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A Question of Balance

Political Context and Military Aspects of the China-Taiwan Dispute

David A. Shlapak, David T. Orletsky, Toy I. Reid,
Murray Scot Tanner, Barry Wilson

Prepared for the Smith Richardson Foundation

NATIONAL SECURITY RESEARCH DIVISION

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Preface

This paper is the final report of a project titled "The Changing China-Taiwan Military Balance," which evaluated key aspects of the China-Taiwan military balance looking out toward 2015. The study addressed four key questions:

- How are the political dynamics of the cross-strait relationship changing, and how could those changes affect perceptions of the military balance?
- How effective might China's growing force of short-range ballistic missiles be in attacking key military targets on Taiwan, such as air bases?
- How have changes in Chinese military capabilities changed the likely outcome of a possible contest for air superiority over the strait and Taiwan itself?
- In the light of the above, how can Taiwan be successfully defended against a Chinese invasion attempt?

This report should be of interest to military, government, and civilian planners, analysts, and scholars working on issues relating to the Taiwan Strait situation, Chinese military modernization, and U.S. military force planning and strategy in the Western Pacific.

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Contents

Preface iii
Figures ix
Tables xi
Summary xiii
Acknowledgments xxi
Abbreviations xxiii

CHAPTER ONE
Introduction 1
A Caveat 3

CHAPTER TWO
Changing Cross-Strait Political Dynamics 5
Beijing's Attitude Toward the Status Quo: Will Patience Remain a Virtue? 6
The Effects of Cross-Strait Economic Integration 8
Mainland Sanctions Against Imports from Taiwan 10
Disruption, Damage, or Sabotage of Financial Markets or Information Networks 11
Selective Harassment or Intimidation of Taiwanese Businesspeople 12
Taiwan's Evolving National Identity 14
The Legacy of Chen Shui-bian 16
The Politics of the Shifting Cross-Strait Military Balance 22
Security Implications of the Changing Political Landscape 26
The Dangers of Disappointment 28

CHAPTER THREE
Missiles over the Strait: China's Short-Range Ballistic Missile Force 31
China's Short-Range Ballistic Missile Force 32
A Simplifying Assumption 34
Air Base Attack 35
Cutting Runways 37
Hangars/Maintenance Facilities 44
Attacking Aircraft Parked in the Open 45
Air Base Attack Observations 50
Concluding Observations 51

CHAPTER FOUR
Assessing the Air War 53
Analytic Approach and Scenario Variables 56
Chinese Aircrew Quality 58
Chinese Air Operations 58
Defenses Against Chinese PGMs 59
Blue Sortie Generation 60
ROC SAM Survivability 60
Shelters at Blue Bases 61
U.S. Forces Engaged 62
Laying Out the Scenario Space 63
Character of the Air War 63
The Base Case Battle 64
Measures of Merit 67
Overall Outcomes and Driving Factors 69
Chinese Air Force Modernization 72
Chinese Aircrew Quality 72
Chinese Air Operations 74
Defenses Against Precision-Guided Munitions 74
Taiwanese Air Force Modernization 75
Blue Sortie Generation 76
ROC SAM Survivability 79
Number of Shelters 80
U.S. Contributions 81

Concluding Remarks: Not Your Father's Air War 84
Sidebar: Would China Attack Japan? 86

CHAPTER FIVE
The Ultimate Roll of the Dice: A Chinese Invasion of Taiwan 91
The Last Campaign of the Civil War: PLA Amphibious Operations, 1949–1955 94
The Falklands Campaign: Amphibious Warfare in the Age of the Antiship Missile 96
Looking Forward: The Lessons of "Operation Corporate" 100
Assessing the Odds: Could the Chinese Invade Taiwan? 103
Adding It Up: The Invasion Threat to Taiwan 118

CHAPTER SIX
Implications, Conclusions, and Considerations 123
The Political Backdrop 124
The Fall of Shot: Of Warheads, Wreckage, and Will 125
Unfriendly Skies: New Concepts Needed for New Challenges 129
On the Beach: Defeating a Chinese Invasion 135
Broadening the Scope: Implications for Other Scenario Variants 137
The Tyranny of Distance and the Longer Term 139
A Question of Balance: Maintaining Equilibrium on the Strait 141

