arabia (IV)				

Cyber State Profile Type

Real profile type noted by roman numeral in parenthesis.

R>P>T (I)	P>R>T (II)	P>T>R (III)	R>T>P (IV)	T>R>P (V)	T>P>R (VI)
Romania (III)	South Africa (I)				
Rwanda (II)	South Sudan (I)				
Senegal (II)	St. Kitts and Nevis ¹ (VI)				
Serbia (II)	St. Lucia ¹ (III)				
Sierra Leone (II)	St. Vincent and the Grenadines ¹ (III)				
Sri Lanka (III)	Sudan (I)				
Tanzania (II)	Turkey (VI)				
Togo (II)	Tuvalu ¹ (III)				
Uruguay (IV)	Vanuatu (I)				
	Venezuela, RB ¹ (IV ^a)				
	Yemen, Rep. (I)				
	Zambia (I)				

Notes: Cyber state profile type is for 2014, unless indicated by a special identifier after the state name, as follows: ¹ 2013; ² 2012. Roman numerals in parentheses signal indicate real state profile for 2015, unless noted by special identifiers within parentheses, as follows: ^a 2014; ^b 2013.

Given the recent construction of the cyber domain and the absence of compelling precedents, the matter of metrics will remain with us for some time to come. We now turn to metrics and measure for lateral pressure.

4.6 Lateral Pressure in Real versus Cyber Domain

Recall that the empirical work for the five phases of lateral pressure research summarized above tends to view expansion in terms of *actual* behavior (rather than the *propensity* for expansion). The difference is nuanced, but important: Behavior metrics are recorded after the fact. They usually reflect capability as well as intent. While this is consistent with the theory, it bypasses the thorny problem of metricizing the *propensity* factor first, and only then of examining connections to actual behavior. It also prevents us from exploring the potential gap or *difference* between propensity and behavior—and the implications thereof.

More recently, we developed the Lateral Pressure Index to quantify the *propensity* for expansion and, to the extent possible, to highlight the relative salience of the individual drivers. After some experimental efforts, we framed the *LP Index* as a function of the geometric mean of the master variables:

We can now turn to a couple of additional questions explored in the sixth phase of lateral pressure investigations: Does the propensity to expand in the real domain similar or different to that in the cyber arena? Are the driving master variables similar or different?

We begin with the distribution of countries ranked by their real LP Index and identify their profile type, (defined in Table 1) as shown in Figure 3. Several results stand out: China ranks highest in the propensity of expansion in the real domain, followed by the United States, and then India. For China and India, as well as for Indonesia, Mexico, Nigeria, and others, the propensity for expansion is driven more by *population* than by resources or technology. It is perhaps to be expected that *technology* is dominant in shaping lateral pressure for the United States, as well as Japan, Germany, France, and others. And *resources* are the critical drivers of lateral pressure for Brazil, Russia, Canada, Australia, and Iran.

