Chapter 1

INTRODUCTION

INNOVATIONS in the production, deployment, and application of military power are crucial to international politics. Unfortunately, most assessments of the international security environment fail to incorporate either the relevance of military innovations or the importance of their spread. For example, in a thirty-year period, from 1850–80, the French Navy became the first to develop shell guns, and the first to deploy a steam-powered warship, an ironclad warship, a mechanically powered submarine, and a steel-hulled warship. These developments should have helped the French Navy gain superiority over its bitter rival, the British Royal Navy, but they did not. Moreover, barely a decade after the introduction of the steel-hulled warship in the 1870s, a new innovative school of naval theorists in the French Navy argued that the future of naval power lay with emerging technologies like torpedo boats and submarines, not the battleship. France was going to jump ahead once again. Yet despite this foresight and demonstrated initiative, most people generally do not consider France a great naval innovator of the period. Why is this? What advantages did it get from its introduction of a series of useful technologies into naval warfare?

The real answer is that the French Navy received no advantage. Unlike the U.S. Navy, whose mastery of the technology *and* organizational practices associated with carrier warfare provided it with a sustainable edge in naval power in the second half of the twentieth century, the French could not institutionalize their advantage. While the French excelled at inventing new technologies, crippling organizational debates prevented the integration of those technologies into French naval strategy. In each case, the French were the first to introduce a new naval warfare capability, while the British Admiralty appeared, in public, disinterested in French developments. Yet in each case the British, who had been carefully studying French advances in private, quickly adopted the new capabilities, improved on them, and used Great Britain's superior industrial production capabilities to eliminate France's ability to gain a relative power advantage from its inventions.

A prescient analysis in 1902 of submarine warfare by Herbert C. Fyfe, the "Sometime Librarian of the Royal Institution, London," includes an appendix on the French Navy that expresses French feelings on the matter:

> "We have seriously believed," says a writer in the *Journal de la Marine*, "that in all the great modifications that have been brought about in the

> construction of submarines is the result of the important changes which the last fifty years of the century have produced in the art of naval warfare. All these changes have been sought out, experimented upon, studied, and finally realized by France, who has also been the first to apply them. These results have established in a brilliant and incontestable manner the skill of our engineers; but our rivals have not only appropriated the results of our labours, but they have not been slow to place themselves on equal terms with us, and finally to excel us in the application of these discoveries. . . . We have been only the humble artisans working for them to establish their superiority." (Fyfe 1902, 281)

While France was the technological first mover in several cases, it failed to harness its advances into an actual war-fighting innovation in a way that increased France's relative naval power.[1] Instead, it was the British Royal Navy that came to exemplify naval power in the mid- to late nineteenth century as it entered an era of naval superiority.

The failure of the nineteenth-century French Navy to exploit its technological inventions in sea power yields two important lessons for a general understanding of military power and international relations. First, inventing technologies or even being the first to use them does not guarantee advantages in international politics. There is a big difference between the introduction of a technology on to the battlefield and the full integration of that technology into national strategy, including warfare and coercive diplomacy. It is the difference between the two, in fact, that often determines success or failure in international politics. It is the employment of technologies by organizations, rather than the technologies themselves, that most often makes the difference.

Second, in contrast to most prior work on military innovation, which has tended to focus on who innovates and why, it is the diffusion of a military innovation throughout the international system that most determines its influence on international politics. The study of military power is incomplete at best without a theoretically coherent understanding of how states respond to major military innovations, and how the pattern of their responses helps drive the rise and decline of nations as well as the patterns of warfare frequently analyzed by other scholars. By developing a theoretical framework that can bring together empirical topics like suicide bombing and carrier warfare that scholars have tended to study separately, this book presents a new, more efficient, way to think about approaching the diffusion of military power.

The introduction and spread of new means of generating military power, sometimes called major military innovations (MMIs), have played a critical role throughout history in determining the global balance of power along with

[1] This introductory section is based on both Fyfe's and Theodore Ropp's work on the French Navy (Fyfe 1902; Ropp 1987, 8–11, 42).

the timing and intensity of wars.[2] The infamous Mongol armies, with their mastery of the composite bow and a new form of cavalry strikes, toppled nations from China to those in the eastern part of Europe because of their leaps in technology and strategy. Hundreds of years later, the German debut of blitzkrieg warfare at the outbreak of World War II helped them rout French forces and consolidate control over Western Europe. But despite their significance in terms of driving change in international politics, the processes that govern the spread of innovations and their effects are little understood in the field of international relations. Several questions about military power remain unanswered: Is it best to be the first mover, to borrow a term from economics, and the first to figure out how to effectively employ new types of military power, like the Germans with blitzkrieg?[3] Or is it better to be a follower, learning from the leader, and trying to extend and improve the original ideas, like the Germans with all-big-gun battleships responding to British innovations? How do nonstate actors fit into this story? Insurgent and terrorist groups have to make decisions about military strategy just like nation-states. How do they decide whether or not to adopt new innovations in how they use force like suicide bombing?

This book addresses the broad puzzle of why some military innovations spread and influence international politics while others do not, or do so in very different ways. These patterns are explained with a theory of the spread of military power called adoption-capacity theory.

Nation-states have a number of possible strategic choices in the face of military innovations. These include adoption, offsetting or countering, forming alliances, and shifting toward neutrality, as noted in the preface. Adoption-capacity theory posits that for any given innovation, it is the interaction of the resource mobilization challenges and organizational changes required to adopt the new innovation, and the capacity of states to absorb these demands, that explains both the system-level distribution of responses and the choices of individual states.

As the cost per unit of the technological components of a military innovation increases and fewer commercial applications exist, the level of *financial intensity* required to adopt the innovation increases. The rate of adoption decreases and alternatives like forming alliances become more attractive. Similarly, if an innovation involves large-scale organizational changes in recruitment, training, and war-fighting doctrine, the innovation requires a high level of *organizational capital* for adoption, and fewer actors are likely to adopt it. Some states will have the necessary capacity and interests, while politics will prevent adoption by others. If capacity and interest are lacking, no matter how

[2] Chapter 2 discusses defining and operationalizing military innovations.

[3] As chapter 2 describes, in the blitzkrieg case, while the British were the first movers with regard to the technology, the Germans debuted the mature innovation.

intrinsically compelling a new innovation may seem, it will not diffuse throughout the system. Accurately measuring these variations in diffusion also more effectively explains shifts in the balance of power and warfare than traditional theories alone can do. While higher financial requirements generally mean that the adoption patterns will benefit preexisting wealthy and powerful states, higher organizational change requirements can handicap the wealthiest states and upset the balance of power toward newer and more nimble actors.

The question of how states deal with periods of uncertainty about military power is of special interest today. Significant global economic turmoil now accompanies ongoing debates about the future of warfare in the information age. International relations scholars have demonstrated that uncertainty about the current and future security environment can be a primary cause of conflict (Fearon 1994a; Powell 1999; Smith and Stam 2004). Sharp debates exist between those who believe that the United States should optimize its military for future counterinsurgency campaigns like Afghanistan and Iraq, and those who believe that the United States should focus instead on its conventional capabilities (Gentile 2008; Mazarr 2008; Nagl 2009). An important wild card for both perspectives is the role of the information age in international conflict.

The information age is popularly described as the application of information technology to enhance the productivity of businesses and government, increasing the ability of societies to rapidly create and disseminate large amounts of information anywhere around the globe in real time. The information age, like the Industrial Revolution before it, will eventually have a large-scale impact on warfare.

While some degree of change is likely inevitable, the details of that change and the consequences are still very much in the air. In particular, the United States currently appears to lead the globe in developing and integrating information age advances into its military forces. But software-heavy developments may come to dominate the information age, rather than expensive physical hardware. The declining cost of computing technology, Internet access, and devices like personal GPS units, along with the dual-use nature of many information age military technologies like precision-guided munitions, mean new capabilities may become available to an increasing number of countries over time. While the United States has led the way in utilizing information technology in its military operations, its lead is far from assured. Peter Singer (2009) has described the way that the robotics revolution will impact the future of warfare, contending that there are risks for the United States as well as potential benefits.

In that hypothetical case, the U.S. government's devotion to its tanks, bombers, and carriers could become an albatross that drags down the U.S. military, which might face organizational challenges in transforming itself, in favor of states that figure out new and better ways to organize their forces to take advantage of information age technologies. Countries like China and India could

end up leapfrogging a U.S. military that is increasingly focusing on irregular forms of warfare like those in Afghanistan and Iraq. Such an outcome is not on the immediate horizon and is far from inevitable, but it is a mistake to think that the United States is guaranteed to have the strongest conventional military forces in the world. These changes will also potentially empower nonstate actors attempting to find new ways to mobilize and fight against nation-states. Terrorist groups are already shifting the locus of their education, recruitment, and training operations to the "virtual" world of the Internet (Cronin 2006, 83–84; Hammes 2004, 198–99). The empowerment of nonstate actors means that a world of information warfare could substantially increase the capacity of terrorist groups and insurgents to deliver disruptive strikes on the major powers. Potential examples include taking down electricity grids or reprogramming satellites, which would further increase security challenges. While adoption-capacity theory cannot purport to provide exact answers, it can help us predict future trends and know the right questions to ask.

In sum, different military innovations spread throughout the international system differently, and the way they spread has a large effect on key issues in international politics like the balance of power and the probability, intensity, and length of wars. Understanding the spread of military power is therefore important not just for international relations theory but also for policy analysts interested in the future of global power and U.S. strategy as well.

Why the Spread of Military Power Matters

Military power is the measure of how states use organized violence on the battlefield or to coerce enemies. It represents the combination of the technology used to fight—"hardware" such as rifles, artillery, and bombers—and the organizational processes used to actually employ the hardware—"software" like recruiting and training. It is tempting, however, to view the spread of military power as simply the spread of military technology, the tools and devices used to prepare for or fight armed conflicts (Zarzecki 2002, 74).[4]

In contrast, in this book I am concerned with the spread and impact of changes in the character and conduct of warfare. While technological change often accompanies the innovations we remember in history, technology alone is rarely enough. Instead, building on work by Emily O. Goldman and others, it is the way militaries take raw technologies and use them that creates military force and influences diffusion patterns (Goldman and Eliason 2003a).

[4] This is also the starting point for most studies of arms races as well as arms imports and exports. The focus on quantitative measures of technology perhaps initially occurred simply because tanks and rifles are easier to count than methods of recruiting and training (Farrell 2005). For more on other theories of diffusion, see chapter 2.

My approach draws on evidence from the business world that shows studying technology alone is not enough to capture the essence of how innovations matter and what makes successful change more likely. For example, in the 1990s, Dell Computers pioneered a model of production that relied on made-to-order computers based on customer specifications, leading to lower inventories and overhead costs than its major competitors. This innovation in its organizational structure improved Dell's ability to integrate exogenous, or external, changes in personal computer technologies. When a technological change occurred, like the release of a new microprocessor from Intel, Dell could integrate it into its consumer production lines within a matter of days and without significant outdated warehouse stock; it generally took weeks for its competitors to do the same. This gave Dell an enormous advantage in its ability to deliver top-notch products to its customers, leading to more sales (Brynjolfsson and Hitt 2000, 29–30). While the technology mattered, since new microprocessors produced changes in computers in ways that altered costs and orders from customers, every computer company received the same chips from Intel. It was Dell's ability to integrate the new technology more efficiently than its competitors that produced its market advantage.

Another example of why both technological and organizational resources matter comes from survey data on business productivity. In 2001, the McKinsey Corporation and the London School of Economics surveyed over one hundred businesses that implemented technological changes, changes in managerial practices, or changes in both areas. The results showed the discontinuous impact of combining organizational and technological change. Businesses that implemented exclusively technological changes experienced a 2 percent increase in productivity, which paled in comparison to the 9 percent increase generated by exclusively managerial changes. Yet businesses that adopted both managerial and technological changes experienced 20 percent productivity increases, almost double the total from adding together technological and managerial change (Dorgan and Dowdy 2004, 13–15).[5] These results explain why companies like Dell succeeded in the 1990s and Apple has done so over the last decade.

Many international security researchers rely on measures of national power like iron and steel production, the numbers of troops or the defense budget of leading states, and their populations. The National Material Capabilities data gathered by the Correlates of War (COW) Project includes information on the military, industrial, and demographic capabilities of each state, which is summed into the Composite Index of National Capability (CINC).[6] CINC-based

[5] Despite many differences, military organizations share some key facets with firms, including the need to compete with other actors, the threat to survival from competitive failures, the development of bureaucracies to regulate and manage their operations, and the need to make strategic choices in response to changes in the external environment (Cronin and Crawford 1999; Waltz 1979).

[6] For more on CINC data and the COW Project, see Correlates of War 2 Project 2006; Singer 1987; Singer, Bremer, and Stuckey 1972.

research has become the standard way to measure power in international relations scholarship. The use of CINC data has produced a number of important insights into international politics, including evidence that materially stronger and wealthier states are more likely to win wars, all other things being equal, and that system power concentration is significantly related to militarized disputes (Bennett and Stam 2004).[7]

A growing body of literature in international relations, however, suggests that measuring military power and predicting military outcomes involve more than simply assessing the material resources states can bring to bear on the battlefield. Studies in recent years using more sophisticated quantitative models have built on some of the early research and shown that simpler models only relying on material power indicators do not reveal the full picture. For example, work by Dan Reiter and Allan Stam (2002) focuses on the political regimes of states, and how they influence battlefield outcomes.

Additionally, research by Stephen Biddle (2004, 21; 2007a, 218–20) demonstrates that material measures of international power are not in and of themselves enough to predict the outcomes of military campaigns. Biddle argues that force employment, or what militaries do with the equipment they have—the decisions they make about how to organize and deploy their resources—plays an important role in determining the military power of states (see also Stam 1996).

Materially strong states with weak force employment concepts sometimes lose, while materially weak states with strong force employment concepts sometimes win. For instance, despite having more ships, guns, and people, the Russian military lost badly to imperial Japan in the Russo-Japanese War. Another example of a sure loser according to conventional measures of military power is Israel, which confounded material indicators in a series of wars against numerically and materially superior Arab foes attacking from multiple sides. These cases show that core issues of international security cannot be explained without reference to much more than the number of people and specific technologies involved (Brooks 2007, 228).

Still, understanding the importance of both organizations and technology in producing military power is only the first step in appreciating the way military innovations influence international politics. The second part of the puzzle is the differences in the capacity of militaries to successfully adapt to changes produced by those innovations. New military innovations are not created equal when it comes to the ease of adoption. For example, the technological

[7] These systematic tests often navigated competing claims in the qualitative literature to help move intractable debates forward. The military dimension of both the Organski-Davies total output model and the Singer-Bremer-Stuckey national power model, for example, rely on military expenditures and personnel as the most important measures of military capabilities (Organski and Kugler 1980, 31; Singer, Bremer, and Stuckey 1972).

components of some innovations, like nuclear weapons, are extraordinarily expensive, especially for first movers and early adopters. In contrast, the unit costs of the technological components of some other innovations, like the rifle or machine gun, are relatively inexpensive. The organizational change requirements of innovations can also vary widely. Utilizing chemical weapons in World War I involved adding them into existing operational plans, not fundamentally changing the way militaries organized themselves. In contrast, adopting Napoleonic mass mobilization required an enormous shift in how militaries recruited and trained as well as the use of the division structure and the creation of skirmishers. It is these shifts in the financial and organizational requirements for adopting innovations—given the different capacities of military organizations—that produce varying implications for the international security environment (Gilpin 1981, 63).

Diffusion begins when a major military innovation reaches a critical "debut" or "demonstration" point. These terms, drawn from studies of business strategy, refer to the point when the relevant community has sufficient information to reasonably understand the significance of an innovation. While much of the time innovations debut through a demonstration during warfare, sometimes the revelation of a new capability during peacetime is enough to trigger a response, as when the British Navy introduced the *Dreadnought*.[8] This can vary depending on a variety of factors. The most critical of these is the extent and success of efforts by the first mover to shield knowledge of how the innovation works from potential adversaries or other states once it recognizes it has developed new military capabilities. Sometimes militaries do try to hide crucial elements of advances from the international community, as the Royal Navy did when it introduced the *Dreadnought* or the United States did with the Manhattan Project even after dropping two atomic bombs. At other times, an innovation debuts in a relatively transparent fashion, as it did when the United States and Japan both placed the aircraft carrier at the center of their fleets in the midst of World War II.[9] The debut point where diffusion starts varies from innovation to innovation.

Explaining the Spread of Military Power

Adoption-capacity theory combines research on the way both militaries and businesses change with new insights into the relative costs of new military

[8] The differences between introducing innovations in wartime or peacetime may be relevant as well.

[9] The question of shielding new military capabilities is related to Robert Axelrod's discussion (1979, 231–32) of when to debut new weapons in the first place. Whether or not the first mover can keep the innovation secret may be more or less possible depending on the domestic and international political environments.

systems to explain how military innovations spread once they have been introduced into the international system.[10] The basis of the theory is recognizing the adoption-capacity requirements of an innovation and how the capacities of individual states measure up.