APPENDIX
Missile Attacks on Economic Targets on Taiwan 145

Bibliography 151

Figures

3.1. CSS-7 (DF-11A) and CSS-6 (DF-15B) SRBMs 33
3.2. Tainan Air Base on Taiwan 36
3.3. Runway Attack Schematic 38
3.4. Probability of a Single Runway Cut, Given Number of Missiles and CEP 41
3.5. Probability of Cutting All Runways, Given Salvo Size and CEP 43
3.6. Large Hangar-Size Buildings on Tainan Air Base 44
3.7. Missiles Required to Hit 150 x 100 ft Structure, as Function of CEP 46
3.8. Missiles Required to Hit 150 x 200 ft Structure, as Function of CEP 46
3.9. Aircraft Parking Ramps on Tainan Air Base 47
3.10. Weapons Required to Cover a Single 800 x 800 ft Ramp 49
3.11. Weapons Required to Cover a Single 700 x 1,250 ft Ramp 49
3.12. Weapons Required to Cover a Single 800 x 800 ft Ramp 50
4.1. Chinese FLANKER Fighter 55
4.2. Outcomes of All Cases 70
4.3. Effects of PLAAF Modernization 72
4.4. Effects of PLAAF Aircrew Quality 73
4.5. Effects of PRC Air Operations 74
4.6. Effects of Anti-PGM Defenses 75
4.7. Effects of ROCAF Modernization, with 60 Sorties a Day per Base 76
4.8. Effects of ROCAF Modernization, with 40 Sorties a Day per Base 77

4.9. Effects of ROCAF Modernization, with 20 Sorties a Day per Base 77
4.10. Effects of Blue Sortie Generation 78
4.11. ROC Surface-to-Air Missile Survivability 79
4.12. Effects of the Number of Shelters 81
4.13. Effects of U.S. Contributions: Carrier Strike Groups Alone ... 82
4.14. Effects of U.S. Contributions: Carrier Strike Groups and F-15s, F/A-18s on Okinawa 82
4.15. Effects of U.S. Contributions: Carrier Strike Groups and F-22s, F/A-18s on Okinawa 83
4.16. U.S. Contributions: CSGs and Guam F-22s 84
4.A. Overall Results, No Attacks on Okinawa 87
4.B. Effects of Attacks on Kadena, F-22 Cases 88
5.1. HMS *Antelope* Explodes in San Carlos Water, May 24, 1982 100
5.2. Hellfire II Missile and Launcher 114
A.1. TSMC Fab 12, Hsinchu Science Industrial Park, Taiwan 147
A.2. Single-Shot Hit Probability Against Rectangular Buildings 148
A.3. Number of Missiles Required to Achieve a 90 Percent Probability of Hit Against Rectangular Buildings 148

Tables

3.1. Characteristics of CSS-7, CSS-6, and Notional SRBM 34
3.2. Characteristics of Notional Anti-Runway SRBM Warhead ... 40
3.3. Military Air Bases and Runways on Taiwan 42
4.1. Projected PLAAF Inventories 54
4.2. Projected ROCAF Inventories 56
4.3. ROC SAM Effectiveness 61
4.4. Sortie Rates and Exchange Ratios 65
4.5. First-Day Sorties Flown 66
4.6. Example Air-to-Air Engagement Rates 66
4.7. Impacts of Scenario Variables on Outcomes 71
5.1. Argentine Fighter Aircraft: Numbers and Losses 98
5.2. British Ship Losses 98
5.3. Major PLAN Amphibious Vessels: ~2010 104

Summary

The military balance across the Taiwan Strait is changing in ways that make more complex both the set of operational challenges associated with defending Taiwan against a possible Chinese attack and the strategic imperative of shaping Chinese behavior so that no such attack ever occurs.

This report documents a follow-on effort to one published in 2000 (Shlapak, Orletsky, and Wilson, 2000), reassessing and expanding that earlier study's snapshot of the cross-strait balance, looking ahead to the 2010–2015 period. As in the 2000 study, we employed a mix of theater-level combat modeling, simpler mathematical models, historical analysis, interviews with experts, and qualitative judgment. The conclusions of the present work have proven to be substantially less optimistic for the Taiwan (and U.S.) side.

The Evolving Cross-Strait Dispute

Ma Ying-jeou's election in 2008 as Taiwan's president and the further consolidation of the Kuomintang's (KMT's) hold on Taiwan's national legislature (the Legislative Yuan, or LY) has led to a reassuring break from 12 years of cross-strait frictions, during the last eight of which (2000–2008) Beijing struggled to keep independence-minded Taiwan president Chen Shui-bian "contained." This period featured the use of economic harassment as a politically satisfying—though not always successful—short-term method of signaling Chinese displeasure. But Beijing's difficulty translating economic leverage into political leverage

is not necessarily good news for either Taiwan or the United States. If China comes to believe that nonviolent tools have lost efficacy, it might be inclined to ratchet up military pressure in the event of a crisis, if only because of a perceived lack of effective alternatives.

Among the more profound changes to affect the political balance between Beijing and Taipei has been the growth of a widespread independent Taiwan identity, a sense of distinct "Taiwanese-ness." By December 2008, survey data indicated that the overwhelming majority of the island's citizens identified themselves as *exclusively* Taiwanese (51 percent) or both Taiwanese and Chinese (41 percent). By far the most troubling statistic, from Beijing's perspective, must be that fewer than 5 percent described themselves as exclusively Chinese. However, the rise of this Taiwanese identity has not yet produced a pro-independence majority on the island.