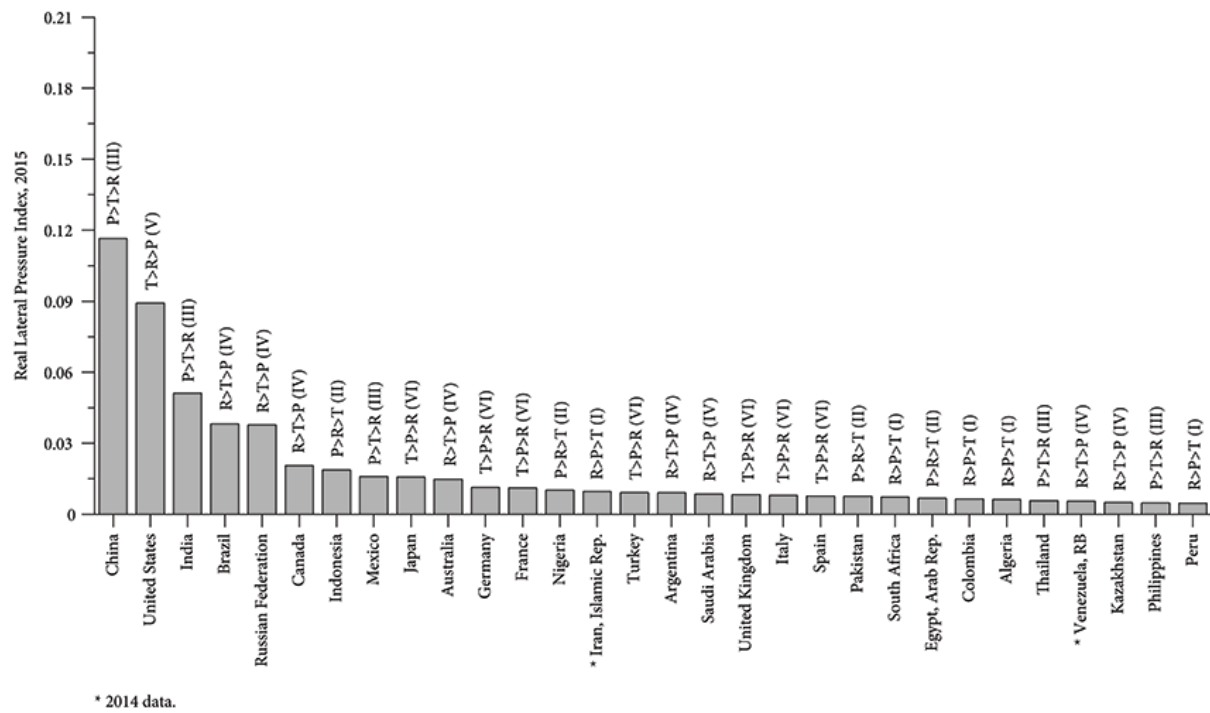


Figure 3. States ordered by real LP Index and identified by real profile type, 2015.

Extending the above, Figure 4 distributes countries across the six real profile types, defined earlier in Table 1.