Approaching the spread of military power from this perspective sidesteps the traditional debate about whether strategic competition, cultural factors, or norms best explains emulation and allows for the construction of a more powerful new theory. There are many reasons why states are interested in adopting innovations: strategic necessity, international norms, cultural openness, the need for interoperability with allies, and many others. Threats are a vital part of the matrix of factors that motivate nation-states. It is even possible that for the states that initiate military innovations, threats play an important role in their drive and capacity to innovate.[11] Prior research, though, has often presumed that for potential adopters, where there is a will to adopt, there will be a way (Elman 1999; Resende-Santos 2007). In the real world, states are sometimes overmatched no matter how well they optimize, and sometimes states do not adopt innovations even when they face large threats. Rather than viewing capabilities as totally fungible depending on state strategy, at least in the short- to medium-term it might be financial and organizational constraints that shape possible strategies as well as the probability of success.

Adoption-capacity theory argues that, once states have the necessary exposure to an innovation, the diffusion of military power is mostly governed by two factors: the level of financial intensity required to adopt a military innovation, and the amount of organizational capital required to adopt an innovation. As briefly introduced above, financial intensity refers to the investments required to purchase the physical hardware associated with an innovation, along with the relative ability of states to make those investments. Key to determining the level of financial intensity required for adoption is whether the relevant technology is exclusively military or has commercial applications, and the cost per unit of the physical hardware associated with the innovation, like a battleship or an aircraft carrier, in comparison with previous procurement. The more military oriented the technology and the higher the unit cost, the higher the financial intensity required for adoption.[12]

[10] The notion of relative costs here is complementary to measurements of military balances that incorporate the way new military advances can influence the relative cost of war (Anderton 1992; Powell 1999, 110–12, 197–98). James Fearon (1995a, 6–8) in particular explicitly recognizes the way that assumptions about rapid emulation have influenced offense-defense debates. Instead, in his view, what matters is the relative pacing of adoption.

[11] Barry Posen (1984, 1993) argues that threats drive the innovation process by determining whether civilian intervention occurs.

[12] This is related to research on capital intensity, but rather than focusing on the trade-offs between labor and capital, financial intensity is more about the way that capital is invested (Gartzke 2001).

The other half of the new theory is organizational capital, the intangible change assets needed by organizations to transform in the face of major military innovations. The study of organizations in general and military organizations in particular is hamstrung by the idiosyncrasies of individual militaries and the difficulties involved in parsing out exactly what determines their propensity to change. Though this will always be an issue, there are a variety of different ways to measure and evaluate the capacity of military organizations to change. Organizational capital is an imperfect but powerful way to conceptualize the potential change capacity of a military organization. Three factors in particular, measurable in military organizations prior to the demonstration of a given innovation, appear to best predict whether or not the organization will have the necessary capacity to adopt. First, the amount of resources devoted to experimentation is an indicator of the willingness and ability of organizations to consider major innovations. Second, as Mancur Olson (1982) contends in economics, older organizations often become bureaucratically ossified as subgroups of control proliferate, generating an increasing number of veto points that prevent innovations from being adopted. Therefore, the longer military organizations last without experiencing serious upheavals such as regime changes from within or defeats in interstate wars, the worse they should be at integrating innovations.[13]

Finally, the way that military organizations define their critical tasks plays a vital role in defining the range of the possible for those organizations (Wilson, 1989). The broader the definition of the organization and its purpose, the better it will be at adopting innovations. Al Qaeda's willingness to consider any and all operational methods for attacking the United States and its allies made it nimble enough to adopt suicide terrorism. Al Qaeda defined the means it would use to achieve its goals very broadly. In contrast, when an organization narrowly defines the optimal means to pursue its goals, the chances get higher that pushback from elites within the organization will prevent the adoption of innovations. A textbook case of how a limited view of the means to success can negatively influence an organization is the U.S. Army during the Vietnam War. The Vietnam era U.S. Army viewed using superior firepower as not just a means to an end but rather an end in itself; its ability to employ that firepower bled into how it measured success and failure. In 1965, the army even defined success based on the generation of enemy casualties.[14] This made it difficult for the army to master counterinsurgency operations requiring a lower emphasis on lethality (Krepinevich 1986, 5). The army instead preferred search-and-destroy

[13] There is no necessary correlation between organizational age and size. Nevertheless, older organizations are more likely to produce special types of bloated bureaucratic structures that make change difficult.

[14] It is even possible, based on Scott Gartner's work (1997), to argue that the focus on overwhelming firepower might have influenced the army's choice of body counts as its dominant indicator, or metric for success, during the Vietnam War.

missions where it could apply maximum firepower and generate the largest number of casualties (Gartner 1997, 130–31).

The speed and extent of an innovation's spread therefore depends on the relative financial and organizational requirements. Those requiring less to adopt will spread faster than those that require more. Adoption-capacity theory shows, however, that the levels of financial intensity and organizational capital required to adopt an innovation not only significantly influence the rate and extent of its spread throughout the international system but also drive its affect on international politics. Since it is generally easier to adopt the physical technologies associated with an innovation than the overall system of fighting, innovations featuring especially high levels of financial intensity are likely to spread, albeit slowly. In particular, financially intense innovations requiring organizational changes that sustain, rather than disrupt, previous critical tasks are likely to spread gradually but consistently, benefiting the preexisting strongest and wealthiest states in the international system. While preinnovation major powers lacking the financial capacity to adopt are likely to slip and become second-rate powers, the innovation is unlikely to reorient systemwide power balances. In contrast, innovations requiring disruptive organizational transformations but relatively reasonable financial investments, like blitzkrieg, the German combination of the radio, airplane, tank, and other motorized vehicles, will spread haltingly, with only a few states adopting the full innovation, and most acquiring some of its technical components but not adopting the new system of warfare. Innovations requiring large degrees of disruptive organizational change most clearly create strategic openings for power transitions and generate larger first-mover advantages. New powers that master the necessary organizational changes can gain an advantage over their potentially bigger though less nimble major power opponents.

Essentially, new major military innovations can create discontinuities in international politics, ushering in the risky situations described by Robert Powell (1999, 85, 199) where the actual balance of power sharply diverges from the distribution of benefits in the international system, because the system has not yet caught up to the new power realities. If a rising power develops a new innovation, it may gain an enormous edge in its drive to the top. In response, status quo powers that can quickly mimic and adapt to new military innovations or respond with their own new innovations have the best chance of limiting the disruptive impact of the innovation as well as maintaining their relative power level in the face of a challenge (Gilpin 1981, 60–61, 161–62). Sometimes, however, new major military innovations confront major powers, but for financial or organizational reasons they cannot adopt in the short- to medium-term. This presents a major power with a fundamental choice: continue posturing as if it is a major power, or recognize the writing on the wall and seek an alternative strategy that may involve making its interests subsidiary to those of another likely adopter. When states choose the former path, like the Austro-Hungarian

Empire did before World War I, it can destabilize the international system by accentuating informational gaps in national analyses of likely war outcomes. The resulting gap between beliefs and reality are a common cause of war because they make miscalculation and escalation more likely on all sides.[15]

Adoption-capacity theory is also useful for explaining the behavior of nonstate actors, as chapter 6 highlights. Like conventional militaries, insurgent and terrorist groups must make decisions about resource allocations and the organization of their forces. Financial intensity and organizational capital are useful metrics for understanding the strategic choices of terrorist groups in the suicide terrorism era. Those groups with critical tasks based in particular operational methods and that existed long before the beginning of the modern age of suicide terror faced substantial hurdles to adopting the innovation. The PIRA and ETA never adopted, for example, while it took Fatah, a key part of the Palestinian Liberation Organization (PLO), nearly twenty years to adopt. In contrast, groups with younger organizational ages and less defined critical tasks, from the broad tactical setup of the Tamil Tigers to the cell-based network of Al Qaeda, were more easily able to take advantage of suicide tactics, providing them with a new weapon.

Just as the tacit knowledge required to effectively operate aircraft carriers creates significant organizational obstacles for countries interested in adopting carrier warfare, the availability of instruction in suicide methods or direct geographic proximity to suicide terrorists has constituted a tacit barrier to entry for some terrorist groups. This is not to say that variables like national liberation movements, religion, and/or fighting for popular influence are not motivating factors for the adoption of suicide terrorism. Rather, adoption-capacity theory can explain both the groups that have adopted and why other groups do *not* adopt suicide terrorism—something prior work has rarely addressed. Prior theorizing on terrorist strategy, like that on military innovation, has tended to focus on what drives the interest of terrorist groups in suicide bombing, implicitly assuming that the desire to adopt suicide terrorism is enough to make it happen (Pape 2005). Applying adoption-capacity theory to the case of suicide bombing shows the web of interconnections between groups and the flaws in trying to predict terrorist group behavior without an understanding of the broader linkages between groups.

It is important not to overstate the scope of the theory. There are a variety of reasons why states are interested in innovations, why states adopt innovations, and why states become more or less powerful. Hopefully this book can make a contribution to ongoing debates in the academic and policy worlds about what types of changes are more or less likely to occur in periods of uncertainty about military power.

[15] This argument builds from work on bargaining, information, and war. In particular, see Fearon 1995b.

Importance for the Future of Warfare

While this book is mostly focused on the military innovations of the past, looking forward to the future is useful both as a demonstration of the theory and to show its relevance to ongoing policy debates. Adoption-capacity theory can help explain the way different types of warfare in the future will provoke different types of reactions on the part of responding actors, and benefit or disadvantage different states. This can help provide a framework for discussion by showing how the likely implications for the security environment depend on particular assumptions about the future.

At present, there is a spirited debate occurring around the world about the types of wars most likely in the future. In the United States, the debate about the utility of "network-centric warfare" has given way to one about whether the United States should focus its limited resources on institutionalizing the hard-earned counterinsurgency lessons of Afghanistan and Iraq, or refocus the U.S. military back toward conventional warfare (Boot 2006, 8–9; McMaster 2008, 25–28). Biddle maintains that there is not enough evidence to overturn the prominence of the "modern system" of warfare—the use of firepower, cover, and concealment to take and hold territory in conventional land engagements. Focusing on the dangers of allowing technology to dictate force structure, he states that the modern system is the "orthodox" approach to war, and that scholars and policymakers should be careful before embracing "heterodox" approaches (Biddle 2007b, 463–64). He also notes that many instances viewed as counterinsurgency campaigns, like Lebanon, have actually revolved around the application of conventional modern system principles (Biddle and Friedman 2008).

Thinking that the information age will make a difference in future warfare does not mean excluding the human element or skill on the battlefield. Nor should believing in the human element along with the importance of tactical proficiency or skill mean ignoring the way that the information revolution may shape the realm of the possible in warfare (Gray 2006). One popular and persuasive perspective, promoted most clearly by Frank Hoffman (2007), argues that the future of warfare will be "hybrid," demonstrating facets of both regular and irregular wars, but in an operating environment characterized by the information age.

If the information age, like the Industrial Revolution before it, is likely to have wide-reaching and complicated effects on society, determining its impact on the security environment matters whether the most probable future combat scenarios are potential U.S.-China scenarios in East Asia, land-heavy wars in the Middle East, or quasi–peace enforcement operations around the globe. It is possible that the most likely wars of the future are irregular campaigns featuring land forces, but that there are also significant possible contingencies involving the heavy use of naval and air forces. The impact of the information

age on each of these might be different, just as it might be different for states and nonstate actors.[16]

The U.S. military struggled during the early part of the last decade learning how to fight against insurgents in Afghanistan and Iraq. Yet many who think about the future of military power argue that at the very least, the U.S. military will indefinitely maintain and deepen its conventional military superiority (Brooks and Wohlforth 2008, 27–35; O'Hanlon 2000, 168–69). Acclamatory statements that the U.S. military has already mastered the information age are surely overstated; the United States leads the world in the application of information technology to its military operations, but U.S. military operations over the last decade suggest that the United States has far from mastered the information age. There are several areas where disruptive changes could influence the trajectory of warfare.

At present, the U.S. military has made great strides in precision warfare—the use of new communications and guidance technologies to hit targets more accurately as well as at greater distances than ever before. These capabilities are cited by both counterinsurgency and conventional war advocates as important for the future, although there are disagreements about their relative effectiveness at present. Whether or not these advances are properly categorized as an MMI is a matter of debate. But the initial demonstration of U.S. precision-guided munitions in the Gulf War may have represented the starting point of the ticking innovation clock, like the debut of aircraft carriers by the Royal Navy and/or the introduction of the tank by the Royal Army in World War I, rather than representing a completed, fully functional MMI (Welch 1999, 122). Linear advances in precision warfare up to this point have extended the edge of the U.S. military at conventional operations. Utilizing the innovation requires expensive platforms like bombers and ships, meaning there is a high level of financial intensity required to adopt. Conducting counterinsurgency operations has proven challenging for the U.S. military, however, due to the large-scale organizational challenge of shifting the armed services away from focusing on overwhelming firepower.

Precision warfare, under most foreseeable circumstances, will initially remain costly even as the reliance on major weapons platforms like bombers decreases. The financial intensity required to implement anything like what the U.S. military does today is so high that even a small decrease in unit costs will not allow many more states to actively seek military dominance. Moreover, as long as the

[16] While critics of network-centric warfare, like Frederick Kagan (2006, 389–90), and scholars studying warfare in the information age, such as Peter Dombrowski and Eugene Gholz (2006, 4–6), are certainly right that the information revolution will not necessarily lead to one particular optimal force structure outcome, that doesn't mean the changes wrought by the information age are irrelevant or that the information age is unlikely to matter at all.

core platforms for using precision warfare are linked to the platforms of today, recruiting, training, and organizing modern militaries will look similar.

Advances in areas like robotics and information technologies such as computing could shift the military power status quo, though. If advances in munitions and especially unmanned vehicles begin to make the expensive launching platforms that sit at the core of the U.S. military irrelevant, it could risk large-scale changes in military power balances. If a cargo ship or cargo plane is suddenly just as good for launching a missile at a target as an F-15, the financial intensity requirements for implementation will drop and the organizational capital requirements will increase.[17] In such a situation, militaries may also have to recruit differently—recruiting unmanned aerial vehicle (UAV) pilots who excel at video games instead of "fighter jocks," for example—and train people to conduct different tasks, since they will be operating mostly with joysticks rather than in actual battle spaces with the enemy.

If rising U.S. military capabilities illustrate a path away from the financially intense platforms that currently help ensure U.S. dominance, while also requiring militaries to organize themselves differently to best take advantage of available capabilities, countries such as China and India could find it increasingly possible and attractive to militarily compete with the United States. This low level of financial intensity and high level of organizational capital required to take advantage of the information age in the area of conventional war would then lower the barriers to entry for potential competitors to the U.S. military. Other states in the international system could then acquire the necessary capabilities to begin effectively reducing the military edge of the United States unless the country continues innovating to stay ahead. Possible areas for development include not only robotics, with UAVs as the most obvious manifestation, but cyberwarfare as well. The resulting situation could cause major shifts in the global balance of power as some states benefit and others, unable to implement, are increasingly left behind. Adoption-capacity theory principles help explain the microfoundations underlying the concern by authors like Max Boot (2006) and Singer (2009) about the way the information age could boomerang, allowing other countries to catch up to the United States in the long run.[18]

Just as it will influence warfare between states, the information age is likely to influence the trajectory of actions by nonstate actors. The commercial spread

[17] This could occur because of increases in range and the miniaturization of tasks currently conducted by support planes like the Airborne Early Warning and Control System into next-generation missiles.

[18] This is true whether one wishes to call this sort of development the second stage of precision warfare or something as yet undetermined but related to the combination of materials, information technology, and communications (Kagan 2006, 395).

of Internet access around the world along with the low unit cost of basic computers and laptops mean that any nonstate group with a minimal level of financial support can establish a Web presence that is useful for coordination, communications, and planning (Arquilla and Ronfeldt 2001).

Given that information age innovations are likely to feature low required levels of financial intensity for adoption, it may open the door to the acquisition of key components by nonstate actors as well. Cheaper and more widely available information age technologies could lower the barriers for groups seeking to challenge state authority, meaning it will become increasingly easy for new groups to spring up in virtual environments and to exchange information across borders (Hammes 2004, 207–9, 218). A proliferation of potential target points could foreshadow more dangerous cyberattacks against everything from the control systems at a power plant to the Department of Defense mainframe to Google. Groups will probably form faster, conduct operations, and potentially disappear, only to pop up again in another guise in another "virtual" place—or even another real place.

Again, these predictions are tentative. The information age may end up mattering quite a bit for some types of warfare, but much less for others. The point is that the debate should be about exploring the multiplicity of ways that periods like the information age may shape many different dimensions of warfare. Adoption-capacity theory is a useful tool to help explain the different outcomes likely in different security environments.

Moving Forward

Chapter 2, which follows, lays out what "counts" as a major military innovation and the theory of diffusion briefly explained above. This theoretical argument concludes with a discussion of the cases selected for analysis: British naval innovations in the late nineteenth and early twentieth century, carrier warfare, the advent of nuclear weapons, and suicide bombing. Chapters on each case follow the theoretical chapter. Two of the chapters—the ones on nuclear weapons (chapter 4) and suicide terrorism (chapter 6)—feature quantitative tests, while two—ones on carrier (chapter 3) and battlefleet (chapter 5) warfare—include more qualitative analysis featuring the use of both primary and secondary sources. Each empirical chapter concludes with an examination of the way that the given major military innovation under examination influenced the international security environment, focusing in particular on power balances, the probability/duration of wars, and alliance patterns. The importance of the variables identified by the new theory are compared with explanatory mechanisms from alternatives described in chapter 2.