Chen's troubled administration, beset by slow economic growth and tormented by a fractious KMT majority in the LY, proved unable to build consensus in a number of areas, most prominently in defense policy and military procurement. Defense appropriations and purchases of important systems were frozen by the partisan bickering that gripped Taiwan's government.

With a solidly entrenched KMT government, as of summer 2009, controlling both Taiwan's executive and legislative branches, even the most paranoid of Chinese leaders must have some confidence that no one on Taiwan will be inclined to "push the envelope" on independence or related issues any time soon. However, it is in these very expectations of a new and more accommodating Taiwan government that the seeds of disappointment and future crisis may lie. Although independence remains a distant dream for the relatively small proportion of Taiwan's citizens who support it, the changes in the political, social, and cultural identity of the island's population are genuine, significant, and enduring, and these realities strongly suggest that even the most flexible Taipei government will reach its limits of possible accommodation well short of Beijing's desired position. The unbridgeable distance between these two positions is not likely to shrink in the coming decade; the opposite may indeed be the case, regardless of which party rules Taiwan.

Further, China's growing military power may convince its leaders that the mainland possesses credible options that go beyond rhetoric and economic harassment if—more likely, when—the next cross-strait crisis erupts. Finally, even after the recent LY reforms, Taiwan remains a "young" and fractious democracy; while Beijing (and Washington!) may hope that the volatility of politics in Taipei will be reduced, it is not unlikely that island politics will retain an eccentric and erratic edge that from time to time will prove irritating to Beijing.

Missiles over the Strait

China's arsenal of short-range ballistic missiles (SRBMs) is growing in both size and quality. Modern variants of the CSS-6 and CSS-7 SRBMs are being deployed in large numbers; these are missiles with sufficient accuracy and possibly the necessary variety of warheads to pose a serious threat to a wide range of targets on Taiwan.

We assessed the potential impacts of these weapons against Taiwan's air bases. Using Monte Carlo techniques to model these attacks, we found that, depending on missile accuracy, between 90 and 240 SRBMs—a number well within the range of estimates of the number of launchers China will field in the near future—could, with proper warheads, cut every runway at Taiwan's half-dozen main fighter bases and destroy essentially all of the aircraft parked on ramps in the open at those installations. By so doing, China could knock the Republic of China Air Force (ROCAF) out of the war for long enough to launch large-scale air raids on Taiwan intended to destroy any aircraft parked in shelters, as well as other hardened targets. Success in this gambit would suppress ROCAF operations indefinitely and lay Taiwan open to further Chinese air attacks.

Assessing the Air War

Chinese military capabilities have advanced rapidly over the past decade. In addition to the progress the People's Liberation Army (PLA)

has made with its stockpile of SRBMs, China has deployed or is deploying modern fighter aircraft, such as the Su-27/J-11, Su-30, and J-10, in sizable numbers. To understand the consequences of these changes, we assessed a cross-strait battle for air superiority in the 2013 time frame. Our analysis indicates that China's ability to suppress or close the ROCAF's bases could gives the PLA Air Force (PLAAF) an almost overwhelming numerical advantage that—coupled with the rough qualitative parity that now exists between the two sides—could allow China to attain air superiority over Taiwan and the strait. This in turn would permit the PLAAF to pound Taiwan with air-delivered precision-guided munitions (PGMs) in preparation for an invasion attempt or as a coercive bombardment.

Further, the missile threat to the U.S. Air Force (USAF) base at Kadena and the U.S. Marine Corps (USMC) base at Iwakuni on Okinawa poses the same kind of danger as that faced by Taiwan's air bases; combined with the lack of good bases for land-based fighters in the area around Taiwan, the United States is unlikely to be able to compensate for the hundreds of ROCAF fighters burning on their parking ramps, trapped behind cratered runways, or hiding in underground shelters. The danger to both ROCAF and USAF operations in the Taiwan Strait is sufficiently grave that a credible case can be made that the air war for Taiwan could essentially be over before much of the Blue air forces have even fired a shot.

The Ultimate Roll of the Dice: A Chinese Invasion of Taiwan

Only one military course of action guarantees China control of Taiwan: a successful invasion and occupation of the island. But amphibious operations are dauntingly difficult, and for years analysts and scholars have assessed China's ability to conduct an invasion as limited, at best. Our analysis of the air war indicates that China's growing military power has changed the nature of the fight for air superiority; have the PLA's burgeoning capabilities also changed the calculus for an invasion attempt?

The Falklands campaign of 1982 is illustrative of many of the challenges that will confront any amphibious attacker in the era of the antiship missile. Nearly half of the surface combatants committed to the South Atlantic by Great Britain were damaged, and 15 percent were sunk by an enemy possessing a literal handful of modern antiship cruise missiles (ASCMs). The British task force also lost 29 percent of its Harrier fighters, while the Argentine air force and naval air arm lost 45 percent of the combat aircraft they sent into action.