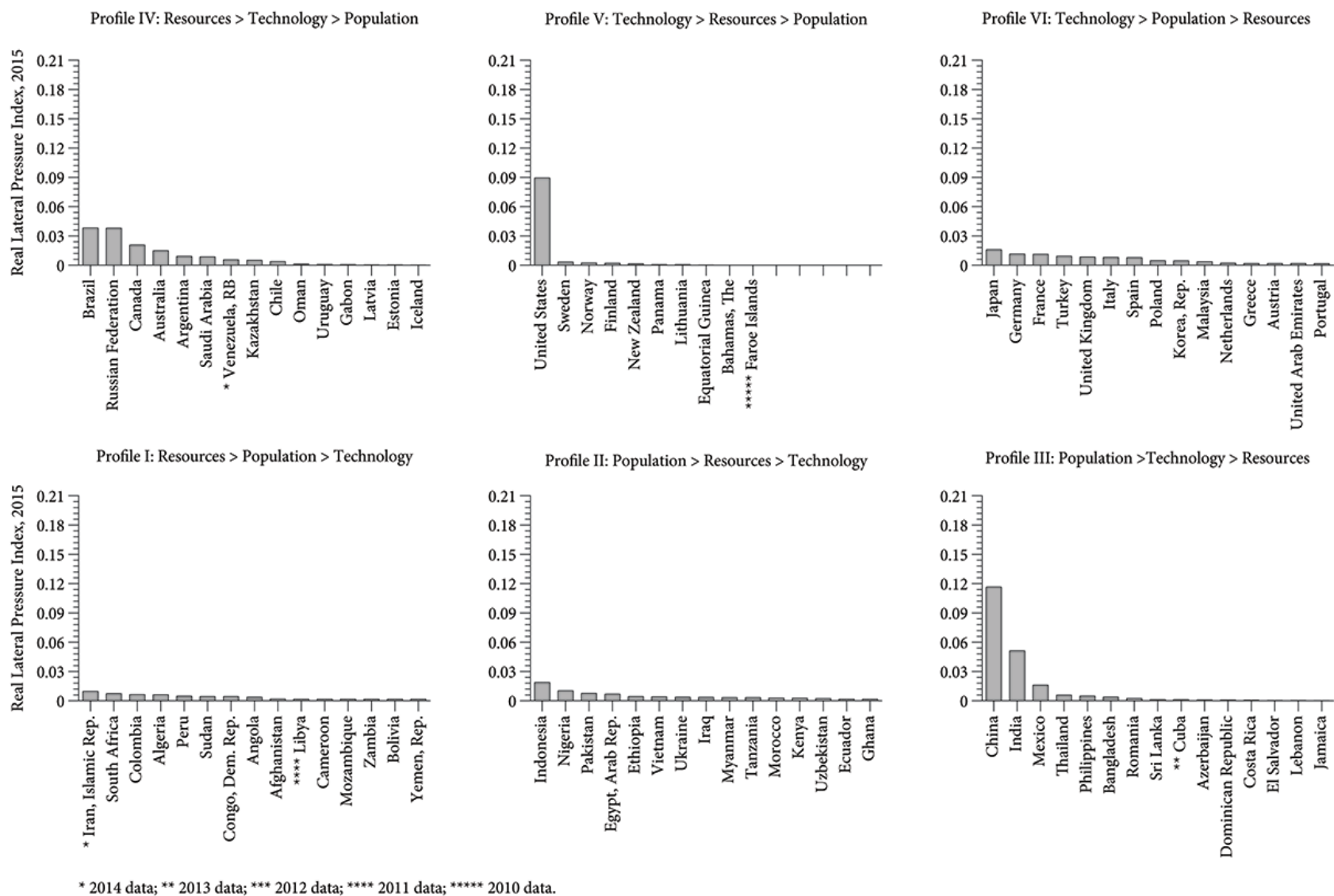


Figure 4. States ordered by real LP Index and real profile type, 2015.

Figure 5 displays the 30 countries with the highest propensity for expansion in cyberspace and identifies their cyber profile type.

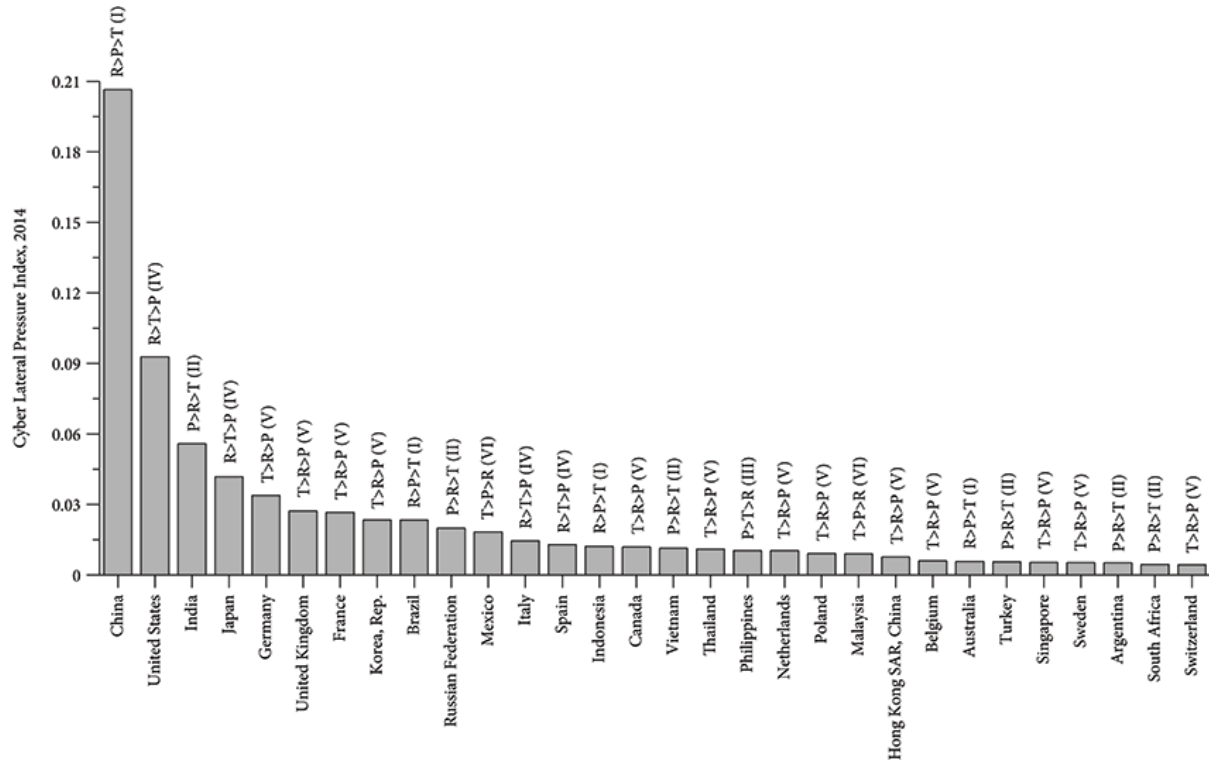


Figure 5. States ordered by cyber LP Index and identified by cyber profile type, 2014.