I test adoption-capacity theory through a multimethod approach to make the overall results more reliable. Additionally, by using rigorous social scientific

methods to study a topic of substantive interest to both academics and policymakers, this study attempts to cross disciplinary lines, and integrate theory and practice (George 1993; Goldman and Eliason 2003b, 22–23).

The conclusion (chapter 7) discusses the implications for scholarly analyses of international relations, and then evaluates claims about the onset of the information age and the ways it may influence the future of warfare. The conclusion describes some crucial issues that are often absent in debates about the future of American defense strategy, and how adoption-capacity theory suggests that the information age may portend a much greater level of risk for U.S. conventional military superiority than some previous authors have envisioned.

Chapter 2

A THEORY OF THE DIFFUSION OF MILITARY POWER

War is a harsh teacher, Thucydides tells us. We either learn from others who are better at fighting than we are or we die. Yet there are puzzles. France knew after World War I that Germany remained economically and demographically stronger than France. Knowledge of the emergence of blitzkrieg warfare in Germany was available. In the 1930s, however, the French Army planned for the same kind of slow, methodical, defensive war that World War I had taught, even though the logic of its alliance system called for an offensive against Germany in the event of a German attack on Poland. Why? Egypt suffered a massive defeat in 1956 at the hands of the Israelis. It received massive financial and military technological assistance from the Soviet Union. It had every incentive to beat the Israelis at their own game, and the material means to do so. But it suffered a massive defeat again in 1967, for exactly the same reasons. France and Egypt should have learned from those countries that most threatened them, yet they did not. Why?

Scholars interested in military power have devoted serious attention to the question of how states try to gain advantages over other states through the creation of new ways of generating military power, also called military innovations. Barry Posen (1984) and Stephen P. Rosen (1991) have theorized about the conditions in which militaries are most likely to innovate, disagreeing about whether innovations happen as the result of pressure from actors outside military organizations, military mavericks within the system, or changing promotion patterns that empower those with innovative ideas.[1] This prior theorizing about military innovations in international politics, though, relies on clear implicit ideas about the way military power diffuses. By making those ideas explicit and engaging in empirical testing to determine which of them more accurately depicts world politics, this book explains how change in the international security environment occurs, advancing our understanding of military innovations beyond the first stage of the innovation life cycle.

Since we care about military innovations because of their consequences for international politics, it is necessary to focus on what happens *after* the initial innovation is demonstrated, not just on the innovation process. For example, blitzkrieg is more than an interesting historical footnote precisely because

[1] For a recent review article, see Grissom 2006. For examples of some key works on military innovation, see Avant 1994; Evangelista 1988; Kier 1997; Mahnken 2002; Pierce 2004; Posen 1984; Rosen 1991; Sapolsky 1972; Zisk 1993.

Germany used it to invade France and France proved unable to effectively respond. It is in the way states respond to innovations, the mechanisms governing the diffusion of military power, that the importance, or lack thereof, of innovations for international politics emerges.

Diffusion and Military Innovation

What Is Diffusion?

The spread of military power works by means of a phenomenon known in many fields as diffusion. The defining text on diffusion research in the social sciences, *Diffusion of Innovations* by Everett Rogers (2003, 11), describes diffusion as "the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system." Critical to diffusion research is the pattern by which successful innovations generally spread throughout a population. Perceptions that an innovation is effective create the framework within which diffusion does or does not occur, meaning there is inevitably some linkage between innovation and diffusion. Normal innovations often diffuse in the shape of an S curve—an insight applicable across a wide variety of disciplines and areas, including agriculture, consumer products, public policy adoption, and military technology.[2] There are three essential stages of diffusion for "normal" products after a triggering event or debut. In the first stage, diffusion is slow as risk-acceptant actors, or early adopters, implement the innovation. In the second stage, once diffusion has reached a critical mass (analogous to a tipping point in game theory literature), the rate of diffusion speeds up and most of the set of actors with the ability to implement the innovation will do so. These are known as main adopters. In the third stage, laggards, or later adopters, implement the innovation. The total number of adopters, or percentage of adopters out of the pool of potential adopters, graphed over time, is known as a cumulative adopter distribution.

Innovations also often mutate as they spread and adopters alter them to the contours of their particular situation. For example, Geoffrey Herrera and Thomas Mahnken (2003, 242) show how, in the pattern of responses to Napoleonic warfare and Prussian open-order tactics in the nineteenth century, countries tended to adopt some key components of the innovations but not others, and modify the innovation depending on their requirements.

Studies of when the diffusion of ideas is more or less likely have also grown in recent decades, but the notion that there are interactions between domestic organizations and developments abroad is well established in the social sciences.

[2] Paul David's work on diffusion in the field of economics has also been significant. See, for example, David 1986.

Scholars ranging from Alexander Gerschenkron (1962), who wrote about competition and industrial development, to Peter Gourevitch (1978), with his argument about the way international politics conditions domestic economic decisions, have demonstrated the important connections between new practices abroad and decisions made at home. This research also shows the significance of developing theories that take into account the possibility that not all diffusion is efficient: some individual actors may not benefit from adoption, and some innovations are not relative improvements.[3]

Research in political science and related fields on diffusion has included work on domestic policy innovations (Berry and Berry 1990; Walker 1969), social policies (Mintrom and Vergari 1998), tort reform (Canon and Baum 1981), and tax policy (Berry and Berry 1992). Internationally, Beth Simmons and Zachary Elkins (2004) have studied the diffusion of financial policy, while others have looked at network effects in post-Communist states (Kopstein and Reilly 2000), Latin American social sector reform (Weyland 2004), international environmental regulations (Busch and Jörgens 2005), elections (Blais and Massicotte 1997), the impact of foreign direct investment on the spread of technology (Borensztein, De Gregorio, and Lee 1998), market-based infrastructure reforms (Henisz, Zelner, and Guillén 2005), gender mainstreaming (True and Mintrom 2001), and the spread of democracy (Cederman and Gleditsch 2004; Ward and Gleditsch 1998), among other topics.

Within the area of international conflict, some scholars have modeled the spread of warfare as a contagion process, drawing on theories from epidemiology (Simowitz 1998; Siverson and Starr 1991; Starr and Siverson 1998). Other studies of war and diffusion have included region-specific studies of Africa and Latin America as well as more general studies of the spread of coercive practices in international disputes (Bremer 1982; Hammarstrom 1994; Starr and Most 1983).

Studying the Diffusion of Military Power

Much of the existing research on the spread of military power comes from those who contend that strategic competition drives the diffusion process, states act primarily to maximize their own external security, and the most important determinant of behavior is the international environment. Applying his general insights on isomorphism, or convergence over time, to military technology, Kenneth Waltz (1979, 127) writes, "Competition produces a tendency toward

[3] David Strang and others have written about a wide variety of topics ranging from the spread of decolonization movements to the spread of poison pills in the corporate world to the student shantytown movement in the campaign for divestment from South Africa (Soule 1999; Strang 1991; Strang and Meyer 1993; Strang and Soule 1998).

the sameness of the competitors . . . [a]nd so the weapons of major contenders, and even their strategies, begin to look the same all over the world." Posen's work (1993) on the Prussian response to mass mobilization and João Resende-Santos's study (2007) of South American militaries of the late nineteenth and early twentieth centuries similarly show the way security challenges drive interest in adopting innovations.[4] Colin Elman (1999, 55–57) maintains that while security maximization can take the form of much more than just adopting an innovation, meaning Waltz's predicted isomorphism is unlikely to occur, the security environment plays a primary role in influencing state choices.[5]

Others evaluate the way that norms derived from "world culture," rather than competitive pressure, influence how states emulate (Farrell 2005, 451–52) or argue that the cultural tolerance of foreign ideas in general predicts the successful adoption of innovations (Goldman 2006, 70; Pollack 2002).[6] Research on the relationship between domestic politics, organizational factors, and military innovation has also played a central role in describing how militaries make decisions (Avant 1994; Evangelista 1988; Goldman and Eliason 2003a; Mahnken 2002; Zisk 1993).

This book attempts to use prior theorizing as a building block to explain how, given the distribution of geopolitical interests and national attributes, the financial and organizational requirements for adopting an innovation determine how it spreads. Prior research has generally addressed one piece of the diffusion puzzle at a time. In contrast, I take the existing literature as a jumping-off point to build a more cohesive theory that describes how innovations diffuse, how states respond to innovations, and how those patterns impact international politics. The question that mostly occupies the previous literature is what makes countries interested in responding to innovations, while the key question examined in this book is what determines the way these innovations end up spreading in general and actually influence the international security environment.[7] Adoption-capacity theory makes clear the distinction between interest in responding to an innovation and the substance of that response.[8]

[4] While some argue that studying emulation differs from studying diffusion because diffusion is descriptive while emulation is about the learning process (Resende-Santos 2007), in reality studying diffusion means evaluating the process by which an idea spreads, and emulation is one way that can occur—as a subset of diffusion.

[5] For an assessment of how strategic competition can influence the innovation process, as opposed to the diffusion process, see Goldman 2007.

[6] Theo Farrell's incredibly detailed work (2005, 470) on the Irish Army and its doctrinal choices after independence is an excellent example of the way that norms can sometimes influence the content of military strategy.

[7] For an exception, see Goldman's work (2003) on the development of carrier warfare, which recognizes the importance of capacity.

[8] The distinction between attempting to implement an innovation and actually doing so has been pointed out in the context of the difference between civilians ordering military reforms and militaries actually implementing them (Elman 1999, 39; Zisk 1993, 5).

Second, instead of focusing solely on whether or not states adopt innovations, adoption-capacity theory makes predictions about all the possible responses for a given state, only one of which is adoption. It also shows the limits to the assumption made by scholars like Resende-Santos about the preferability of emulation. Third, adoption-capacity theory uses the same theoretical premises to make predictions about how states will respond to innovations, the system-level distribution of responses, and the effect on international politics. Linking together how states respond to innovations and the consequences of those responses allows for broader insights into international politics. I return to the prior literature again below to look at the distinction between adoption-capacity theory and previous research.

Military Power and Major Military Innovations

Defining Major Military Innovations

When the production of military power changes, meaning the character and conduct of warfare change in some measurable way, it is called a military innovation; the bigger the change, the bigger the innovation. MMIs are defined for the purposes of this book as major changes in the conduct of warfare, relevant to leading military organizations, designed to increase the efficiency with which capabilities are converted to power.[9] They are sometimes, but not always, closely related to changes in the technology used by military organizations. This book is concerned with new ways that military organizations generate power—and respond to innovations in the production of military power—not simply technological inventions.[10]

Given the possibility for misunderstandings about terminology that seem endemic to discussions of military innovations, some clarification is necessary. The "conduct of warfare, relevant to leading military organizations" refers to the way that leading states, sometimes called major or great powers, organize their militaries and plan to fight wars. The notion of changing the character of warfare refers to shifts in the core competencies of military organizations, or

[9] Where scholars most often disagree is about which shifts in military power should count as innovations. The definitional distinction between innovations being designed to help states get ahead and actually helping states get ahead is crucial (Gray 2002; Krepinevich 1994).

[10] This move is similar to the one made by Robert Gilpin (1981, 60). Approaching the question of shifts in power from the perspective of the diffusion of innovations also moves beyond the offense-defense balance paradigm, which makes sense since it is the relative balance of forces and beliefs about battles that influences behavior in militarized situations, not something inherent about particular technologies. Also, the offense-defense balance literature underplays the role of politics in determining behavior (Lieber 2005).

shifts in the tasks that the average soldiers perform.[11] Including "designed to increase the efficiency with which capabilities are converted to power" in the definition expresses the idea that all innovations are not the same and all are not successful. While the goal of major military innovations is to produce increases in military capabilities, whether that occurs is independent of the definition. This distinction is necessary to avoid tautology in the definition and measurement of the object of interest, the military innovation, and dependent variables like power balances and war.

How Major Military Innovations Emerge

Once we have determined what a military innovation is, we can move on to analyzing the way they debut in the international system and subsequently diffuse. Studies of the diffusion of consumer durables in the business world show that an incubation period often occurs between when new products enter the commercial market and when the product matures and sales take off. For example, the data on the spread of color televisions and compact disc players shows a large gap between the initial development of each product and when sales increased in the broader population (Golder and Tellis 1997, 257; Mahajan, Muller, and Bass 1990, 3).[12] The idea of an incubation period also makes sense in the military context, helping to distinguish between technological invention and a military innovation, because the specific technical capabilities that represent the public face of a military innovation are often introduced years, if not decades, before militaries develop them further and figure out how to use them to produce military power differently. In the case of the tank, for example, the technology was first used by the British at the Battle of Cambrai in 1917, but the mature innovation, which included the tank as well as a series of other technologies like radios and air power, did not debut until the use of blitzkrieg by the German military in World War II (Welch 1999, 122). In the intervening incubation period, the Germans were able to determine how best to utilize the new technology and reform their operational concepts to implement combined arms warfare.[13]

[11] This does not exclude the possibility that other actors might innovate. It is just to point out that an innovation reaches critical mass in a social system when key actors are forced to adapt in one way or another. The innovation well could come from below.

[12] Rajeev Kohli, Donald Lehmann, and Jae Pae (1999, 138, 141–42) speculate that the incubation period may function differently for discontinuous versus continuous product innovations.

[13] Prominent historian Ernest May finds Germany's success particularly impressive in comparison with France's failure. He describes France's military organization as "sclerotic" and unable to take advantage of an edge in the numbers of troops and tanks on the western front in 1940 due to massive intelligence failures by the Allies (May 2000, 10, 451–52). May's work also shows that simple measurements of forces on the battlefield like troop counts or the counts of particular technologies

Separating the incubation period from the takeoff period of a mature innovation reveals the importance of determining the *demonstration point* for each major military innovation. The demonstration point for each MMI occurs when the potential of its full capabilities is reasonably known in the international system through an action by a first mover, rather than the capability merely being the subject of internal exercises or debates.[14] This is when the clock begins ticking on potential adoption by other states.[15] An MMI exists as a discontinuous change based in part on the perspective of the states that view the demonstration of the innovation, not necessarily as a discontinuous change for the first-moving state.[16] For example, while many German officers viewed blitzkrieg as the logical culmination of German military advances in the 1920s and 1930s, most French and British military officers saw it as a radical departure from previous patterns of warfare on its debut (Mahnken 2003, 253).

Each innovation has a unique life span; different innovations have relevance in international politics for different time periods. New developments, potentially even in response to a major military innovation, could trigger a new MMI in a short period of time, constraining the time period of relevance for an innovation. For instance, while the principles of warfare in the age of sail stayed relatively constant for hundreds of years, the mechanized battlefleet system that replaced the sailing navy in the late nineteenth and early twentieth centuries was itself replaced just a few decades later by carrier warfare at the onset of World War II. Nuclear weapons have maintained their hold as a critical element of global power since 1945, a period of over sixty years, while blitzkrieg warfare supplanted trench warfare after only a few decades.[17] Given that innovations can matter for varying period of times and different areas of warfare such as land or sea, it makes sense to study the innovation as the unit of analysis, rather than trying to build something like a comprehensive data set that crosses several innovations.

like tanks or planes do not always predict battlefield success. While the Germans had 76 first-line divisions and 26 second-line divisions in May 1940, at the outset of the war, the Allies had 93 first-line divisions and 30 second-line ones. Moreover, while the Germans had 2,439 tanks deployed on May 10, 1940, the Allies had 3,079 (476–77). Instead, to supplement those measures it is also important to understand the way that organizations employ force—a conclusion this book draws as well. The point here is not that quantitative measures are not useful, just that more sophisticated models are sometimes necessary, and it is crucial to incorporate how militaries use raw materials.

[14] Many innovations debut in wartime. It is possible for an innovation to debut through the announcement of a new capability, revelations about doctrine or new technologies, or in other ways. Warfare, however, is the most likely demonstration point, because states may save new innovations for wartime and because the rest of the international community is more likely to be paying close attention (Axelrod 1979).

[15] This distinguishes between diffusion processes and simultaneous developments by multiple states. It is theoretically possible that more than one state could introduce the same innovation, meaning there is more than one first mover.

[16] For more on differing perceptions, see Jervis 1976.

[17] For an alternative perspective, see Biddle 2004.

Outlining Possible State Responses to Major Military Innovations

Once a military innovation debuts, those states interested in responding have a variety of options to choose from. Presume for a moment that states will generally respond to innovations in ways that they believe will maximize their foreign policy interests, however defined. The decisions of the state are influenced by a series of incentives and constraints that will shape its eventual response strategy. The geostrategic environment is one of the most significant factors determining the range of states interested in an innovation.[18] Other factors, ranging from international norms to cultural openness to the need for interoperability with allies and many others, may also influence interest in responding to an innovation.

Yet it makes sense to separate whether or not a state needs to respond to an innovation from the content of that response. That states may attempt to maximize their security does not necessarily suggest that they will adopt an innovation. Instead, as Elman (1999, 55–57) argues, while maximization could take the form of adoption, it could also take the form of relying on alliances and/or trying to counter an innovation through alternative means. While the question that some realists and others have traditionally asked about emulation may effectively answer why states are interested in responding to innovations, existing research has difficulty explaining what predicts the content of responses to innovations. Writing on the spread of military innovations or military technology traditionally views the strategic choices of states in response to innovation as a yes or no question—either innovations are adopted or they are not.[19] In reality states can pursue a much broader range of options, sometimes simultaneously, and those options may be preferable to emulation/adoption in some circumstances.