The Falklands war illustrated three important characteristics of modern amphibious warfare:

- First, there is no place to hide in amphibious warfare. Ultimately, the attacker's ships must approach the hostile coastline to land troops and supplies; a properly equipped defender should be able to create a lethal engagement zone stretching from the shore to the visual horizon without needing to rely on complex kill chains.
- Second, modern weapons are deadly to warships. Even damage that does not sink the ship can cause a "mission kill" that renders the vessel operationally useless until repaired. There would seem to be special dangers for amphibious assault ships that, packed with combat-loaded tanks, fighting vehicles, and trucks, must at some point approach the beach.
- Third, distance matters. Had the British and Argentine militaries squared off on neutral ground or in European skies and waters, the outcome would have been a rout for the UK. The geographical advantage enjoyed by Argentina allowed its otherwise outnumbered and outclassed armed forces to make a go of it against the British.

To take these lessons forward, we performed a simple quantitative assessment of China's ability to move assault troops across the strait and explored concepts for defeating the attack. This analysis suggested that Taiwan might be able to defend against a Chinese invasion attempt by employing a "four rings" strategy:

- "Thinning the herd" of approaching ships using what amounts to unordered fire of longer-range ASCMs.
- Slowing the approach to the beach with modern sea and surf mines.
- Engaging assault vessels, whether large ships or small craft, on their final run to the beach with concealed or very mobile short-range missiles, such as Hellfire.
- Combining air-delivered weapons with direct and indirect fires to damage or destroy Chinese ships or craft while they are unloading ashore.

Because this concept does not rely on exquisite targeting or complicated kill chains, it could prove fairly robust even in circumstances in which the defender lacked control of the skies over the beachhead.

Conclusions

While the relationship between Beijing and Taipei is more stable in 2009 than it has been in years, it is not clear that this honeymoon will last forever. China has not renounced its "right" to use force to forestall Taiwan's "independence," nor discussed amending its anti-secession law, nor withdrawn any missiles from the hundreds it points at Taiwan. Just as President Ma is constrained by the limits of the possible within the Taiwan polity, so too are President Hu Jintao and his colleagues atop the Communist hierarchy. The goal of "reunification" has become a core tenet of China's own politics, and any movement away from it could spell trouble for any leadership in Beijing, just as growing too accommodating toward China would be dangerous for Ma or any other leader on Taiwan. Given this reality, what can be said about the cross-strait military balance?

In the near-to-mid-term we conclude the following:

- China's ability to suppress Taiwan and local U.S. air bases with ballistic and cruise missiles seriously threatens the defense's ability to maintain control of the air over the strait.

- Restructuring Taiwan's air defenses to "ride out" heavy strikes on its bases and other installations can complicate Chinese planning and reduce the leverage that Beijing can derive from its offensive forces.
- Regaining the initiative in the air may require that the United States and/or Taiwan field a new, expensive, and politically problematic suite of strike capabilities (e.g., hundreds of medium-range ballistic missiles) aimed at China's own air base infrastructure.
- Making clear to Beijing the consequences of attacking U.S. bases and forces in East Asia in terms of counterstrikes on the Chinese mainland has the potential to enhance deterrence.
- A reasonably robust "four rings" defense against a large-scale Chinese invasion should be possible even with a degree of PLA control of the air, but it will require new capabilities and concepts to be put in place.

In the longer term, the United States and Taiwan may confront an even more fundamental strategic dilemma, one inherent in the basic geography of the situation. This geographic asymmetry—Taiwan lies close to China and very far from the United States—combined with China's growing capabilities and the lack of basing options for U.S. forces in the vicinity of the strait, call into question Washington's ability to credibly serve as guarantor of Taiwan's security in the future.

The situation in the Taiwan Strait can be seen as a possible prelude to a broader challenge to the United States in East Asia that might emerge in the next 10–20 years. What roles can and should the United States seek to play in an East Asian landscape that includes an economically vibrant, militarily powerful, politically unified, and self-confident China? Looking at Taiwan and beyond, what is the new equilibrium in East Asia, and how can the forces at work there be managed to make that equilibrium tolerable to the United States? That, indeed, is the ultimate "question of balance" posed by any examination of the growing imbalance of military power across the Taiwan Strait.

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We fear that we have left out many individuals whose contributions to this work were vital, and we apologize to each and every one. We also apologize to the reader for errors of commission and omission that may remain in this report, despite the heroic efforts of all who tried to root them out. These gaffes are the only aspect of this report for which responsibility lies entirely with the authors.

Finally, the lead author wishes to dedicate this report to the memory of his brother who, from my earliest remembrance, taught me the power of ideas and the intrinsic and inexpressible beauty of the life of the mind.