We now turn to Figure 6, which shows the top-ranking countries ordered by the LP Index within each of *cyber* profile groups. Note that, for China in cyber Profile I, resources are dominant relative to population and technology. In Profile II—for example, India and Russia—are driven by their respective online populations and, secondarily, by their access to cyber resources, and lastly by cyber technology. Online population also dominant for Profile III states as well (such as Philippines and Kuwait), with their cyber technology surpassing their access to cyber resources.

Briefly, Figure 6 shows that for the United States, as well as for Japan, and other countries in cyber Profile IV, resources dominate, compared to their share in global cyber technology related capabilities or online population. States in Profile V (Germany, United Kingdom, France, and notable others) have a greater share of global cyber technology related capabilities and cyber resources than their share of the global online population. Profile VI states, such as Malaysia and Mexico, are characterized by the salience of cyber technology, but their online populations are large relative to their cyber resources.

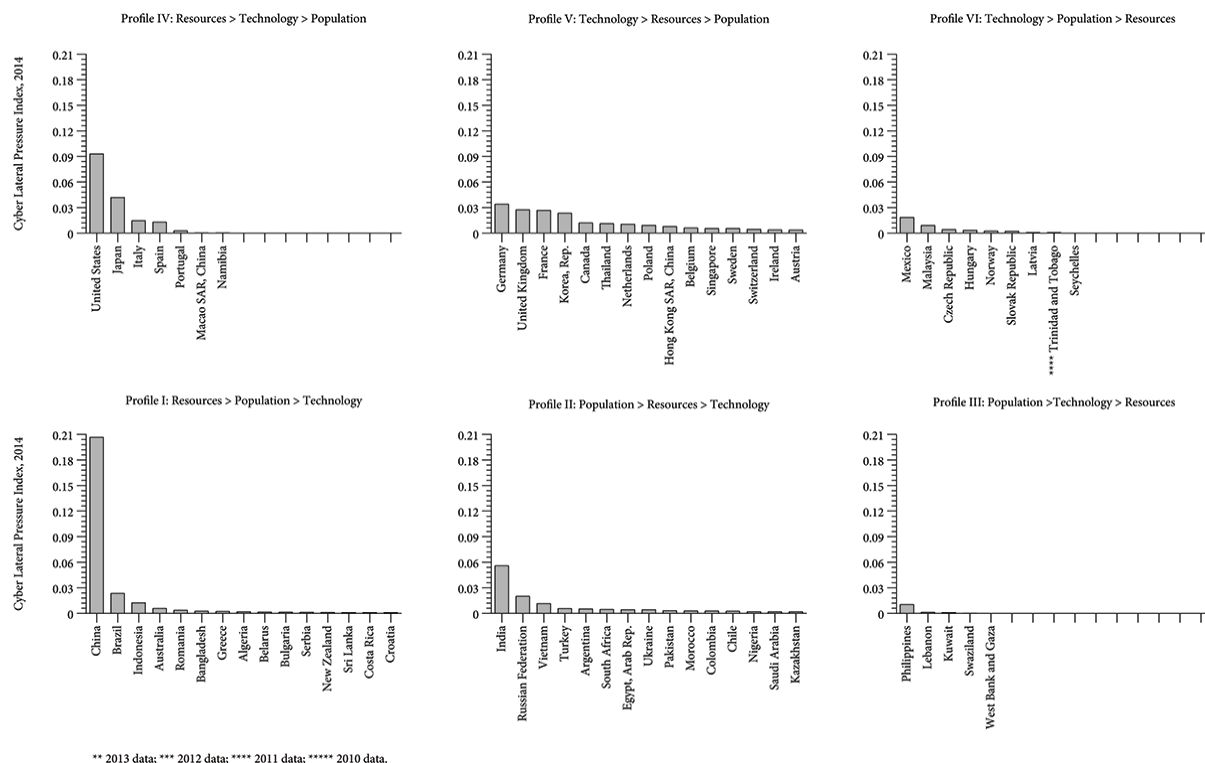


Figure 6. States ordered by cyber LP Index and cyber profile type, 2014.