Implicit assumptions about the fungibility of capabilities have also driven the threat-based story about emulation—the idea that any state can adopt an innovation if it faces a large enough threat. But if capabilities were entirely fungible, it would make something like military victory logically impossible if both states optimized their militaries, since each state, facing a threat to its survival, would continually innovate and parry the thrusts of its opponent. The real world strongly suggests otherwise. To give an extreme case, no matter how a country like Belgium optimized prior to the Second World War, it could not defeat Germany. Especially in the short- and medium-term, we can

[18] See the work by Elman, Posen, and Resende-Santos cited above.

[19] See, for example, Resende-Santos 2007.

reverse the traditional story and assert that capabilities form a constraint that influences national preferences by defining the range of the possible. While the "rational shopper" approach assumes that, essentially, "where there is a will there is a way," the reality is more complicated.[20] If capabilities are not entirely fungible and the optimal response to an innovation is not necessarily adoption on the part of a threatened state, something more is required to unpack the diffusion process.[21]

Research on domestic politics and military organizations suggests that, like the strategic environment, domestic political and military organizational factors are vital in shaping the way military organizations behave.[22] Posen's work (1984) on military innovation, for example, indicates that both the external security environment and organizational factors can play important roles. Figure 2.1 highlights the range of potential responses that states have when thinking about how to deal with a new military innovation.[23]

One set of possible responses involves external actions, or changes that a state can make to its foreign policy to deal with the potential repercussions of another state adopting a military innovation.[24] A state could decide that the implications of the innovation make the achievement of national foreign policy goals no longer possible, requiring a lessening of overall foreign policy assertiveness or even a shift toward neutrality. This could lead to what Paul Schroeder (1994, 117) describes as "hiding" in international politics or potentially "transcending": pushing for international institutions or other means to deal with a situation in which a state no longer has the relative power to protect itself.

Another possible external response is to attempt to mitigate the costs of nonadoption by allying with a likely adopter (Walt 1987).[25] One option is balancing, creating or joining an alliance against the state that initially debuts the military innovation with another state or a group of states likely to successfully adopt or counter the innovation. The converse of balancing is bandwagoning, allying with the pioneering state that generated the innovation. Alliances boost the relative power of the involved states, because these states can work together

[20] "Rational shopper" is taken from Goldman and Ross (2003, 380).

[21] John Nagl's study (2005, 219) of U.S. and British counterinsurgency strategy in Malaya and Vietnam comes to a similar conclusion, arguing that the optimization of U.S. forces for conventional war after World War II made it difficult to adapt to counterinsurgency requirements in Vietnam.

[22] See, for example, the work by Evangelista, Zisk, and Mahnken cited above.

[23] This figure is not meant to suggest the paths are all exclusive, just to show the different possibilities. For a realist take, see Resende-Santos 2007, 69.

[24] This rubric assumes that a state has some time to adapt. The results might be different if a state faces a severe, short-term threat.

[25] This is similar to Powell's argument (1999, 176–79) that states sometimes may turn to alliances as a response strategy when potential adversaries experience increases in military capabilities. On how states make alliance choices, see also Snyder and Christensen 1990.

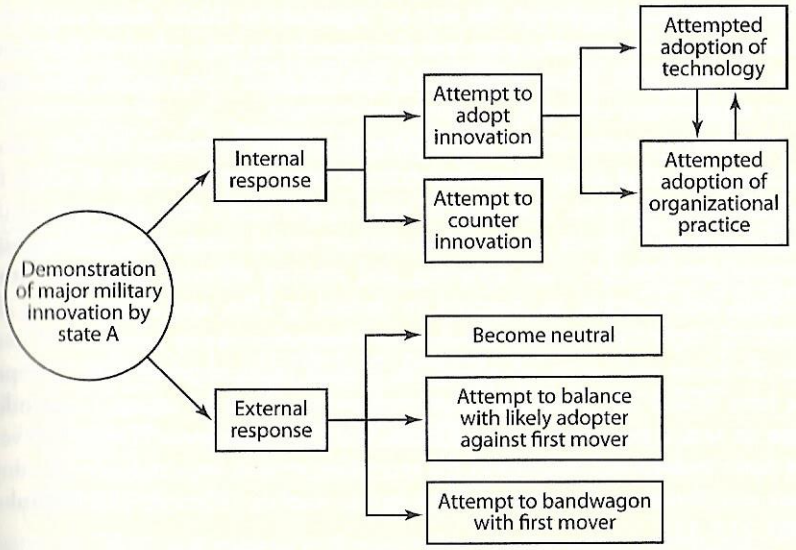

Figure 2.1. Potential state responses to major military innovations.

to do more than they could do alone.[26] Alliances may also help a state more rapidly gain access to the knowledge necessary to implement the innovation, either through buying time to build the capacity to adopt or through direct assistance from the first mover (Goldman and Ross 2003, 375–79).[27] For example, in 1945, when the British Navy reengaged the Pacific theater of World War II, its alliance with the United States facilitated greater power projection through several mechanisms, including technology transfers. The British Navy then used its alliance with the United States to learn more about adopting carrier warfare.[28]

In addition to external response strategies, states may also pursue internal military changes. One option is to try to adopt part or all of the innovation, meaning the innovation diffuses from country A to country B. Partial adoption often involves adopting technological or operational but not organizational aspects of an innovation, since it is generally much less disruptive to adopt

[26] I am grateful to an anonymous reviewer for making this point clearer.

[27] The argument here makes sense even if the balancing/bandwagoning terminology is flawed, as some have observed, because states generally view themselves as balancing even if an external perception would suggest otherwise (Schroeder 1994, 119).

[28] For more on this example, see chapter 3. Essentially, alliances help boost the power of states by allowing them to combine their resources, transfer technology/knowledge, and free up resources that a state might have to spend elsewhere, among other mechanisms. For more on alliances, see Leeds, Long, and Mitchell 2000; Leeds 2003; Levy 1981; Morgan and Palmer 2003; Sloan 1996.

technologies than to change the way an organization thinks about employing military force. Some states may lack the capacity to fully adopt in the short-term but will build or buy some of the technological components. This introduces a time-delay element.

Alternatively, some states might have the financial means to fully adopt and recognize that adoption makes strategic sense, but be unable to adopt for organizational reasons. This type of state might think that adoption would trigger domestic revolts or upset key military social hierarchies, outweighing the military benefits from adopting and making effective implementation unlikely. For example, in response to defeats at Ulm and Austerlitz at the hands of Napoléon's armies, the Austro-Hungarian Army reorganized itself into divisions and corps, adopting the French organizational form. Despite the best efforts of Archduke Charles, however, fears of internal instability from an armed populace caused Austro-Hungarian emperor Francis I to veto the more widespread reforms to the recruiting system required to truly adopt mass mobilization, the crux of Napoleonic warfare (Herrera and Mahnken 2003, 214–15).

Additionally, some states have the raw financial and organizational capacity to adopt an innovation, but do not do so because the financial and nonfinancial (frequently domestic political) costs of adoption are viewed as higher than those of nonadoption, especially when an external alliance strategy is possible. In the same Napoleonic warfare case, despite possessing the capacity to adopt, the British Army instead pursued an alliance strategy. Army and political leaders thought that the probability of extensive British land engagements on the continent was sufficiently low that the domestic costs, in the form of public upheaval, from shifting to mass mobilization through conscription outweighed any benefits. The existence of a viable alliance strategy made paying the costs of adoption less attractive to Great Britain (Herrera and Mahnken 2003, 216–17).

Another internal response strategy is countering an innovation, also sometimes described as offsetting (Goldman and Ross 2003, 288–89). Countering is defined for the purposes of this book as an internal military response that excludes adopting the innovation, yet can range from trying to neutralize its impact with inexpensive tactics drawn from existing forces and operational plans to the search for another new military innovation to counter the first one. An example of countering through existing military means was the camouflage practices used by the Serbian military in response to the U.S.-led air campaign over Kosovo in 1999 (Thomas 2000, 13–15). A case of a countering strategy that became an innovation in its own right was the development of the *trace italienne*, the squat and broad-angled bastion fortress. It came about as a response to increasing cannon quality that gave attacking armies the ability to batter down the tall, thin walls of most fortresses in early modern Europe (Parker 1996, 9–11).

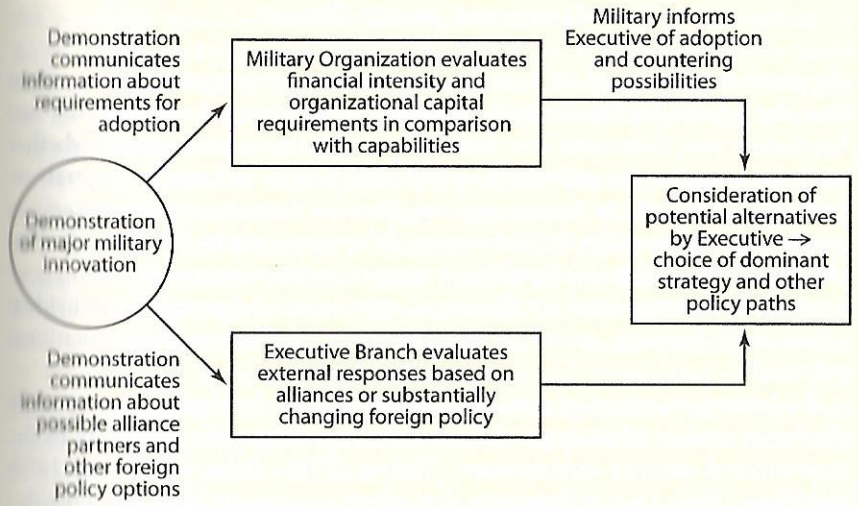

Figure 2.2. "Ideal" state response to demonstration of major military innovation.

In general, revelation of an "average" (MMI) triggers two simultaneous processes in an "ideal" state.[29] The military evaluates the requirements for adopting the innovation in relation to its current and potential capabilities, along with the possibility of a countering strategy, while the executive determines the potential utility of external policy solutions like alliances or a shift to neutrality. In states based on civilian control of the military, the military reports back to the executive, who then weighs the relative costs and benefits, probably with continuing advice from military leaders, of the different strategic possibilities. In the case of an average middle power with an advanced industrial base and medium-sized economy, the most likely choices are partial adoption, especially of some technological components, but a larger emphasis on an alliance-based response. The character of the alliance-based response depends on the relationships between the responding state, the first mover, and other potential adopters. Given the current international security environment, if the responding state is Canada and the first mover is the United States, bandwagoning is likely. If the responding state is Japan and the first mover is the People's Republic of China, balancing is probably more likely. Figure 2.2 graphically depicts an idealized version of this response process.

Given this range of options and idealized decision-making process, what factors determine how military power spreads throughout the international system? What influences the paths that particular states will adopt?

[29] Ideal types are theoretical constructs of potential state behavior useful for identifying what many states might do but not designed to exactly mimic state behavior (Weber 2002).

Adoption-Capacity Theory

As previously discussed, it is in the response to a major military innovation that the impact on the international security environment emerges. The two key factors that determine how hard it is to adopt an innovation and whether or not a state has the capacity to adopt, which then influences the strategic pathway it is likely to choose, are the *financial intensity* and *organizational capital* required to adopt the innovation. Adoption-capacity theory posits that the financial and organizational requirements for adopting an innovation govern both the system-level distribution of responses and the way that individual actors make decisions, as well as the subsequent implications for international politics.[30]

Evaluating the range of available strategic choices for states is conceptually similar to studies of strategic choices under conditions of uncertainty in the international security environment (Fearon 1994b; Lake and Powell 1999; Schelling 1966). One difference is that adoption-capacity theory is more decision theoretic. At the system level, the theoretical predictions are based on the requirements for adopting the innovation and assumptions about the distribution of capabilities in the international system. While over time all of these things vary, in the short-term they are invariant enough to allow for stable predictions. Based on a range of possible choices, the theory also derives the most probable strategic choices for individual states given their capabilities, the requirements for adopting the innovation, and the configuration of the international system.[31]

Financial Intensity

The idea that resources matter in determining global power is not new. A core tenet of many international relations theories is the idea that material capabilities influence the overall relative balance of power in the international system, driving the alliance and other decisions of states, whether mechanistically, through the way it influences debates between interest groups within countries, or in other ways (Baldwin 1979; Waltz 1979). Financial intensity refers to

[30] This assumes a somewhat "normal" distribution of capabilities in the international system at the time the innovation is demonstrated. While capabilities in the international system are rarely normally distributed in a statistical sense, there is usually a sufficiently broad range of interests and capabilities such that the assumption is useful for understanding the effect of an innovation.

[31] This makes sense when thinking about the spread of military power because military organizations are not infinitely pliable, especially in the short-term. So while the theory deals with strategic choices, it does not deal with them in a game theoretical fashion that allows for mixed equilibriums. If adoption-capacity theory is incorrect, military organizations will end up being much more elastic than predicted, suggesting that future research efforts might more fruitfully focus on the issue differently.

the particular resource mobilization requirements involved in attempting to adopt a major military innovation.[32] The higher the cost per unit of the hardware associated with an innovation and the more the underlying technologies are exclusively military oriented, the higher the level of financial intensity required to adopt the innovation.

The cost per unit of technologies is important. Lower unit costs can allow for more experimentation by a military organization, making it easier to test new equipment and determine its feasibility for full deployment. For example, changes in production methods made possible by the Industrial Revolution helped lower the cost per unit of the rifle, which had existed for over two hundred years, but never systematically made its way on to the battlefield because of its previously high unit costs. Alternatively, the production of one B-2 bomber, costing between one and two billion dollars per plane on average, is so enormously expensive that experimentation is not possible on the same scale (Pike 2005a; U.S. Air Force 2006a).[33]

The underlying technology driving a military innovation can take many forms, but it is usually either an essentially commercial technology, meaning private businesses have economic, nondefense incentives to develop the technology, or an essentially military technology, meaning it was invented for military reasons and will arouse little initial interest from businesses outside of defense contractors. Underlying commercial technologies will generally require lower net capital investments for a military organization than underlying military technologies, because market competition creates incentives for private firms to pay some of the product development costs.[34] For instance, the cannons produced during the early modern European period were solely military investments, requiring a higher relative capital investment than something like the railroad in the mid- to late nineteenth century, which nondefense commercial interests had an incentive to build.[35]

[32] Financial intensity is somewhat related to the economics literature on "capital intensity," which refers to the level of financial investment necessary to accomplish a task in comparison with the physical or material investment in the form of labor. For some recent examples, see Arai 2003; Berman, Bound, and Machin 1998; Gartzke 2001; Sattinger 2004. In contrast, financial intensity is only partly about the overall investment level. While it is possible in the military power area that there are some innovations that require more labor and less capital to implement, and vice versa, financial intensity refers to the structure of capital investments. Nevertheless, it is certainly true that innovations requiring high levels of financial intensity to implement generally require higher capital levels, potentially necessitating a trade-off with labor given limited budgets.

[33] The type of experimentation that is more likely to result when the cost per unit is low may have interesting spillover effects on organizational capital as well. Experiments can help acclimate military cultures to new technologies and organizational practices.

[34] There may be reasons such as secrecy or control of production why the military would want to develop and produce some of its own weapons. The relative cost, however, will be higher.

[35] It is true that cannons originally developed from casting procedures used for bells, but unlike railroad tracks, once invented, there was no reason to produce cannons except for military purposes.

The financial intensity level of each innovation is derived using budget data to determine the cost per unit of the technology in comparison with the cost per unit of the prior dominant technologies, and using available data on production processes to determine whether the underlying technology is mostly commercial or mostly military. Depending on the case, the financial intensity capabilities of each potential adopter are then measured by comparing factors like the unit cost of the technology for the first mover to the defense budget of potential adopters, the gross domestic product (GDP) and defense spending of the first mover to that of potential adopters, and the relative industrial capabilities of the first mover and each potential adopter, taken from national capabilities data.[36]

Table 2.1 shows how these factors determine the relative level of financial intensity required for adoption. MMIs that require high levels of financial intensity for implementation, meaning the cost per unit is high and the underlying technological basis is military, not civilian, are harder to adopt than those requiring low levels of financial intensity.

Financial Intensity Hypothesis: The greater the financial intensity required to implement the innovation, the slower the spread of the innovation at the system level and the lower the probability that a state will attempt to adopt the innovation.

Organizational Capital

Just as the financial requirements for adopting an innovation can vary, the organizational requirements for adopting an innovation can also vary. For example, in the late nineteenth and early twentieth centuries the British Navy confronted two large innovations in naval warfare. The first, battlefleet warfare, was the culmination of naval industrialization. Epitomized by the *Dreadnought*, the first all-big-gun battleship, battlefleet warfare required changes in the education, recruitment, and training of naval personnel. Instead of training soldiers to climb the rigging, for example, soldiers had to learn advanced math to plot gun trajectories. And instead of mastering sails, they had to take apart and put together engines. But the core of the innovation involved doing what the British Navy had always done: bringing its guns to bear in battle to destroy the capital ships of the enemy. This made the innovation organizationally easier to implement. The second innovation, submarine warfare, represented a more disruptive change. The potential shift in naval power away from the gun and capital ship, and toward the torpedo and submarine, contradicted centuries of thinking about the production of naval power and specifically challenged the core competency that had defined British naval supremacy: gun

[36] Data often drawn from the Correlates of War Project Material Capabilities data set (2006).