Abbreviations

AAM	air-to-air missile
AFV	armored fighting vehicle
ASCM	anti-ship cruise missile
ASL	March 2005 Anti-Secession Law
AWACS	Airborne Warning and Control System
BDA	battle-damage assessment
BMD	ballistic missile defense
BVR	beyond visual range
CANA	*Comando Aviacion Naval Argentina* (Argentina's naval air arm)
CCP	Chinese Communist Party
CEP	circular error probable
CSG	carrier strike group
DoD	U.S. Department of Defense
DPP	Democratic Progressive Party
FAA	*Fuerza Aerea Argentina* (Argentina's air force)
FAE	fuel-air explosive
HE	high-explosive

IC	integrated circuit
IDF	Indigenous Defense Fighter
ISR	intelligence, surveillance, and reconnaissance
IT	information technology
JASDF	Japanese Air Self-Defense Forces
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JICM	Joint Integrated Contingency Model
KMT	Kuomingtang
LACM	land-attack cruise missile
LGB	laser-guided bomb
LST	tank landing ship
LY	Legislative Yuan
MITL	man-in-the-loop
MOS	minimum operating strip
MRBM	medium-range ballistic missiles
PGMs	precision-guided munitions
PLA	People's Liberation Army
PLAAF	PLA Air Force
PLAN	PLA Navy
PRC	People's Republic of China
QVI	quick victory invasion
RAF	Royal Air Force
RN	Royal Navy
ROC	Republic of China
ROCAF	Republic of China Air Force

SAM	surface-to-air missile
SHORAD	shorter-range air defense
SRBM	short-range ballistic missile
TFW	Tactical Fighter Wing
TLAM	Tomahawk Land Attack Missile
UAV	unmanned aerial vehicle
USAF	U.S. Air Force
USMC	U.S. Marine Corps

CHAPTER ONE

Introduction

The military balance across the Taiwan Strait is changing in ways that make more complex both the set of operational challenges associated with defending Taiwan against a possible Chinese attack and the strategic imperative of shaping the behavior of both China and Taiwan so that no such attack ever eventuates.[1]

While this report primarily concerns itself with the first set of questions—what might a battle for Taiwan look like and how can the United States and Taiwan better prepare to win any clash—it must inevitably engage the second conundrum as well, and its conclusions incorporate reflections on both topics.

In 2000, the RAND Corporation published a report that assessed the emerging cross-strait balance and made recommendations based on that analysis (Shlapak, Orletsky, and Wilson, 2000). It concluded

> that any near-term Chinese attempt to invade Taiwan would likely be a very bloody affair with a significant probability of failure. Leaving aside potentially crippling shortcomings that we assumed away—such as logistics and C2 [command and control] deficien-

[1] In this report, when we refer to "China" or "the Chinese," we mean the People's Republic of China (PRC), while "Taiwan" and "the Taiwanese" refer to the Republic of China (ROC). To avoid strangling ourselves in our sentence constructions, we will sometimes reference Taiwan as a "nation" or in some other way that could be read as imputing to the authors a particular attitude or opinion regarding Taiwan's actual or deserved status. For purposes of this report, the facts on the ground are clear: In matters of defense, Taiwan is, empirically, an autonomous actor with its own policies, forces, and threat perceptions, and we treat it analytically as such.

> cies that could derail an operation as complex as a "triphibious" (amphibious, airborne, and air assault) attack on Taiwan—the [Chinese military] cannot be confident of its ability to win the air-to-air war, and its ships lack adequate antiair and antimissile defenses. Provided the ROC can keep its air bases operating under attack . . . it stands a relatively good chance of denying Beijing the air and sea superiority needed to transport a significant number of ground troops safely across the strait. (p. xvi)

This report documents a follow-on effort that reassessed the cross-strait balance, looking ahead to the 2010–2015 period. As in the 2000 study, we employed a mix of theater-level combat modeling, simpler mathematical models, and historical analysis. In addition, Chapter Two, which describes the evolution of cross-strait political relations, draws heavily on interviews, conducted by one of the authors, with both Chinese and Taiwanese officials, academics, and experts.

Although this analysis focuses on the military dimension of the China-Taiwan problem, we recognize that the issue is at heart a political one, pitting Beijing's commitment to an ultimate reclamation of Taiwan against Taipei's desire to remain an autonomous entity. In Chapter Two, we address that issue, assessing the forces at work both on the mainland and in Taiwan that are driving each side's perceptions of and behavior toward the other. Chapter Three focuses on China's missile force and its ability to threaten military targets on Taiwan. In Chapter Four, we present the results of an in-depth analysis of the air war that would be an important element of any large-scale clash across the Taiwan Strait. In a sense, this chapter updates the core analytic piece of the 2000 report; it concludes with a discussion of how things have changed and are likely to continue to evolve.

In Chapter Five, we consider a Chinese amphibious assault on Taiwan. Using a mix of simple arithmetic and historical evidence, we examine the difficulties that the People's Liberation Army (PLA) would likely encounter in any attempt to put a substantial number of boots on Taiwanese ground.