We conclude this section with a high-level comparison of lateral pressure in the cyber versus the real arena and raise the following question: Is state propensity for expansion in the cyber domain congruent with propensity to expand in the real domain?

Figure 7 presents the logarithmic distribution of the LP Index for the traditional order and for cyberspace, and the inset shows the same in the original metrics. Clearly, the top rankings in lateral pressure, real and cyber, go to China, the United States, and India – in that order. The equality-line in Figure 7 signals similar propensity for expansion in the cyber and the real domains. States situated above the line are those with greater lateral pressure in cyberspace than in the traditional international arena. States below the equality line demonstrate more lateral pressure in the traditional mode than they do in cyberspace. A closer look enables added, more detailed, inferences pertaining to states and profile type.

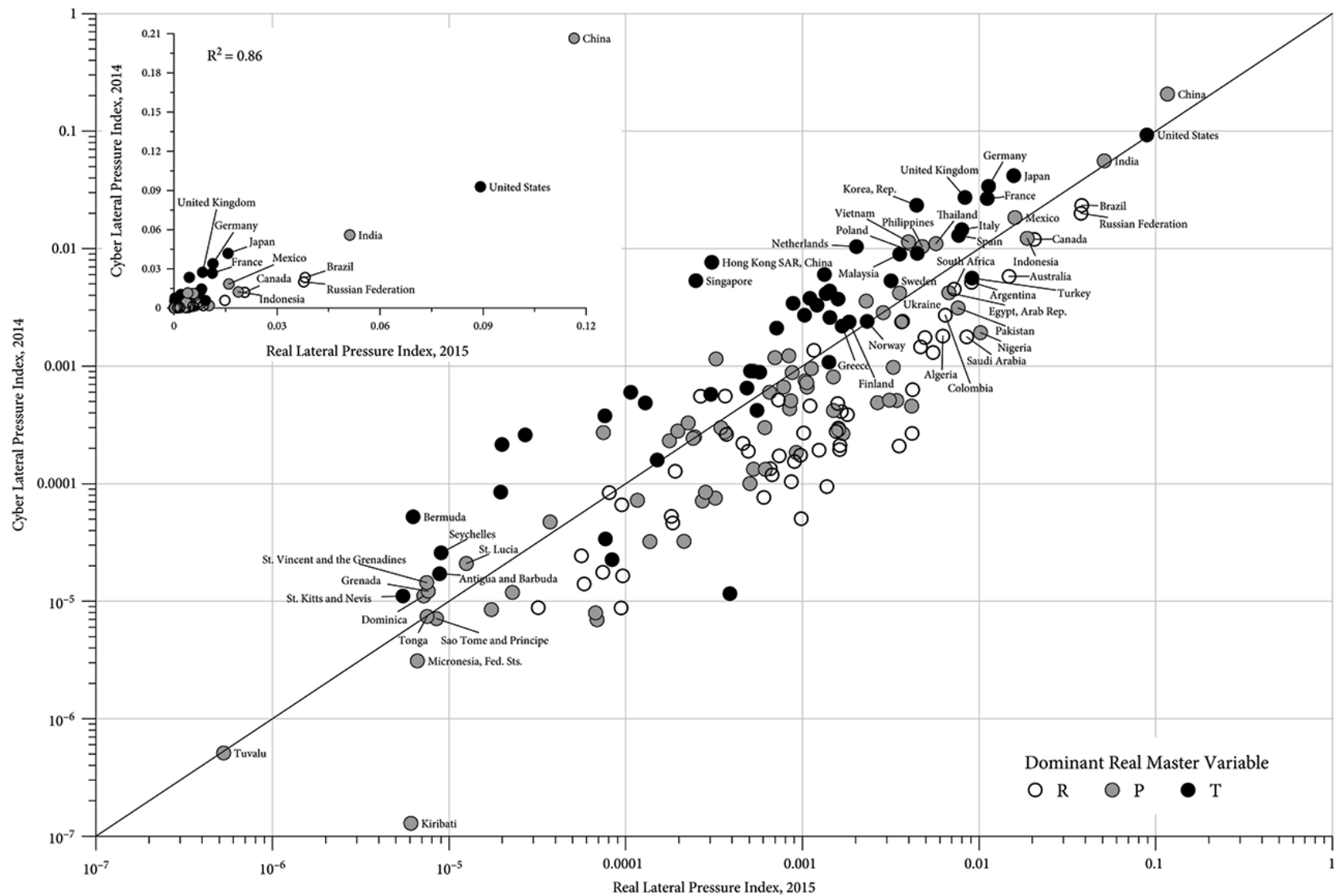


Figure 7. Lateral pressure in real vs. cyber domains.

States with *technology* dominance in real Profile V ($T > R > P$) and Profile VI ($T > P > R$)— such as the United States, Japan, Germany, United Kingdom, and France—are leaders in the cyber domain. By contrast, states with real *resource* dominance – such as South Africa and Colombia in Profile I ($R > P > T$) and Russia, Brazil, Canada, Saudi Arabia and Australia in Profile IV ($R > T > P$) show less propensity for cyber than for real expansion. The same holds for countries for real Profile II: ($P > R > T$) states whose *population* dominates, but resources are greater than technology, (as such as Indonesia, Nigeria, Pakistan, and Egypt. Profile III ($P > T > R$) countries, also with population dominance, but with technology greater than resources in real – such as China, India, Mexico, Thailand, and Philippines – exhibit greater lateral pressure in cyberspace than in the traditional world.

On balance, several patterns are noteworthy: First, many states demonstrate different profiles type in the real vs. cyber domain. Second, states also differ in the dominant master variable that is evident in their lateral pressure – real or cyber. Third, with notable exceptions, individual states also differ in the propensity to expand in the real vs. the cyber world. Fourth, it is perhaps to be expected that real technology is the salient factor for lateral pressure in cyberspace. Finally, while these observations are state-based, it is useful to signal some added inferences for the international system as a whole. For example, the cluster situated bottom left of the inset in Figure 7 situate states with limited, if any, lateral pressure – real or cyber. Concurrently, the correlation coefficient, also in the inset, points to more system-wide (or overall) convergence than divergence lateral pressure, real vs. cyber.