TABLE 2.1
Financial Intensity Drivers

		Cost per unit	
		Low	*High*
Underlying basis of the technology	*Civilian*	Low financial intensity	Medium financial intensity
	Military	Medium financial intensity	High financial intensity

battles between capital ships. The innovation required not just changes in education, recruitment, and training but also wholesale shifts in force structure and plans for the use of force. This made it much more difficult to implement, and is one of the reasons that Admiral John Fisher's attempt to transition the British Navy away from the all-big-gun battleship and toward flotilla defense failed (Lambert 1995a, 1999; Sumida 1995).

Thus, different military innovations can place different demands on organizations as far as the degree and type of transformation required. Organizational capital is an intangible asset that allows organizations to change in response to perceived shifts in the underlying environment. For militaries, organizational capital represents a virtual stockpile of change assets needed to respond to changes in the character of warfare. For those who study firms, one simplistic way to measure organizational capital is to write an equation that subtracts the value of the physical assets held by a firm from the value of the company as perceived by investors, measurable in its stock price. The difference represents the intangible value of the company, or the value not captured by its physical assets.[37]

Jason Cummins (2004, 4), from the Division of Research and Statistics in the Federal Reserve System Board of Governors, provides one useful way to define organizational capital in the context of information technology:

> So what exactly is organizational capital? As a purely mechanical matter, I define organizational capital as an adjustment cost from IT investment, defined as the difference between the value of installed IT and that of uninstalled IT. Suppose a company purchases database software. By itself, database software does not generate any value. At a minimum, the software must be combined with a database and, perhaps, a sales force. Organizational capital defines how the database is used and, consequently, how software investment creates value.

[37] This can include things like brand reputation, financial accounting issues, perceived knowledge as it relates to future innovations, human capital in general, and other issues (Bond and Cummins 2000). See also Lev and Radhakrishnan 2003, 2005.

New military technology, like the new database software described by Cummins, does not produce value on its own. It is only in combination with organizational methods that technology has value for producing military force. In this way, organizational capital is the *non*technological aspect of force generation, demonstrated through doctrine, education, and training. Organizations with a high degree of organizational capital are much more able to take advantage of new innovations and transform themselves successfully for the future than organizations with a low degree of organizational capital.

The preceding discussion raises a measurement problem: if organizational capital consists of relatively intangible organizational assets, how should these assets be measured? The demands on military organizations in periods of uncertainty vary in ways potentially similar to variance in the demands on firms during periods of rapid change. Lynne Zucker and Michael Darby posit that successful firms take advantage of organizational assets and a culture of innovation to stay ahead during periods of uncertainty. Firms, even leading ones, are not necessarily immutable. For example, the fact that some leading pharmaceutical firms radically shifted their identities in response to the biotechnology revolution while others failed demonstrates that different firms respond in different ways to external demands (Zucker and Darby 1996a, 960, 971; Zucker and Darby 1996b).

Organizational capital is a critical element of firms' success, helping businesses survive during periods of change by giving them the institutional capacity to shift practices without being blocked by bureaucratic obstacles. Because it is difficult to copy business processes, as opposed to specific technologies, organizational assets are difficult to duplicate. Darby and Zucker find a ten- to fifteen-year gap between the beginning of the biotechnology revolution and widespread knowledge of the practices necessary to take advantage of the revolution for business purposes. In between, tacit knowledge of how to conduct specific research was held by key scientists working for a few firms and others in their immediate vicinity, making the knowledge "naturally excludable" from outside firms (Darby and Zucker 2003, 2). These human resources then became the basis by which an existing incumbent firm stayed ahead when further change appeared likely (Zucker and Darby 1996a, 12709; Zucker and Darby 1996b, 965–67).

Even detailed case studies on business processes have frequently been insufficient to enable copying by other firms. Erik Brynjolfsson, Lorin Hitt, and Shinkyu Yang (2002, 144) explain the difficulties involved:

> Intel, for example, has adopted a "copy exactly" philosophy for any chip fabrication plant built after the first plant in each generation. Wholesale replication of even seemingly insignificant details has proved more reliable than trying to understand which characteristics really matter. Going from the plant level to the firm level only complicates the imitator's task.

A useful set of alternative operationalizable markers from this business innovation literature can help us measure both the level of organizational capital possessed by a military organization and the baseline level of organizational capital required to implement a given MMI. Three measures of the level of organizational capital possessed by a military organization are the critical task focus of an organization, experimentation resources, and organizational age.

CRITICAL TASK FOCUS

Typically measured by statements of intent and planning documents, the critical task of an organization is that which the organization views as its main "goal"—what it seeks to achieve. While not always referred to as a critical task in literature on organizational effectiveness and the integration of innovations, the notion of a critical task captures the central operating principle of organizations. Having a critical task helps organizations frame and justify their actions, providing a central theme for motivating workers. As business innovation scholar Clayton Christensen (1997, 168) writes, "Over time, however, the locus of the organization's capabilities shifts toward its processes and values." Critical task focus is the extent to which the means by which an organization achieves its goals are conflated with the goals themselves (Wilson 1989, 25–26). Many successful firms come to define their business processes and values based on the strategies that initially led to success. The embedding of a particular vision of a critical task within the organizational architecture then shifts from where a business allocates resources to the metrics used to make decisions to the processes used to design metrics. One example is the failure of the Digital Equipment Corporation (DEC) in the shift from minicomputers to the personal computer. The organizational process at DEC prioritized reinforcing the high-margin minicomputer business, even though it also had high overheads. Since the emerging personal computer market looked miniscule in comparison, with low overheads and profit margins, DEC's organizational decision making blinded it from seeing the shift in the market. As Christensen (1997, 169–71) describes, eventually DEC failed, not because it lacked the resources to compete in the personal computer arena, but because the business processes designed to maximize profits in the minicomputer arena embedded an inappropriate critical task at the core of the business.

In general, businesses with narrow critical tasks associate particular ways of doing business with the goal of the business. Businesses with broader critical tasks are those that delink the goal of the organization from the means used to achieve that goal. Kim Clark shows how firms often use their experiences to build specific types of knowledge and skill. They identify key problems and solve them through the creation of efficient business practices. Still, when exogenous technological shocks occur or customer preferences change overnight, successful businesses can find themselves hamstrung by the organizational climate they previously created (Clark 1985). Competence-destroying

innovations, like the development of private airlines or mass production processes for cement, can disadvantage firms that previously held large segments of market share (Tushman and Anderson 1986).

The critical task focus for a firm thus becomes myopic at times not because a firm is poorly managed but precisely because smart managers optimize their entire organization, from production processes to decision-making hierarchies, to grow their market share in a particular business area (Christensen 1997, 98). Firms frequently create strategic group identities to reduce uncertainty through the use of predictable metrics and planning processes. Especially when these identities form around production processes or specific ways of achieving market share, they make it more difficult for firms to respond to radical innovations in core practices (Henderson and Clark 1990).

In contrast, the broader the critical task focus—meaning the less specifically a firm links its organizational identity to particular production methods—the easier it is to incorporate new ways of achieving organizational goals—that is, adopting an innovation—without encountering too many bureaucratic stumbling blocks to implement the change. The more specifically a military organization defines its critical task, the harder it should be for the military to adopt an innovation. Entrenched interests within the organization will be more likely to rebel on the grounds that a proposed innovation is outside the scope of acceptable activities. An organization with a broader critical task focus will find it easier to justify, within the organization, how the innovation fits within the regular "actions" of the organization.

One often-cited example of differences in critical task focus comes from the U.S. Marines and U.S. Army. The critical task of the Marines is described broadly as being a "warrior," and the Marines envision all Marines as soldiers with rifles first rather than identifying each Marine by their specific task. This has made the Marines more receptive to a wider variety of core operational concepts including amphibious warfare, trench warfare, counterinsurgency, and urban warfare, since they all involve the activities of a warrior. The army, in contrast, as James Q. Wilson (1989, 43–44) has pointed out, has traditionally defined its critical task as massing firepower to win conventional wars, making it more difficult to justify the incorporation of new war-fighting methods like counterinsurgency (Krepinevich 1986, 5). The army preference for operations emphasizing overwhelming firepower also likely influenced the army's decision to use casualties inflicted on the enemy as its dominant indicator, or key metric of success, during the Vietnam War (Gartner 1997).[38] The army's operational focus on overwhelming firepower drove its strategy, rather than the other way around. This is related to work by John Nagl (2005, 216–17), who

[38] Beginning in 1965, General William Westmoreland based U.S. strategy around search-and-destroy missions designed to use overwhelming firepower to generate casualties (Gartner 1997, 130–31). This explanation is very much in line with adoption-capacity theory.

uses the U.S. Army in the Vietnam War to argue that the way organizations view themselves and their critical mission can hinder learning even in the face of strong evidence suggesting current methods are failing.

EXPERIMENTATION

The prescriptions for firm success outlined by Christensen use the organizational commitment to experimentation as an accurate way to measure organizational capital. Christensen contends that the firms best prepared for disruptive innovations are those with ongoing experimentation efforts and/or spin-off companies that can avoid substantial losses if the spin-off fails. Spin-offs with loose ties to the established company, because they measure success in relation to their new competitors, rather than the rest of the company, are best positioned to highly value the small profit margins likely to accrue at the beginning of a transformative period (Christensen 1997, 176–77).[39]

High overall investments in experimentation may make militaries more receptive to innovations; experiments demonstrate an institutional willingness to think outside the box, meaning the organization builds in the capacity to integrate innovations. The George W. Bush–era Office of Force Transformation in the U.S. Defense Department was one example of a subunit focused on experimentation. Within the Marine Corps, the Marine Corps Warfighting Lab is another locus of experimentation. In fact, while a key finding in the business innovation literature is the relationship between corporate "skunkworks" and success in the face of innovation, the term itself is derived from the work of a defense contractor. When Lockheed designed the P-80 Shooting Star jet plane during World War II under high secrecy, a circus tent with a top-secret incubator was positioned next to a plastics factory. Rogers (2003, 149) writes, "The strong smells that wafted into the tent made the Lockheed R&D workers think of the foul-smelling 'Skunk Works' factory in Al Capp's Li'l Abner comic strip. The name stuck and came to be generalized to similar high-priority units that have been created by various companies since."[40]

ORGANIZATIONAL AGE

Organizations generally acquire some degree of rigidity over time, independent of domestic politics and overall political centralization, throwing up barriers to transformation that undermine organizational capital levels. While business innovation research demonstrates that firm identities are not entirely immutable, the conventional wisdom—that it is difficult for large organizations

[39] Because the market size is smaller for emerging component markets, the profit margins are often smaller.

[40] Experimentation is a better proxy than research and development. Organizations may pump tons of resources into research and development, but if they do not invest in the right areas, they may end up promoting incremental improvements to the *last* great thing, rather than the next great thing (Christensen 1997).

to transform to face new business challenges, especially when the challenge is disruptive to their fundamental business model—is the conventional wisdom for a reason. Olson's research shows that the age of an organization often predicts its productivity level.[41] Based on a number of case studies and a wide variety of data from studies of businesses to studies of cross-national post–World War II economic growth, Olson's work (1982, 76–77) demonstrates that older organizations many times become more stagnant, making them ill equipped to deal with transformational change.[42]

Olson (1982, 31) argues that collective action incentives decrease as group size increases, because the benefits from collective action are more diffused, making it harder for larger groups to act in pursuit of common interests. Attempts to solve these problems by creating subgroups to promote change often backfire, fueling the development of bureaucratic sublayers of inefficiency by reformers and corresponding interest groups that mobilize to block reform, requiring special interest groups to help people navigate the bureaucracy. The result is an increasing number of veto points in the overall organization with the capacity to block change. Interest groups that have cartelized for the purposes of distributing benefits will have incentives to block resource redistribution, especially to new groups forming in response to changing conditions. This can delay the adoption of new technologies and the more efficient distribution of resources (Olson 1982, 64–65). The theoretical extension to the military realm is obvious. Well-defined military service cultures often militate against change, because service groups will defend existing distributional bargains about the spending of defense dollars against attempts to reallocate. The basic prediction is that as organizations age, the level of organizational capital declines.[43]

These three measures of organizational capital are potentially operationalized by using internal documentation (when available) to code for the critical task focus of militaries, budget data to code for the commitment to experimentation, and the time gap since a regime change or a major war in which a

[41] For some critiques of Olson, see Coates and Heckelman 2003; McLean 2000; Unger and Van Waarden 1999.

[42] For example, Olson argues that the destruction of Germany and Japan during World War II allowed the two countries to start anew economically, resetting their organizational ages. This made it easier for them to take advantage of innovations in the post–World War II period (Olson 1982, 76–77).

[43] There are additional indicators likely unrelated to the transformational capacity of organizations but that may matter, including the centralization of authority, receptivity to information, civil-military relations, and organizational size (as opposed to organizational age, which is more about whether the bureaucracy is bloated than its absolute size, though they are sometimes related). The importance of centralization, civil-military relations, and information are probably subsidiary questions to the issues of critical tasks and organizational age, since the predictions are relatively similar (i.e., the expansion of veto points as organizations age induce the same types of dysfunctions as those predicted by a civil-military explanation). The question of organizational size likely depends on the character of the military innovation and varies based on other factors.

state lost, whichever occurred more recently, to code for organizational age.[44] When evaluating the organizational capital requirements for a given innovation, I determine the level of organizational capital possessed by the first mover(s) for each innovation, which is a good proxy for the requirement since there is sometimes uncertainty about the exact measurement of the three indicators. Combined with general measurements, a given innovation is assessed as requiring a certain amount of organizational capital to adopt.[45] Then, the organizational capital required to adopt an innovation is compared with the organizational capital possessed by individual states to determine the propensity of each state to adopt the innovation.

> **Organizational Capital Hypothesis:** The greater the organizational capital required to implement the innovation, the slower the spread of the innovation at the system level, and the lower the probability that a state will attempt to adopt the innovation.

It is important to note that this understanding of organizational capital is not without its limitations. Studying organizational change is difficult, and the wide variety of factors that determine the way organizations make decisions makes it impossible to encompass all of them in any particular theory. The three factors described above—critical task focus, experimentation, and organizational age—are designed to proxy for the type of characteristics likely to exist in organizations more or less able to adopt new military innovations.

Predicted System-Level Diffusion Pattern

While the particular international context in which an innovation arises matters a great deal, the best general predictors of the way it is likely to diffuse throughout the international system are the relative levels of financial intensity and organizational capital required to adopt the innovation. Combining the predictions about financial intensity and organizational capital highlights the way that different requirements for adopting an innovation should influence the way it spreads throughout the international system.

[44] When possible in the empirical chapters, the regime change data comes from Polity while the war loss data comes from the COW Project (Marshall and Jaggers 2002; Sarkees 2000). Major wars are measured as wars where the demand involved regime change (Horowitz, Simpson, and Stam 2009). An alternative measure is wars that are followed by regime change, though this conflates the two measures.

[45] Using the first mover as a model for the required level of organizational capital is imperfect, but it does contextualize the adoption requirements. It is possible that over time, the level of organizational capital required to adopt some innovations will decline. This is an important limitation to the first-mover test. Yet it is only one of several ways of measuring organizational capital. If the first-mover test leads to an exaggeration of the adoption requirements, it will show up in the empirical chapters, since the adoption-capacity theory will predict a much smaller and more limited spread of the innovation than what actually occurs.

TABLE 2.2
System-Level Diffusion Predictions

		Level of financial intensity required to implement major military innovation	
		Low	*High*
Level of organizational capital required to implement major military innovation	*Low*	Rate/extent fast	Rate/extent medium
	High	Rate/extent medium	Rate/extent slow

State-Level Predictions

Moving from system-level predictions to individual states requires acknowledging additional complexity. One key factor is whether knowledge concerning how to adopt has diffused to a particular state. While the adoption-capacity requirements can predict how an innovation will spread in general, forecasting the decisions of specific states requires understanding their particular motivations as well. One could argue that the system-level predictions, when applied to individual states, are tautological because they predict that those states with the capacity to adopt will do so. Yet threats and internal politics may lead states toward choices that maximize their utility for preference functions other than making the most of short-term military power.

STRATEGIC CHOICES

In general, states responding to a major military innovation are likely to choose a dominant response strategy that consumes the bulk of their time and effort from the range of possible choices outlined above—though they may simultaneously pursue a few different paths.[46] The dominant strategy is an attempt by the state to maximize its utility in response to a given innovation, though states can and do make bad choices. The payoff for adopting a particular strategy is a function of state certainty about the substance of the innovation, depending on how effectively information about the innovation has spread, the interest a state has in adopting given its geopolitical position and domestic political configuration, and its adoption capacity, its ability to adopt the innovation based on the combination of its financial and organizational resources. While other factors also influence responses to innovations, these factors should generally be the most critical.

As Posen's work (1984, 233, 239–40) on the interwar period in Europe suggests, large-scale geopolitical threats could increase the urgency with which

[46] In an idealized state, while initially states will have debates over the appropriate response to an innovation, with advocates existing for a range of possible responses, eventually one emerges for a variety of reasons as the dominant response even if elements of others continue to exist. Alternatively, see Resende-Santos 2007, 67–69.

states respond to new military innovations. Threats will not necessarily lead to adoption, however—just the optimization of response strategies. Depending on its preinnovation configuration of alliances and adoption capacity, a state's optimal response strategy could be a dominant alliance strategy, an adoption strategy, a countering strategy, or a shift toward neutrality.