Finally, in Chapter Six, we tie together these varied analytic threads to put forward conclusions about the cross-strait balance and make recommendations for both Taiwanese and U.S. strategists and

planners. Here, too, we must return to the political questions that dominate the China-Taiwan conundrum, and we attempt to describe how the military balance affects the equilibrium of the overall relationship between China, Taiwan, and—importantly and inevitably—the United States.

A brief appendix outlines a possible Chinese strategy for attacking semiconductor fabrication plants, a key economic target, on Taiwan.

A Caveat

China could undertake a use of force against Taiwan in myriad ways. Beijing might attempt to coerce Taipei through economic or cyber warfare; by an air and sea blockade; by missile and air bombardment; or by outright invasion.[2] In this report, we concern ourselves only with an invasion scenario and only one variant of that, what is often called the "quick victory invasion," or QVI. This approach, which appears to be consistent both with China's concepts for the use of military force and the kinds of capabilities the PLA is developing, postulates a fast-moving offensive. It would begin with a preliminary "softening up" phase of missile and air attacks against Taiwan's military infrastructure, aimed at reducing the island's overall defense capacity and achieving some degree of air control over the strait. After very few days, China would attempt to push an invasion force across the Taiwan Strait, landing on the beaches in the northwest portion of the island. After a brief consolidation period, the PLA forces would break out and move swiftly to eliminate residual Taiwanese defenses and occupy Taipei. With the fall of Taiwan's capital, Beijing believes, the government would capitulate.

As we said, this is not the only invasion scenario, nor are we asserting that it is necessarily the most likely. It is, however, analytically very interesting, because it offers a fairly full range of offensive and defensive operations: missile and air strikes, air-to-air operations, and combat on and under the sea. It represents perhaps the "highest

[2] China could also attempt more than one of these stratagems, sequentially or in parallel.

end" of warfare that is conceivable in the early 21st century, bringing the most advanced military technology to bear at large scale and on both sides. Also, each of the constituent elements of this campaign—attacks on Taiwan's infrastructure, antisurface and antisubmarine warfare, and air warfare in its various modes—would also be important in many other forms of cross-strait conflict. We therefore believe that many of the insights derived from studying this particular scenario are of value in assessing many other forms of China-Taiwan conflict. Thus, while the QVI contingency is not the *only* cross-strait scenario worthy of study, it is an important and illuminating case.

CHAPTER TWO

Changing Cross-Strait Political Dynamics

Almost 60 years after the defeated Chinese Nationalists (the Kuomintang, or KMT) fled the mainland for Taiwan, the relationship across the Taiwan Strait continues to evolve. The 2008 election of the KMT candidate Ma Ying-jeou as Taiwan's president and the further consolidation of the KMT's hold on Taiwan's national legislature (the Legislative Yuan, or LY) appear to portend a reassuring break from eight years of cross-strait verbal pyrotechnics provoked by the independence-minded Chen Shui-bian of the Democratic Progressive Party (DPP). Nonetheless, there are powerful structural forces that promise a continuation and perhaps deepening of Beijing's doubts about the ultimate resolution of Taiwan's status. To the extent that these forces offset the reassuring tone offered by the KMT leadership, the dynamic between China and Taiwan will remain volatile and potentially crisis-prone.

In this chapter, we will discuss five forces and trends shaping the cross-strait political dynamic and explore their impact on the future of China-Taiwan relations:

- China's attitude toward the cross-strait status quo
- the exploding cross-strait economic relationship
- Taiwan's changing national identity
- the legacy of Chen Shui-bian
- changes in the cross-strait military balance.

We will discuss each in turn, then suggest the implications of these changes for the Taiwan Strait security situation.[1]

Beijing's Attitude Toward the Status Quo: Will Patience Remain a Virtue?

A crucial and often overlooked factor in maintaining stability across the strait is and will remain Beijing's willingness to accept the status quo and not insist that Taiwan make actual progress toward unification. Any Chinese impatience with the pace of movement toward Beijing's objective raises the danger of a major cross-strait crisis.

Beijing's patience, in turn, is largely a function of its oscillating self-confidence about long-term trends. When China's leaders believe that long-term political, economic, and social trends are moving Taiwan toward unification, or are, at least, discouraging moves toward independence, they feel more secure and are less likely to demand concrete progress toward their goal. But pressure will build on Beijing to act if it feels that these same trends are encouraging Taiwan to drift toward formal independence, or are undermining any remaining prospect for unification.

China's comfort with the status quo has had marked ups and downs. From 1979 until then president of Taiwan Lee Teng-hui began to publicly embrace the notion of a separate, sovereign Taiwan-based Republic of China in the late 1990s, Beijing for the most part showed a public willingness to be patient.