5 What Next for Lateral Pressure Theory?

It should come as no surprise that the next steps in lateral pressure theory and quantitative analysis must concentrate on connecting the dots, closing the loops, and addressing critical imperatives for the 21st century. Innovations in quantitative analysis may well follow this general trajectory, as we began to appreciate the implications of the constructed domain, the endogenization of the environment, the salience of sustainability, and, increasingly, the inevitable imperatives of cybersecurity. It also should not come as a surprise that each phase of empirical analysis explores different modes of analysis as we become more and more aware of the complexity inherent in the theory and in the underlying realities that it seeks to represent.

Major challenges for 21st century international relations theory and analysis, policy, and practice were embedded in Figure 2, showing the complexities of human security. This figure displays some notable spillover effects across the three domains. Generic in nature, the particular issues represented along the trajectories of the figure are all critical features of 21st century international relations. Partitioning and separating issues, identifying system boundaries, and avoiding unnecessary contamination effects in empirical investigations are all becoming more and more daunting.

The next challenge is to gain a better understanding of (a) the dynamics of lateral pressure within and across each of the three domains; (b) the ramifications for the international system as a whole, in terms of conflict and cooperation; (c) the internal civil and sovereign effects (if any) of lateral pressure and attendant consequences; (d) the impacts of, and for, state-firm interactions; and, to the extent possible, (e) the assessments of system sustainability at all four levels of analysis and across the three increasingly intertwined domains of interaction—the human system, cyberspace, and the natural environment.

Appendix 1

Table [A1](#) lists the indicators used for calculating the master variables for state profiles and LP Index in the real domain. By necessity, for the cyber domain we have used a different set of variables that reflect access to and participation in the cyber arena, as shown in the table.