Domestic political costs and benefits may also influence state decisions. For example, the failure of the Archduke Charles to fully implement the Napoleonic reforms in the Austro-Hungarian Army, discussed above, was rooted in domestic political turmoil that prevented effective mobilization, and meant that if mobilization did occur it would threaten regime stability. So despite a strategic need and the financial capacity to adopt, a lack of organizational capital and domestic political constraints prevented successful adoption.

In situations where geopolitics and domestic politics influence response strategies away from adoption, it becomes more likely that states will pursue countering strategies as one alternative. Countering attempts, which try to offset the value of an innovation through low-cost alternatives or substitutions for a lack of particular capabilities, are generally much easier for an organization than adoption. The potentially inexpensive nature of countering may make it an especially attractive solution for states that may believe they can emulate and adopt the innovation over time but need to stall in the interim, or states lacking the capabilities to adopt in any reasonable time frame but that do not want to abandon their current foreign policy through new alliances or a shift toward neutrality.

SUCCESS AND FAILURE

Predicting the likely dominant strategy that states will choose in response to changes in the production of military power is not enough to answer the puzzle posed at the outset of this book. Determining how military innovations diffuse requires figuring out not just what a country will try to do but also whether it will actually work. For the external strategies possible in response to an innovation, predicting success and failure is not difficult; it depends on the willingness of states to sacrifice foreign policy goals, and who their friends and adversaries are in the international system. The failure of states' countering or adoption attempts are much more interesting. The requirements for implementing each innovation determine which states are least likely to adopt and/or most likely to fail, and these vary widely across innovations. This builds on Goldman's notion of capacity and distinguishes adoption-capacity theory from realist perspectives, given that Resende-Santos (2007, 9–11) explicitly notes that neorealist theories like his cannot explain the success or failure of strategies, only whether states will emulate.

For those states that attempt to adopt an innovation, the key determinant of success is whether the financial and organizational requirements for implementing the innovation "match" the capabilities of the state pursuing an adoption

strategy.[47] These claims about success and failure could function in two different ways: one focusing on selection, and the other focusing on organizational myopia. A selection argument might presume that a state only attempts adoption if it is the best option, meaning that the state has the capacity to successfully implement the innovation.[48] On the other hand, as Robert Jervis (1976, 189–91) maintains, slowly changing perceptions can cause organizational myopia as actors fail to correctly assess their own capabilities and the situations they face. The empirical tests in subsequent chapters will help arbitrate between these two different ways of thinking about the relationship between strategic choice and implementation success.

Implications for International Politics

Given that innovations represent potentially important shifts in military power and that different innovations are likely to have different adoption requirements, influencing the way that they spread in the international system, what does that mean for the international security environment? One way of thinking about the impact of innovations is to look at the content of particular innovations and the way they influence international interactions. For example, since nuclear weapons radically increased the destructive power of a single bomb, they changed the character of warfare. In another possible case, the "modern system" took advantage of changes in firepower, transportation, and communications, leading to large shifts in force structure and battle planning that escalated the destructiveness of wars (Biddle 2004). But this type of analysis alone would view war too much in a vacuum, rather than evaluating the *relative* implications of innovations for the international security environment. While the content of specific innovations clearly matters for changing the way a particular war is fought, it is the spread, or lack thereof, of those innovations that determines the overall winners and losers in international politics.

If military power is based in the ability to adopt the key military methods of a period, then the creation of military innovations and their disparate impact on different states throughout the system is one way that large-scale shifts in the relative military balance of power occur.[49] Power transitions, or periods

[47] Adoption capacity is clearly endogenous in many cases to strategic choices; states with higher financial and organizational capabilities will be more likely to attempt adoption in most cases, though the British response to Napoleonic warfare, described above, shows that this is not necessarily the case.

[48] It is also possible rationally that an attempt to adopt an innovation might be the preferred strategy even if leaders believe the attempt will fail. The attempt could signal a commitment internationally that influences allies and potential adversaries, and might also just be the least bad option in a comparative sense, given the relative costs of the various external policy alternatives.

[49] This builds on Gilpin 1981, 59–62.

when some states rapidly rise while others decline, are critical times in global politics because they may be the dry timber through which major fires, large-scale wars, can start.[50] Analyzing how the rise and decline of states influences the international security environment has been an important subject in international relations for decades (Copeland 2000; Gilpin 1981; Kugler and Lemke 1996; Organski and Kugler 1980; Waltz 1979).[51]

Understanding the diffusion pattern of the dominant innovation of a time period and the match of adoption requirements to the capabilities of states can help us more accurately explain power transitions. In contrast to his general contention about the inevitable decline of existing powers, Robert Gilpin (1981, 161–62) writes, for example, that existing powers can reinvent themselves and stay on top, pointing to Chinese and British developments over time. He does not explain, though, why it is that they can reinvent themselves when facing some challenges, but face "institutional rigidities" (189) at other points that hasten their decline. So what explains their eventual decline?

Most narrowly, adoption-capacity theory can explain the *mechanism* by which these transitions sometimes occur. Military innovation diffusion is part of the causal process governing power transitions.[52] The predictions made by adoption-capacity theory about the way adoption requirements and state responses will influence the spread of a military innovation also lead to predictions concerning the importance of innovation diffusion for the international security environment. Further, differentiating between financial and organizational requirements for adopting innovations and the implications for international politics can also explain the process by which new states take the lead for Gilpin, or how the costs of war shift for Powell.

More broadly, at the system level, adoption-capacity theory explains both why some shifts in relative power occur and how. Some new major military innovations constitute disruptions in international politics that can generate large power disparities. First movers that innovate and generate new ways of producing military power can gain significant advantages; the exploitation of these advantages then can usher in power transitions, exposing status quo powers that can become overmatched paper tigers. Rising powers that become first movers are especially likely to experience large gains in relative power. First-moving existing powers or existing powers that can rapidly emulate or

[50] The phrase power transition is used to describe increases and decreases in relative power, not the power transition "school" (Organski and Kugler 1980). Subsequent discussions of shifts in power should hold whether or not traditional power transition dynamics or Powell's argument (1999, 85, 199) about the divergence between the distribution of power and the distribution of benefits holds.

[51] In this section, the terms existing and rising power refer strictly to relative capabilities in the period prior to the introduction of the innovation, not intentions.

[52] For an example of work that does discuss the affect of innovation diffusion on power, see Goldman and Andres 1999.

otherwise adapt to an MMI can make relative power gains, or help stave off disadvantageous power shifts. Innovations more generally trigger strategic responses on the part of the rest of the international system, with success and failure in the world of the new innovation determined by the match between the financial and organizational requirements for adoption and the financial and organizational capabilities of interested states, modified by their alliance postures and other options.

New major military innovations sometimes present major powers with challenges they simply cannot meet, if they lack the financial or organizational capacity to adopt. These shifts in relative power and periods of instability with declining powers do not occur because a state makes a mistake. Rather, sometimes the financial and organizational requirements for the next major military innovation are just beyond the capability of a major power to implement. Adoption-capacity theory is a protorationalist explanation for change in response to innovation; rather than looking to pathologies or other reasons why states fall by the wayside in the international power game, it is simpler to look at what it would have taken for a state to "keep up," and whether the state was simply unable to do so. Especially when preexisting powers desperately want to stay on top, they may end up with an attribution bias that causes them to exaggerate their capabilities. It is in these situations that the most dangerous power transitions occur. These faltering states are the most likely to engage in foolhardy military strategies that make escalation more probable.

Alternatively, the recognition that their relative military power will only decline for the foreseeable future could create incentives for risky military gambles as leaders enter a "use it or lose it" mind-set. Fear of structural military decline could also cause a general heightening of tension that leads to war as a declining power covers for insecurity about their capabilities with greater levels of belligerence at the same time that potential adversaries are gaining military confidence due to successful adoption of the new innovation. Strong incentives might exist for national leaders to try to gamble for resurrection with regard to the reputation of the country as a global power, especially given the potential personal cost to the leader if the leader is blamed for overseeing national decline (Goemans 2000).[53] While this possibility exists, it is also extremely difficult to test since it requires not only knowing what a country did and why but getting detailed information on the risk perceptions of leaders as well.

Rather than decline being inevitable, as it is for those that presume the diffusion of knowledge will inevitably harm system leaders, shifts in power and their timing are better understood as a function of the adoption requirements of the key military innovations of a period.[54] Not all innovations will benefit rising

[53] On the other hand, the risk of removal from office if the state gets involved in a war and loses could induce caution.

[54] Ronald Rogowski (1983, 735) makes this point about Gilpin's inevitability argument as well.

powers and hurt established ones. An international configuration that might seem ripe for change could hang on for decades or longer because the dominant form of military force favors the existing power. It is only the emergence of a new innovation requiring a high level of organizational capital to adopt that drives a nail through the coffin of the existing power. Or as Ronald Rogowski (1983, 735) hints, it is necessary to combine the organizational insights of Olson with Gilpin's arguments about shifts in relative power, which adoption-capacity theory does. This allows us to predict not only that a shift in the distribution of power is likely but also the *timing and character* of that transition.

So how do different adoption requirements for innovations, when summed over the international system, actually translate into changes in how an innovation will influence the international security environment? There are two key ways that the diffusion of military power matters for the overall international security environment: through the implications of the system-level distribution of responses, and from first-mover advantages and power asymmetries for particular states. The former is more about the relative balance of power between states, while the latter is more about the implications for the relative timing, intensity, and geographic scope of warfare.

DIFFUSION AND SYSTEM-LEVEL CONSEQUENCES

Returning again to the business innovation literature, Christensen highlights the way that differences in the adoption requirements for innovations in the business world influence the probability of firm success and failure. He differentiates between sustaining innovations, or those that improve current business practices, and disruptive ones, or those that make following prior business practices likely to lead to firm failure instead of success (Christensen 1997, xiv–xv).[55] Christensen studies the disk drive industry and its transition through several different stages of innovations. He finds that in every case of a sustaining innovation, like thin-film disks and heads, established firms like IBM led the way. Yet disruptive changes almost always caused major transitions in the industry. By the time the new technology became clearly more efficient than the old one and generated new markets of sufficient size for big firms to become interested, it was too late for entrance by most of the established firms (13–15). Essentially, leading firms failed when confronted with innovations that required a new way of doing business, but succeeded when confronted with innovations that enhanced the previous way they did business.

That insight forms the basis of the relevant predictions about MMIs.[56] Focusing on variations in the financial and organizational requirements for adopting an innovation yields four ideal types of cases: requirements are either

[55] These ideas build on some of the concepts contained in Joseph Schumpeter (1942).

[56] Others have also used Christensen to make arguments about military innovations, including Dombrowski and Gholz (2006, 18, 26–29) and Terry Pierce (2004).

high financial–high organizational, low financial–low organizational, high financial–low organizational, or low financial–high organizational.

Innovations requiring low levels of financial intensity and organizational capital to adopt are not terribly interesting from a relative power perspective. Nearly all affected states should be able to quickly and efficiently adopt the innovation, since it presents neither significant financial barriers to entry nor extremely complicated organizational procedures. One example of this might be the rapid adoption of chemical warfare by the entente powers following Germany's use of poison gas in the Second Battle of Ypres in World War I. Other possibilities are more interesting. MMIs requiring a large financial investment but not much organizational transformation are likely to benefit pre-innovation great powers and/or the system leader, since they are the wealthy states, and best positioned to simply build or buy the relevant technology and plug it into their military. Preexisting major powers will merely incorporate the new technologies and some doctrinal changes into their existing organizational structures, meaning they can rapidly build up in the new area of capabilities. Nonmajor powers will face huge financial barriers to entry even if adoption is possible from an organizational perspective. An example of this, discussed in greater detail below and in chapter 4, is the spread of nuclear weapons, especially in the first decades after World War II.

In contrast, innovations requiring high levels of organizational capital to adopt but low levels of financial intensity can generate disruptions in the balance of power due to the metamorphic organizational shifts required to take advantage of the new ways of war. Rebecca Henderson (1993, 250, 254–55) divides innovations into categories based on the relative degree of economic/technological and organizational change necessary for implementation, studying innovations in the photolithographic alignment equipment industry, a subset of the semiconductor industry.[57] She finds that the types of innovations that caused the most industry turnover were technologically incremental but organizationally radical, such as contact printers and scanning aligners. The failure of firms like Parker-Elmer when faced with organizationally radical changes like stepper aligners highlights the primacy of organizational change as a causal variable (261–62). Organizational inertia made the efforts of leading firms less effective than those of market entrants. While leading firms were not absent when radical innovation occurred, their ability to take advantage of those types of innovations was lower than those of entry firms. When innovations were organizationally incremental, however, leading firms capitalized because their existing business structure was reinforced by the new innovations, giving them a larger advantage over smaller firms (267–68).

[57] Photolithographic aligners are critical elements in the production of solid-state semiconductors, representing up to 30 percent of the production costs in a semiconductor facility (Henderson 1993, 256).

When new military innovations require high levels of organizational capital to implement, Henderson's research and Christensen's work on firm failures suggest that just as those firms that are most successful in existing markets often flounder in the face of disruptive innovations, having the ability to heavily and successfully invest in the military capabilities that enhance combat effectiveness during one period may handicap the capacity of a military organization to transform to deal with the next era. These firms struggle for similar reasons to those described by Jervis when assessing how decision makers integrate new information. Jervis explains how preexisting beliefs shape the way that decision makers integrate new information. Their worldviews, which have served them well in the past, can blind them to changing circumstances, since they see things through the lens of their past experiences and beliefs. Therefore, they apply the same cognitive map to a new circumstance even though it is now inappropriate (Jervis 1976, 143).

In the military context, since these types of innovations will require doing business differently, rather than doing it better, research and development segments of leading military organizations are more likely to dismiss early signs of the innovation as irrelevant to core competencies, placing them at a tacit knowledge disadvantage if/when they attempt to catch up later.

The low required financial intensity will decrease the barriers to entry in the international system, potentially allowing new states to compete by at least partially wiping the military slate clean. This will threaten the position of existing powers as some likely try to resist the change, while others recognize that an adoption-capacity gap means the state must choose an alternative strategy and accept a period of relative decline. Many argue that combined arms warfare, also known as blitzkrieg, falls into this category. As Ernest May (2000, 476–80) and others have pointed out, the other armies of Europe possessed much of the same, if not more, raw military equipment: radios, airplanes, tanks, and motorized vehicles. It was the way Germany put together those technologies into maneuverable, deep-strike packages that was inventive. The German departure from the French strategy of static defenses and trench warfare required a significant shift in training and operations, making maneuver warfare difficult to adopt for many militaries (Boot 2006, 233–36). France, in contrast, represented a military with a low level of organizational capital due to its high organizational age; this is one reason that its victory in World War I locked in flawed lessons about future wars that prevented it from grasping the potential of maneuver warfare (May 2000, 449–50).

Finally, shifts requiring high levels of organizational capital and financial intensity, precisely because their spread rate and extent is likely to be constrained, should theoretically have the largest effect on the balance of power because countries that do take advantage of the MMI will gain long-term asymmetrical power advantages. Major powers that lack the capacity to adopt the new MMI are also the states more prone to making strategic errors when

facing a challenge.[58] The carrier warfare case, described in more detail in chapter 3, exemplifies this rare but powerful high-high case.

Table 2.3 outlines the idealized relationship between the diffusion of a given MMI in a normally distributed international system (an important qualifying assumption) and its impact on global power.

Regardless of one's theory of change in the balance of power, the above examples demonstrate that shifts in the ability to produce power matter. Military innovation diffusion represents one causal process governing the timing and character of power shifts that have been previously explained on the basis of other factors. The degree to which leading countries take advantage of new forms of military power helps predict long-term trends relating to the international balance of power.

First-Mover Advantages

Economists have argued about the relative advantages a firm achieves when it is the first to introduce a new technology or marketing strategy into a given market, making it the so-called first mover (Bain 1956; Schumpeter 1942). While the notion of first mover generally refers to the ability to bring a new product to market in a way that captures large amounts of market share, it is useful to break down first-mover advantage into its component parts. There is both a technological and an organizational component to first-mover advantages. The technological advantage refers to hardware; firms break ground directly in the area of a given product, like semiconductor improvements, or introducing entirely new products, such as the personal computer. The organizational advantage is when firms take a given technology, and figure out how to produce and market it in ways that give the firm an advantage. The production line, which Henry Ford developed for the Model T, exemplifies an organizational first-mover advantage.

There are some clear advantages to being a first mover in terms of long-term rents and business viability (Milner and Yoffie 1989, 244). One analogy between the military and business world comes from patent law, which influences the ability of firms to maintain a monopoly on production knowledge and extend their first-mover advantage (Mykytyn, Bordoloi, McKinney, and Bandyopadhyay 2002, 1). Industries like pharmaceuticals that depend on secrecy regarding production processes have shown that patents are critical to the long-term viability of first-mover advantages (Lieberman and Montgomery 1988, 43–45). Military organizational processes are somewhat (though not entirely) comparable to the special knowledge a company has when it invents a product.

[58] These states may or may not be in decline prior to the onset of the innovation. Adoption-capacity theory is agnostic on that point.