From those final years of Lee Teng-hui's administration through the spring of 2005, however, Beijing's policy statements on Taiwan reflected periodic spikes in its sense of urgency. For the most part, Beijing still indicated an implicit willingness to wait for resolution so long as Taipei simply refrained from active moves toward independence. On several occasions, however, the Chinese leadership stated or hinted that

[1] The research for this chapter was completed before the March 2008 elections in Taiwan, and writing concluded shortly after Ma Ying-jeou took office.

prolonged stalemate was not acceptable, and that it might employ force if Taiwan delayed indefinitely in making progress toward unification.

The harshest of these signals was contained in a white paper on Taiwan that Beijing released in 2000, which warned that Taipei could invite attack by simply delaying negotiations indefinitely: "If the Taiwan authorities refuse, *sine die*, the peaceful settlement of cross-strait unification through negotiations, then the Chinese government will only be forced to adopt all drastic measures possible, including the use of force to safeguard China's sovereignty and territorial integrity and fulfill the great cause of reunification" (Taiwan Affairs Office, 2000, p. 7).

However, some Chinese foreign affairs specialists have confided to U.S. interlocutors that the threatening tone of the 2000 white paper proved counterproductive to Jiang's strategy of bringing Taiwan closer. Reporting to the 16th Congress of the Chinese Communist Party (CCP), Jiang used a softer tone, saying only that "the Taiwan question must not be allowed to drag on indefinitely" (Jiang 2002), and threatening rhetoric largely vanished from Beijing's statements for the following three years.

China's March 2005 Anti-Secession Law (ASL), drafted in the wake of Beijing's disappointment over Chen Shui-bian's March 2004 re-election as president, again hinted that it might consider using force if Taiwan delayed unification indefinitely. The ASL's language, however, was far less ominous than in 2000; it imposed no deadline for unification, nor did it even make mention of Beijing's long-preferred "one country, two systems" framework. Nevertheless, as Beijing listed the conditions under which it might employ "non-peaceful means" against Taiwan, it did state that if the "*possibilities for a peaceful reunification should be completely exhausted*," Beijing might use force ("The Anti-Secession Law of the People's Republic of China," 2005; emphasis added). War and peace could, in other words, turn on Beijing's long-term sense of hope for eventual reunification.

Beijing argues that the passage of the toughly worded ASL was a key component in its new, more sophisticated Taiwan policy. Its goal in the ASL as well as with the tough statements issued the eve of Chen's May 20, 2004, second inaugural address, was to firmly regain the initiative in defining the relationship while making clear the outer limits

of China's patience. Beijing hoped that its strong rhetoric, along with repeated U.S. criticism since 2003 of Chen's allegedly provocative statements, would leave Taiwan's president politically boxed in.

Indeed, soon after Chen's inauguration, Beijing began greatly moderating the tone of its rhetoric and indicated a greater patience about accepting the status quo, so long as Taipei did nothing to upset it. Rather than pushing timetables for unification, Beijing displayed a greater willingness to play for the long term and settled for preventing moves toward formal Taiwanese independence. Beijing used new "carrots" in this strategy to seduce key elements in Taiwan's society and political leadership, such as hosting outgoing KMT leader Lien Chan and People's First Party leader James Soong on the mainland as heroes, and extending special economic treatment to farmers, students, and investors. The goal was to exploit these economic and social ties to build a powerful base of support in Taiwan "from the bottom up" and politically further isolate Chen Shui-bian and his "deep green" (pro-independence) supporters at home.

So long as political trends in Taiwan do not once again shift to disappoint Beijing's hopes, the Hu Jintao leadership is likely to remain self-confident about long-term trends and not resurrect destabilizing demands for active progress toward reunification. But, as we will argue below, social and political trends in Taiwan could, once again, disappoint Beijing and spur it to reassess its faith in the future. Indeed, this may be the most easily foreseeable scenario for a cross-strait crisis in the years to come.

The Effects of Cross-Strait Economic Integration[2]

Taiwan and the mainland's rapidly expanding economic relationship has increased Beijing's capacity to inflict pain upon Taiwan short of the use of military force. When Beijing perceives that it needs to "send Taiwan a message," economic harassment has proven a politically satisfying—though not always successful—short-term method of sig-

[2] For a more detailed discussion of these trends and issues, see Tanner (2007).

naling its displeasure. In a crisis, the temptation for Beijing to exploit even more painful economic levers could prove irresistible.

Since the early 1980s, cross-strait trade, investment, and other economic ties have exploded, driven by far-reaching economic and political reforms and natural complementarities between the two economies. As a result, the two economies are now in a deep, wide-ranging relationship of "asymmetric interdependence," in which each side relies on the other for important contributions to its economy, and each would suffer great economic pain and dislocation in the event of a major disruption in that relationship. But as Taipei's leaders have long feared, Taiwan depends on the mainland for a far higher percentage and a far broader range of its economic activities than vice versa.