Table A1. List of Variables Used for Real and Cyber State Profiles and LP Index

Master Variable	Real	Cyber
Population	Population, total	Internet Users
Resource	Surface area	Fixed-telephone subscriptions
		Mobile-cellular telephone subscriptions
		Fixed (wired)–broadband subscriptions
		Wireless-broadband subscriptions
Technology	Gross domestic product	ICT goods, exports

To standardize the lateral pressure methodology, consistency and convenience must be added to the process of data extraction and analysis. *World Development Indicators* (World Bank, [2017](#)) is the primary data source overall, and *World Telecommunication/ICT Indicators database* (ITU, [2017](#)) is the source for cyber resource data.

All the price variables used for calculating master variables are given in constant U.S. dollars. Normalization of the selected indicator ensures that the master variables are of the same order of magnitude and independent of their units of measure. This step provides confidence that the lateral pressure profiles of different states are comparable and meaningful.

Appendix 2

Table A2. Countries With Similar Profiles, Real and Cyber

R>P>T (I)	P>R>T (II)	P>T>R (III)	R>T>P (IV)	T>R>P (V)	T>P>R (VI)
Afghanistan	Albania	Lebanon		Finland	Czech Republic
Algeria	Armenia	Philippines		Sweden	Hungary
Angola	Bosnia and Herzegovina	West Bank and Gaza			Malaysia
Belarus	Cabo Verde				Seychelles
Botswana	Comoros ²				Slovak Republic
Cameroon ³	Ecuador				Trinidad and Tobago ³
Congo, Dem. Rep.	Egypt, Arab Rep.				
Georgia	Gambia ²				
Guinea ¹	Jordan				
Guinea-Bissau ¹	Kenya ¹				
Kyrgyz Republic	Kiribati ¹				
Madagascar ¹	Macedonia, FYR				
Mali	Micronesia, Fed. Sts.				

R>P>T (I)	P>R>T (II)	P>T>R (III)	R>T>P (IV)	T>R>P (V)	T>P>R (VI)
Mauritania ^(a)	Morocco				
Mongolia	Myanmar				
Montenegro	Nigeria				
Mozambique	Pakistan				
Nicaragua	Samoa				
Niger ^b	Sao Tome and Principe				
Papua New Guinea ^(a)	Tajikistan				
Solomon Islands	Timor-Leste ¹				
Suriname	Tonga ^b				
Zimbabwe	Tunisia				
	Uganda				
	Ukraine				
	Vietnam				

Notes: Cyber state profile is for 2014, unless indicated by a symbol after the state name, as follows: ¹ 2013; ² 2012; ³ 2011. Real state profile is from 2015, unless indicated by the letter (a) in parentheses, in which case it is for 2014.

Appendix 3

Due to missing data, state profile and LP Index in real domain are not available for the following countries: American Samoa; British Virgin Islands; Cayman Islands; Channel Islands; Curacao; Democratic People's Republic of Korea; French Polynesia; Gibraltar; Guam; New Caledonia; Northern Mariana Islands; San Marino; Sint Maarten (Dutch part); Somalia; St. Martin (French part); Syrian Arab Republic; Turks and Caicos Islands; and U.S. Virgin Islands.

By the same token, missing data prevent the construction of cyber state profile or cyber LP Index for the following: American Samoa; Andorra (VI ^b); Aruba (VI ^c); British Virgin Islands; Cayman Islands; Central African Republic (I); Chad (I); Channel Islands; Cuba (III ^b); Curacao; Democratic People's Republic of Korea; Equatorial Guinea (V); Eritrea (I ^d); Faroe Islands (V ^c); French Polynesia; Gabon (IV); Gibraltar; Greenland (IV ^c); Guam; Haiti (II); Islamic Republic of Iran (I ^a); Isle of Man (VI ^a); Kosovo (III); Lao People's Democratic Republic (I); Liberia (I); Libya (I ^d); Liechtenstein (VI ^c); Maldives (III); Marshall Islands (III); Monaco (VI ^c); Nauru (VI); New Caledonia; Northern Mariana Islands; Palau (IV); Puerto Rico (VI ^b); Republic of the Congo (I); San Marino; Sint Maarten (Dutch part); Somalia; St. Martin (French part); Syrian Arab Republic; Turkmenistan (I); Turks and Caicos Islands; United Arab Emirates (VI); U.S. Virgin Islands; and Uzbekistan (II).

Note: Roman numerals in parentheses indicates the real state profile for special identifier, unless noted by a symbol following the profile type within parentheses, as follows: ^a2014; ^b2013; ^c2011; and ^d2010.

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