TABLE 2.3
Relationship between the Spread of Military Power and the Balance of Power

		Level of financial intensity required to implement major military innovation	
		Low	*High*
Level of organizational capital required to implement major military innovation	*Low*	• Diffusion fast • Impact short-term and not likely to be structurally significant • Relatively shorter first-mover advantage • Key example: chemical warfare	• Diffusion medium • Risks reinforcing existing global power balance • Relatively shorter first-mover advantage (except in extreme cases) • Relatively benefits existing powers • Key example: nuclear weapons
	High	• Diffusion medium • Risks reordering global power balance in ways likely to threaten existing powers • Relatively longer first-mover advantage • Key examples: suicide terrorism, Napoleonic warfare, combined arms warfare (blitzkrieg)	• Diffusion slow • Likely to have substantial and long-lasting disruptive impact on balance of power • Relatively longer first-mover advantage • Key example: carrier warfare

Like businesses, MMI first movers have a natural incentive to maintain secrecy about new technological capabilities and their organizational processes, since either or both could be based on knowledge that the first mover wishes to prevent from leaking. But once a demonstration occurs or enough information spreads, it is difficult to maintain secrecy for all but the most complex innovations. Like firms choosing research and development strategies, military organizations have to determine whether to allocate limited resources toward reinforcing competence in current military areas, or potentially becoming a first mover in new military technology or innovative organizational processes (Lieberman and Montgomery 1988, 54).

The length of the first-mover advantage for a given innovation affects its consequences for international politics for two reasons. The relative power of a first-mover state should increase faster vis-à-vis peer states during its first-mover period than in any other one. Additionally, the substantive effect of a specific military innovation should also be especially pronounced for first movers. For

example, some innovations, like Prussian open-order tactics in the late nineteenth century, involve taking advantage of breakthroughs in transportation, such as the railroad. In that case, the content of the innovation, combined with the first-mover advantage, produced an enormous military edge for Prussia against France in the Franco-Prussian War. But the innovation quickly—albeit partially—spread, to some extent negating Prussia's first-mover advantage over the medium-term (Herrera and Mahnken 2003, 226).[59]

The adoption requirements for an innovation influence the length of the asymmetrical advantages that adopters receive, especially first movers, changing the way an innovation matters for the security environment. If an innovation is relatively easy to adopt, an actor will be unable to hold on to its first-mover advantage long enough to establish a dominant monopoly; adoption will be relatively easy for both early adopters and those that follow. The length of the first-mover advantage will decline, and the *relative* impact on the international balance of power will also be smaller. Other states in the system will mimic the first mover quickly enough to negate many of the advantages to being first.

In contrast, innovations that are more difficult to adopt, especially in terms of organizational requirements, will provide greater first-mover advantages to early adopters, helping them achieve larger international political advantages. Innovations based on new knowledge are more difficult to adopt, either because expertise at prior key competencies makes acquiring the new knowledge harder or because they are breakthroughs in new areas where others lack knowledge. These innovations are also entry enhancing, meaning the door is open for massive market upheavals (Darby and Zucker 2003, 2, 8; Tushman and Anderson 1986).

First-Mover Gains Hypothesis: First movers should experience relative gains in power proportional to the length of their monopoly over the MMI and its relevance in international politics. The length of the first-mover advantage will be inversely proportional to the diffusion rate of the innovation.

First-mover advantages might not apply in all cases, however. Late movers have an edge in some business environments because they can take advantage of technological improvements to innovations that reduce the uncertainty and risk associated with a given product (Lieberman and Montgomery 1988, 47–48; Tellis and Golder 2002).[60]

[59] It is also important to distinguish between those states that follow the first mover, like Germany with all-big-gun battleships, and true late movers, like North Korea with nuclear weapons. "Late-mover effects" refers to the latter, not the former.

[60] This concept is related, though not quite the same, as the argument that Gerschenkron (1962) makes about the advantages of "backwardness." Gerschenkron's assertion is more about development than about the response to innovation winners. There is a potential disadvantage to being a first mover in a military area that relates to organizational inertia as well. For example, automobile first-mover Henry Ford continued to use the same business model to produce his cars even after developments in the industry should have caused changes (Abernathy and Wayne 1974, 109). So the organizational model that led to his success also led to a form of bureaucratic lock in due to its high organizational age and narrow critical task focus.

Late-Mover Gains Hypothesis: Late adopters will face lower barriers to adoption due to more available information about the innovation, giving them a relative power edge over first and early movers once adoption occurs.

War

The diffusion pattern for major military innovations can also influence a broad range of factors related to how states select into wars and fight. Rapid changes in military effectiveness may also affect the overall utility of military power as a method of accomplishing political objectives.

GEOGRAPHY

The effect of geography on international interactions, especially military interactions, is well-known (Diehl 1985; Vasquez 1995). While most disputes are between contiguous states because they are fighting to control territory, the technology and thinking about the use of military force undergirding most military operations should not be ignored. If it takes years and/or decades to reach the land of an adversary, it will be much harder to fight a war than if an adversary is right next door.

MMI diffusion, presuming the MMI is successful (which is not necessarily the case), should substantially alter the geography of military incidents by allowing states that experience MMIs to militarily interact with a broader geographic range of states. The effect should be more pronounced when both states in a dyad have experienced an MMI, but should also exist in an asymmetrical relationship.

Even if a particular innovation is not directly related to the technology of travel, major military innovations may give a state the ability to conduct more deadly military interactions in a wider geographic range. For example, the rifle and machine gun allowed for the projection of lethal force with fewer troops than were previously necessary, increasing the geographic scope of expeditionary forces.[61]

To the extent that MMIs shift outward the geographic range of the possible in a military sense, they should introduce more systemic instability, meaning

[61] For instance, take two states that have normal economic and diplomatic relations but cannot interact rapidly due to geographic constraints. If an MMI makes it possible to effectively project military force faster at a much greater distance than was previously possible, one or both states will have the ability to more credibly make military threats. This could fundamentally shift state-to-state relationships.

periods with MMIs are more likely to have more militarized interstate disputes (MIDs) and wars on a systemwide level, not just for those states experiencing an MMI or competing with a state experiencing an MMI.

SPEED

In addition to widening the geographic range of states with which a given state can interact, some MMIs may also enhance the speed of those interactions. If states can more quickly mobilize military forces, they can issue credible threats more often and in a wider variety of situations, including economic and diplomatic cases. MMIs that allow for the projection of force faster and in greater depth could still allow states greater coercive options in regular interactions, meaning they should influence the way that states behave even if both states have achieved an MMI.

It is possible that rapid mimicry may erase the speed-based impact of an MMI, meaning that neither side gets an advantage once the first-mover advantage has been countered. Still, MMIs should enable states to issue credible threats in a shorter time frame than was previously possible. Also, a state that has experienced an MMI could have the ability to respond to diplomatic overtures much more quickly than was previously possible. The end result is that the rate of military interactions between countries should increase at the subwarfare level (i.e., low-level militarized disputes) because of the increase in the opportunities for interaction offered by an MMI.[62]

INTENSITY

Diffusion patterns will also influence the rate and extent of casualties, or war intensity. If slower-spreading MMIs lead to more asymmetrical wars between MMI adopters and nonadopters, those wars are likely to be shorter. Yet the wars themselves will probably feature much higher relative casualty rates suffered by the nonadopter, controlling for war length and engagement size. In contrast, wars fought during periods of rapidly spreading MMIs are likely to be especially intense as states deploy heightened military capabilities against each other and raise the overall level of violence without changing the balance of forces, meaning the war is likely to be both bloodier and longer.[63]

[62] Alternatively, MMI adoption could increase the number of choices for an adopting state in a given militarized situation, lengthening the decision-making process.

[63] As described above, innovations are themselves rarely offensive or defensive; the question is whether one side has an asymmetrical advantage. If an innovation tends to make attacks easier if the defender has not adopted, though, versus making defense easier if the other side has not adopted, it could lead to some advantages. This line of thinking shows the importance of organizational plans for using technology, rather than technology in and of itself. Technology only acquires an offensive or defensive character in the hands of military organizations. See Goldman and Andres 1999.

Military Interaction Hypothesis: In general, states that experience an MMI will have more frequent, varied, and intense military interactions with a broader range of states than those that have not experienced an MMI.

Answering Objections

There are several potential questions raised by adoption-capacity theory.[64] One clear criticism is that this story only deals with the "supply-side" of the equation, ignoring the issue of why states might be interested in adopting innovations. This is an important related issue, but this book is designed to build on existing work and deal with a distinct question. As noted above, there has been a great deal of prior work, much of it good, on why states are interested in adopting innovations. Adoption-capacity theory begins at the point that diffusion starts, *after* the point at which the international system, or norms or other factors, influence whether or not a state feels compelled to respond to an innovation. It is variation in the adoption requirements for innovations in relation to the capacity of a state to adopt that determines the *content* of state responses. The geostrategic environment can make a country want to respond to an innovation, but state capacity to adopt will be a critical input into the character of that response. That analysis helps a state figure out whether adoption, using external alliances, or shifting to neutrality, for instance, might be the best response. And of course, those choices are not necessarily exclusive.

Critics of the idea that organizational capital matters might protest that rational national leaders should recognize that their military organizations are ossified and adjust national policy accordingly to boost the organizational capital of their military, giving them the capability to adopt necessary innovations. Domestic political constraints, however, often prevent leaders from enforcing large-scale organizational changes on a national military in the short-term. Most national leaders, even in nondemocracies, depend on support from at least one and sometimes more major nonmilitary constituencies in addition to support from the military. Barbara Geddes's work (1999) explaining the restraints on leaders in different types of nondemocracies shows that few leaders have true dictatorial power to quickly enact large-scale changes. The process of building support takes time and bureaucratic political capital. Given that leaders want to stay in power, they are unlikely to push for changes that they think will decrease their chances of political survival, especially if ejection from office may make their personal survival less likely as well (Goemans 2000). So if the short-term risk to the leader from a "nonoptimal" response is lower than if

[64] For instance, there are potentially significant questions regarding how power transitions function and the war-escalation process that are excluded for space-related reasons.

the leader pushes for adoption, most leaders will rationally decide not to push for adoption.

Rosen's work (1991) on military innovation also shows that external pressure from politicians is often not enough to cause militaries to change their organizational setup, especially pressure related to war fighting. For example, many link the operational struggles of the U.S. Army in the Vietnam War in part to its failure to reform despite pressure from civilian leaders. In the early 1960s, U.S. president John F. Kennedy directly ordered the army to focus on and train for counterinsurgency warfare. Despite this high-level pressure, the army failed to significantly change, instead opting to cosmetically modify its training programs and define counterinsurgency as a lesser and therefore easier form of conventional warfare (meaning training for conventional war would also prepare the army for counterinsurgency warfare). As a result, the U.S. Army entered the Vietnam War much less able to fight an insurgency than it would have been if external civilian pressure had been enough to cause change (Bacevich 1986).

Another potential critique is that perceptions of innovation effectiveness, rather than adoption capacity, predict the distribution of responses to an innovation. If countries only adopt those innovations that work, does this provide evidence against adoption-capacity theory? This question misconstrues the point of adoption-capacity theory. It is certainly true that perceptions of the effectiveness of an innovation create the framework within which diffusion does or does not occur. For example, strategic bombing is an innovation that did not diffuse in part due to perceptions of ineffectiveness. No theory can explain everything. The point of adoption-capacity theory is that within the range of those innovations that states might be interested in adopting, wanting to adopt an innovation is not enough to predict the distribution of responses or the affect on international politics.

Moreover, if knowledge of innovation effectiveness is all that is necessary to predict diffusion, there should be either a lot more diffusion of innovations than happens empirically—since most MMIs do not spread widely, especially initially—or all actors with the capacity to adopt an innovation should adopt. But instances like the British Army in response to Napoleonic warfare, which had the capacity to adopt mass mobilization but chose not to, show that countries do not automatically mimic successful innovations just because they can (Herrera and Mahnken 2003, 216–17). Also, if perceived effectiveness is the key factor, the pattern of responses to innovations should not change based on the adoption requirements, meaning empirical variation in the number of states that adopt, counter, and/or form alliances shows that automatic adoption of successful innovations does not occur. Instead, it is the relative financial and organizational requirements for adopting an innovation that best predict the distribution of responses and many individual actors.

Finally, in many cases, only a small number of actors either adopt an innovation or have the ability to adopt. These relatively small sample sizes, rather than representing a problem for the theory, help illustrate the difficulties involved in adopting especially complicated innovations. If innovation adoption was easy and many states could quickly adopt major military innovations, even though how wars are fought might change, a given innovation would be unlikely to change the international security environment much in a *relative* sense. The lack of innovation diffusion in some situations, despite clear strategic need, demonstrates adoption-capacity theory at work.

This book represents an attempt to fuse together some important aspects of previous research into a more coherent explanation for the diffusion of military power. Therefore, when assessing alternative arguments, in many cases pieces of them overlap with adoption-capacity theory, although pieces of them diverge as well. Additionally, in some instances I explain what alternatives from the literature might look like even though the literature does not explicitly address the same questions. That is a crucial caveat on this section, but it also means I am trying to build the strongest possible alternatives for comparison. Drawing from these preexisting theories means this section focuses more on attempts to derive orthodox and exclusive versions of alternative explanations than anything else.[65]

Returning to the existing research on the diffusion of military power within the international relations literature, as described above it is possible to derive three competing schools of thought: a more or less neorealist set of arguments concerning the critical role threats and strategic competition play in governing the diffusion process; a norms-based contention that innovation adoption occurs when states try to gain status or legitimize their existence, not as a strategic measure to increase relative power; and a cultural assertion about the importance of cultural similarity in allowing responding states to adopt innovations. As explained above, adoption-capacity theory both builds on and moves beyond this research, but it is essential to discuss some of the distinctions.

Strategic Competition

The broadest version of this realist line of argumentation is that states engage in security maximization in response to military innovations, with geopolitical pressure based on the particular situation of a state determining the particular national response to an innovation. The behavior of military organizations in response to innovation is determined by systemic pressure.[66] Resende-Santos's

[65] For example, while interservice competition undoubtedly plays a critical role in the process in some respects, there is not an account of its relationship to the diffusion process writ large. Moreover, the understanding of organizational capital presented here incorporates some elements of interservice rivalry.

[66] Goldman and Eliason (2003b, 8) also make this point.

recent book (2007) on South American militaries in the late nineteenth century maintains that the severity of external threats explains the extent of emulation and that countries attempt to emulate successful innovations in relevant areas of warfare.[67]

The strategic competition alternative is powerful because most instances of military diffusion probably have *some* strategic aspects at their core, whether it is due to perceptions of threats motivating interest groups to promote particular types of changes or global norms causing the interpretation of events to occur in such a way that it makes certain innovations more likely to diffuse than others. Indeed, when applied to the decisions of particular states, adoption-capacity theory similarly contends that the geopolitical position of a state helps predict its behavior—though in a less mechanistic fashion.

Nonetheless, there are several reasons to think the picture offered by the strategic competition perspective is incomplete, especially in the case of Resende-Santos's research (2007, 296, 300), which is the most recent realist work on the topic. First, a strict strategic competition approach excludes the notion that financial and organizational capacity play important roles influencing the response to innovations. As described above and as the subsequent empirical chapters will show, however, factors internal to military organizations play a critical part in determining how militaries approach war and organize themselves to fight. Case studies ranging from British strategy in the Boer War to U.S. naval developments in the 1920s and 1930s to Soviet military innovation in the post–World War II period show the significance of internal military organizational factors in driving the innovation-adoption process (see, for example, Avant 1994; Farrell 1998, 408–9; Rosen 1991; Zisk 1993).

Second, strategic competition can predict potentially which states might be interested in adopting an innovation, but it does not predict which of them will actually succeed in adopting; it can only predict interests, not outcomes, since it cannot explain capacity (for a similar point, see Goldman 2003). For example, Resende-Santos (2007, 9) explicitly excludes whether or not attempts at adoption succeed from his theory. While a neorealist might respond that sufficiently motivated states will always just build the capacity to adopt an innovation, the discussion above shows that sometimes the organizational or financial barriers to change may be sufficiently large that adoption becomes unrealistic. Adoption-capacity theory predicts both the strategy a state will adopt and whether or not attempts at adoption, if they occur, will succeed.

Third, a pure strategic competition approach risks tautology: if the theoretical prediction is that states adopt military innovations when they feel strategic pressure, one could argue that by definition, anytime a military adopts

[67] Waltz (1979, 92, 106, 127) suggests that emulation rapidly occurs in response to innovation and that security maximization is only really a question of adoption. Elman (1999), however, disagrees.

an innovation it demonstrates the "capability," broadly defined, to adopt the innovation and the state must have faced a strategic threat, while anytime an innovation is not adopted it demonstrates the *lack* of capability or need, broadly defined, to adopt. Threats do clearly matter and influence the way that actors view the potential risks involved in making defense planning choices. But threats alone are insufficient; questions of the relative benefits or costs of innovations are something that several theories could potentially explain, meaning it is inappropriate to describe all approaches that argue states weigh costs and benefits as "realist" (Zarzecki 2002, 67).

In addition to these arguments, there are other important distinctions between adoption-capacity theory and Resende-Santos's claim. He argues that countries emulate military systems with proven success in warfare, using the South American adoption of the German military model (Resende-Santos 2007, 80–81). But the international response to the *Dreadnought* shows that large-scale responses to a new innovation, both emulation and alternative strategies, can occur even before use in warfare (see chapter 5). Adoption-capacity theory is also focused on something smaller since it concentrates explicitly on the response patterns to the debut of a particularly large and crucial class of military innovations, rather than a situation where an established model has existed for decades. Additionally, while he only looks at whether or not states emulate, adoption-capacity theory predicts the alternative response strategy of states, which could be emulation, but could also be something else. Finally, adoption-capacity theory makes predictions about the systemwide response to an innovation, while Resende-Santos addresses how individual states might respond.

International and Domestic "Norms"

Another perspective on the diffusion of military power maintains that shared norms of appropriate behavior determine the way that states respond in the international environment and that military affairs are no exception (DiMaggio and Powell 1983; Finnemore 1996). One phrase often used to describe this approach to studying military organizations is "sociological institutionalism" (Hall and Taylor 1996).

Dana Eyre and Mark Suchman apply sociological institutionalism to military technology purchases in the developing world, contending that the spread of military technology is based more on perceptions of appropriateness by minor powers than genuine security concerns (Eyre and Suchman 1996, 96; Suchman and Eyre 1992; Wendt and Barnett 1993). Theo Farrell's work (2005) on convergence due to norms, described above, also fits into this category.[68]

[68] There are several variants of these arguments, including competitive isomorphism, or mimicry due to competitive pressure, which leads to predictions similar to the realist claims explained above.

Institutional isomorphic approaches often predict mimicry due to status seeking rather than competition.

To some extent the norms alternative is not necessarily competitive with adoption-capacity theory, because adoption-capacity theory is not deterministic on the reasons why states might attempt to purchase specific technologies. Because the locus of the theory involves systems of fighting, or the organization of military forces for warfare, it is entirely possible that weapons transfers, especially, occur at least partially in line with the predictions of this norms research.

While norms may play an important role in determining the rate and extent of diffusion, the norms approach is also incomplete (though to be fair, scholars like Farrell acknowledge that norms are not the only variable that matters). First, even if actors adopt organizational approaches due to the influence of international norms, those norms may exist as heuristics that maximize efficiency for nation-states in the international system. Some research in economics suggests that in "noisy" environments, or environments in which there are multiple conflicting signals, the adoption of goods or services by high-status actors functions as a proxy assessment of the quality of the good. That is to say, nation-states may converge on similar ways of producing military power because they are the best practices, not because they want to model other states to legitimize their existence.

Most important for studying the diffusion of military power, even if a norms perspective can explain the reason actors are interested in choosing particular strategies, it cannot explain implementation success or failure. Either a more fine-grained perspective or an approach where the norms motivating interest in the adoption and implementation of the innovation are relatively identical is necessary. A comparative advantage of adoption-capacity theory is its ability to describe the range of strategic choices in response to innovation, and whether those choices, including adoption, are likely to lead to success or failure for a given state.

"Culture"

Building on research inside and outside international relations, Goldman has shown that the levels of cultural tolerance help explain when states will make serious efforts to adopt innovations from abroad. Political systems that are more tolerant of external ideas are more likely to adopt innovations created abroad, since the public and elites will not view the innovation as an existential threat (Goldman 2006, 70). This is consistent with Michael Fischerkeller's research (1998) on the cultural foundations of military assessments.

It is essential, though, not to totally discount the significance of survival motivations for determining military organizational approaches, as Goldman (2006) also recognizes. While elites may block organizational changes that undermine their power or influence, the incentives to adopt efficient ways of producing military force will be powerful and frequently generate countervailing interest groups. The threat levels facing a country or the initial relative power of interest groups may get filtered through a cultural viewing lens—but they may have independent power as well, influencing the way domestic actors perceive the necessity of change.

Goldman (2007) and Elizabeth Kier (1997) also recognize that culture is not static. The debates over the implementation of a particular military organizational approach could lead to minds being changed and the creation of new cultural norms, especially if the approach is adopted in response to shocks like an unexpected defeat in a war.[69]

Second, arguments often called cultural may also fit into domestic political or organizational approaches, meaning determining causal priority is difficult. For example, while elites want to survive in their positions of authority and might view the adoption of some particular military organizational approaches as threatening, it is difficult to draw the line between calling that sort of rigidity and power seeking a "cultural argument" versus a "domestic politics argument," with the organization of the state or military playing the determinative role in predicting the outcome of attempted military organizational changes.[70]

One limitation with this cultural alternative is that it is only focused on the question of innovation adoption; it does not make predictions about strategic choices in general. The idea that cultural openness may influence the interest states have in adopting innovations is also consistent with adoption-capacity theory, since adoption-capacity theory does not exclude other motivations for adoption.

Finally, the strong cultural perspective also risks tautology in some cases because it is difficult to evaluate variables like openness to cultural diversity without evaluating if the state in question actually adopted the particular innovation being studied.[71] This risks the independent variable (the level of acceptable cultural diversity) being coded on the basis of variation in the dependent variable (whether or not the innovation is adopted). This is clearly problematic; it both artificially creates the appearances of a causal linkage where one may not exist and could lead to attribution bias because it incorrectly identifies the actual source of cultural diversity, failing to independently define that variable.

[69] Another possibility is that culture may sometimes serve as a proxy for substantive debates, with cultural language serving as a way of explaining material concerns. The point is not that culture does not matter, just that it is important not to view culture as necessarily static.

[70] Goldman (2006) explicitly tests these arguments against each other in her work on the Ottoman Empire and Meiji Restoration, finding that political culture, in the form of elite beliefs, influences the receptivity of a society to military innovations. Adoption-capacity theory attempts to provide an explanation for issues like why elites' attitudes might be more or less receptive to innovations in a given case.

[71] Goldman's work (2006) explicitly hedges against this possibility.

Adoption-capacity theory can also arguably describe the conditions in which cultural openness is likely to occur, especially with regard to military organizations. Militaries with high levels of experimentation, young organizational ages, and critical tasks less defined by operational methods have higher levels of organizational capital, making it easier for them to be culturally open and adopt innovations. This is a more complete argument explaining innovation capacity because it allows for concrete predictions about when cultural tolerance is likely to occur, along with falsifiable indicators such as the commitment a military has to experimentation.

Case Selection and Next Steps

This book employs two primary research methods—qualitative cases studies and quantitative analysis—to determine how states respond to new major military innovations, and how those responses affect international politics. The case studies are necessary because, as discussed above, differences in how long innovations remain relevant and the possibility of overlapping innovations in different areas of warfare, like land and sea, make a comprehensive data approach untenable. Additionally, innovations occur in part as an action-reaction process. New innovations displace, or sometimes even exist alongside, the dominant weaponry and strategies of previous periods. This means attempts to measure the diffusion of innovations are often "right censored." We rarely get to see the full distribution of responses to an innovation, over time, since new innovations arise to replace old ones while states may be trying to build the capacity to adopt or develop a long-term response strategy. In other cases, we might get to see the full distribution. But the potential for right censoring makes it difficult to evaluate the diffusion process.

Instead, the unit of analysis is the innovation itself. Process tracing is used for each case to establish the existence of the innovation and evaluate the extent to which diffusion processes governed the specific strategic choices of key states. Quantitative analysis provides a bigger-picture perspective for some of the cases, showing trends only comprehensible when the reactions of all states are aggregated together at the system level. The methodological combination increases confidence in the accuracy of the results by ensuring that both the micro- and macrolevels are consistent with the theory.

Table 2.4 shows a range of military innovations that scholars have claimed "qualify" as major military innovations from 1800 to the present. Since many scholars diverge in their thinking about which cases count, this study uses the universe of major military innovation candidate cases as its range.[72] Even if

[72] The debate over which military innovations count is an important issue that deserves recognition. This book can only examine a small number of cases, and there are disagreements over which cases should count. But this book represents a first step toward a more integrated theory of innovation diffusion.

Table 2.4
Range of Possible Major Military Innovations, 1800–Present

Timing	*Revolution*
Nineteenth century	Napoleonic revolution/levée en masse
Nineteenth century	Strategic communications/mobility
Nineteenth century	Professional staff personnel and procedures
Nineteenth century	Prussian open-order tactics: Railroads/rifles/telegraph
Early twentieth century	**Battlefleet warfare**
Nineteenth to twentieth centuries	Tactical fires (machine gun and artillery)
Nineteenth to twentieth centuries	Medical
Nineteenth to twentieth centuries	Fortifications (trenches)
Twentieth century	Chemical weapons
Twentieth century	"The modern system"
Twentieth century	Total industrialized war
Twentieth century	Blitzkrieg
Twentieth century	**Carrier warfare**
Twentieth century	Tactical air attack
Twentieth century	Air warfare (bombing)
Twentieth century	Submarine warfare
Twentieth century	**Nuclear weapons**
Twentieth century	Mao Tse-tung's "people's war"
Twentieth century	**Unconventional war/suicide terrorism**
Twentieth century	Microelectronics/genetics engineering
Late twentieth century	Information war/network-centric warfare
Late twentieth century	Fourth-generation warfare

scholars disagree about which cases meet their particular definition, they generally agree that the set of cases under consideration represents the most important military innovations. The existence of the scholarly debate itself also indicates that it makes sense to select cases from the broader set.[73]

The major military innovation cases evaluated in this study are the following: early twentieth-century battlefleet warfare, mid-twentieth-century carrier

[73] Some of the cases on this list overlap because scholars disagree in the way they categorize an innovation. For example, some scholars break up innovations like Prussian open-order tactics into three technologically defined component innovations: railroads, rifles, and the telegraph. The coding is based on information gathered by the author and Alexander Roland (1997). The bold cases are those covered by this book in depth.

warfare, nuclear weapons, and suicide terrorism. As table 2.5 shows, this selection of cases maximizes variation on the two key independent variables: financial intensity and organizational capital. It also allows for significant time variation, over a period of a century, and cases that focus on both nation-states and nonstate actors.

Carrier warfare is one of the only (strategic bombing may be another) major military innovations requiring high levels of both financial intensity and organizational capital to adopt. Even during the interwar period, when the battleship was still considered the most important element of the modern navy, aircraft carriers had already overtaken the battleship in terms of the cost per unit. Aircraft carriers are as complicated to operate as they are expensive, especially the adoption of carrier task forces, the crux of the carrier warfare innovation. Operating a floating airfield and the ship itself, plus coordinating with support ships, is simply a much harder set of tasks than lining up the big guns of a battleship and firing.[74] In addition to this operational complexity, the critical task of carrier warfare, the massed air strike, replaced the five-hundred-year stranglehold of the big gun over naval warfare. So carrier warfare represents a disruptive innovation requiring enormous levels of organizational capital to implement, alongside its high cost.

Nuclear weapons, like carrier warfare, require high levels of financial intensity for adoption, but in contrast they only require low levels of organizational capital. Nuclear weapons are the only weapon in history where the mere possession of one unit, one nuclear bomb, regardless of anything else, substantially impacts international security, as the unresolved North Korean and Iranian nuclear controversies highlight. There is no other weapon where just threatening to develop a single decades-old version vaults a country onto the priority list for high-ranking U.S. government officials. The uniqueness of nuclear weapons as a symbol of power for coercive purposes in and of themselves, and the potential destruction in the case of use, makes studying the spread of nuclear weapons and the strategic choices made by states in response to nuclear weapons especially interesting. It requires a low level of organizational capital to adopt, despite its organizational complexity, because there is no particular organizational form that is necessary to acquire and deploy nuclear weapons.

The suicide terrorism case is distinctive because it involves an attempt to apply a theory designed to predict the behavior of traditional military organizations to terrorist groups—nonstate actors. Suicide terrorism represents the premier military "innovation" among tactics by terrorist groups (and arguably all nonstate actors) over the last twenty-five years.[75] The chapter focuses on the

[74] While battlefleet warfare was not easy to adopt either, carrier warfare was harder.

[75] Depending on how one thinks about guerrilla warfare, and whether current nonstate violent movements are substantially similar to or different from past guerrilla warfare strategies, "modern" guerrilla warfare could also qualify.

TABLE 2.5
How Variation in Adoption Capacity Drives Case Selection

	Required level of financial intensity	*Required level of organizational capital*
Battlefleet warfare (chapter 5)	Medium	Medium
Carrier warfare (chapter 3)	High	High
Nuclear warfare (chapter 4)	High	Low
Suicide terrorism (chapter 6)	Low	High

terrorist group as the unit of analysis, looking at the factors that drive some terrorist groups to adopt suicide terrorism but others to stick with prior tactics. Some revisions are necessary to account for the differences between states and nonstate actors, yet the core theoretical contentions are pertinent. Terrorist groups still face organizational challenges and financial constraints, meaning adoption-capacity theory is applicable.

As referenced above, the adoption of suicide terrorism requires a low level of financial intensity. There is also no real "signature" technology underlying the innovation. Delivering explosive destruction through the necessary death of the transmitter, the suicide bomber, is a different operational paradigm from something like kidnapping or hijacking, however. As an innovation that requires high levels of organizational capital but only low levels of financial intensity to adopt, the suicide terrorism case is a nice contrast to the nuclear weapons one. By showing the portability of the theory beyond simply those MMIs mostly of interest to great powers, this case highlights the utility of adoption-capacity theory for thinking about strategic choices in response to all types of military innovations and perhaps for outside the military realm as well.

Finally, since no cases truly fit in the "low-low" box, further diversification along the key independent variables was conducted by selecting an innovation requiring medium levels of both financial intensity and organizational capital to adopt. The battlefleet warfare case involves the creation of the all-big-gun steel battleship, the culmination of the fifty-year-long operational shift away from the wooden-hulled sail navies that had dominated naval warfare for centuries. Battlefleet warfare also involved skyrocketing procurement costs for the new ships because the fast rate of warship obsolescence in the late nineteenth and early twentieth centuries due to rapid technological changes meant states had to consistently ramp up their naval procurement budgets. Give that preinnovation spending was already high at the unit cost level and the underlying basis of the previous era had also been military rather than civilian, the financial intensity required for battlefleet warfare was medium. Modern battlefleet warfare forced enormous changes in recruiting and training, because the core tasks conducted by the average sailor had changed from climbing the rigging

and trimming sails to operating steam boilers and using automated fire control systems for the big guns. Still, battlefleet warfare was also a sustaining innovation because while it required large-scale changes in recruitment, education, and training, the critical task of most navies remained the same: seeking a decisive battle in which it could deliver the maximum possible number of shells on to enemy ships. Thus, the organizational capital required for adoption was medium.

Each chapter proceeds by outlining the essence of the innovation and its emergence in the international system, then applying the theory to predict the strategies states will choose in response, whether those that attempt to adopt the innovation will succeed or fail, and how the overall distribution of choices influenced key aspects of the international security environment. Depending on the available data, the empirical chapters feature different combinations of qualitative and quantitative methods. The suicide terrorism and nuclear weapons chapters include quantitative statistical tests for the diffusion of the innovation, while the battlefleet and carrier warfare cases rely more on process tracing based on primary and secondary source research.

Conclusion

Adoption-capacity theory is a new approach to studying the introduction and spread of major military innovations. It builds on existing research on military innovations and emulation to produce a framework for explaining the way that military innovations spread throughout the international system. It also helps us understand, conceptually, the way that the uneven pace of military innovation diffusion functions as one of the major driving factors underlying shifts in relative power and warfare. The next four chapters empirically test adoption capacity on the cases described above: carrier warfare, nuclear weapons, battlefleet warfare, and suicide terrorism.

Chapter 3

CARRIER WARFARE

As the predominant form of naval power, aircraft carriers are one of the clearest symbols of military strength on earth. Short of the atomic bomb, nothing signifies the power of a great nation like the possession of a fleet of aircraft carriers, able to control the oceans and project power across great distances. It was the transition from battleship to carrier warfare that helped shepherd in the era of U.S. naval supremacy, and the complexities involved in adopting the innovation have ensured U.S. naval superiority ever since. The United States currently possesses an overwhelming advantage in naval power fueled in large part by its dominance in carrier warfare. While the United States presently operates eleven fleet carriers, no other country operates more than one fleet carrier—and only one other country, Great Britain, operates more than one carrier of any kind. Only the U.S. Navy, the Royal Navy, and the World War II era Imperial Japanese Navy have ever adopted the core organizational practices associated with carrier strike operations, the crux of carrier warfare. This is curious given the natural desire of states to protect their own security by building up their military forces with the best available technologies and practices. If the effective operation of aircraft carriers is a critical element of naval power, why haven't more countries adopted the innovation?

This chapter builds on work by Goldman and others on the development of carrier warfare during the interwar period and the early years of World War II, when carrier warfare matured. The chapter focuses on what happened next: the post–World War II gap between the diffusion of aircraft carrier technology and the diffusion of carrier warfare as an operational practice—the carrier strike operations almost simultaneously implemented as the core element of naval operations by the U.S. and Japanese navies after the Battle of Midway. One explanation for the nondiffusion of carrier warfare and the slow diffusion of carriers themselves involves geostrategic requirements: states simply have not needed carriers. Another possibility is that the failure of carrier warfare to diffuse in the post–World War II era lies somewhere between security requirements and the difficulties, financial and organizational, involved in adopting. The high financial and organizational requirements for adoption caused most naval powers to evaluate the costs and benefits of their naval strategy differently than they did in response to the naval innovations of the past, driving a larger proportion of states to drop out of the naval power game, bandwagon, or try to counter U.S. naval supremacy through alternative means.