Though China and Taiwan had virtually no economic contact a quarter century ago, China had replaced the United States as Taiwan's number one export market by late 2001. Cross-strait two-way trade rose from an estimated $950 million in 1986—the last year before Taiwan lifted the ban on its citizens traveling to the PRC—to more than $98 billion by the end of 2008, the latter figure being equal to 20 percent of Taiwan's total trade (Bureau of Foreign Trade, 2009).[3] China is also the number one venue for Taiwan's foreign investment and the number one production base for many of its most profitable exports, especially from the information technology (IT) sector. Cross-strait economic ties now carry terrific weight within both economies, particularly in Taiwan. Exports to the mainland market made up almost 17 percent of Taiwan's entire gross national product by the end of 2008. Taiwanese foreign direct investment in the mainland accounts for much more than half of all Taiwanese foreign direct investment.[4]

Fearing precisely the coercive potential that Beijing apparently seeks, Taiwan's government has struggled mightily since 1979 to strike

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[3] Values are in then-year U.S. dollars. They have been converted from New Taiwan Dollars using the average exchange rate of each given period. They include re-imports and re-exports.

[4] Estimates of cross-strait trade and investment vary significantly from source to source. The data in this section, unless otherwise noted, are from Taiwan's Mainland Affairs Council Web site (Mainland Affairs Council, no date). The site is also a very convenient "one-stop shopping" site for data from many Taiwan, mainland China, and Hong Kong sources.

a balance between growth and security in its cross-strait economic policy.[5] Both governmental and business leaders in Taiwan have sought to draw on mainland China's rapid growth as a vehicle to boost domestic growth, while, at the same time, both the Lee Teng-hui and Chen Shui-bian administrations sought to limit Taiwan's economic dependence on Beijing.

Unquestionably, the advocates of liberalizing cross-strait trade and investment relations—in particular, Taiwan's influential mainland-invested business community (the *taishang*)—have won the lion's share of these policy battles. Still, their success can be overstated. Lee and Chen periodically showed real willingness to resist pressure from the *taishang*, and they can point to some significant successes in limiting Taiwan's dependence. Among the most notable victories has been a modest slowing in the pace of high-tech investment on the mainland, and the maintenance of a significant technological "gap" or "lag" between what Taiwanese firms produce on the island and what they produce across the strait. Taipei's efforts to get the *taishang* to diversify their investments to less threatening Asian venues have been far less successful (Tanner, 2007, pp. 33–72).

Beijing has sought to exploit more intimate cross-strait economic ties by applying or publicly contemplating three forms of pressure against Taiwan at various times over the past two decades.

Mainland Sanctions Against Imports from Taiwan

Taiwan's exports to the mainland constitute a very large and growing portion of its total exports, and Taiwan would suffer very substantial economic dislocation from any large-scale mainland shutdown of imports from the island. Final assembly of between 50 and 90 percent of the most profitable IT products of Taiwanese firms—including

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[5] Many economic and security analysts in Taiwan use the phrases "marginalization" and "hollowing out" to describe what they see as a gradual process by which China uses its vast market leverage to lure the creative high-tech core of Taiwan's vibrant economy to set up shop on the mainland, then gradually take it over or supplant it with Chinese technological and managerial prowess. The result, according to this view, will be a "hollow" Taiwan economy that is pressed to margins of the global high-tech economy and unable to sustain the island's economic security.

desktop and notebook computers, LCD monitors, motherboards, and DVD/CD-ROM drives—now occurs at Taiwan-owned factories on the mainland (Tanner, 2007, pp. 33–72). These production lines would be shut down if China stopped the importation of components from Taiwan.[6]

Such an import ban would be very difficult for Beijing to enforce, however, because, in the absence of direct shipping links before 2008, Taiwanese exporters became become very adept at moving goods to China discreetly through such third parties as Hong Kong or South Korea. Large-scale sanctions on imports from Taiwan would therefore likely require a highly effective and disciplined blockade of *all* exports from the island—in other words, an act of war that would risk U.S. military intervention (Tanner, 2007, pp. 38–41; Ma, Wenhui, and Kwok, 2002, pp. 29–30).

China might also be shooting itself in the foot by imposing such sanctions, because many key industries in coastal regions rely heavily on Taiwan-invested factories, and these regions would suffer severe recession, unemployment, and perhaps social unrest as a result of an import cutoff. China's IT sector, in particular, could be devastated if coercive measures were taken against Taiwan. It is unknown exactly how much of China's IT hardware exports are produced by Taiwanese-owned factories, but estimates range from 40 to 80 percent (Tanner, 2007; see also Einhorn et al., 2005).

Disruption, Damage, or Sabotage of Financial Markets or Information Networks

Both Chinese and Taiwanese experts agree that the mainland can seriously threaten Taiwan's economy by targeting its key markets (stocks and bonds, foreign exchange) as well as its information networks for deliberate disruption. They regard such disruption as a major potential vulnerability for Taiwan's economy.

Regarding the stock market, Taiwanese officials developed during the 1990s–2000s powerful administrative systems, extensive experi-

[6] Based on 2004–2005 estimates by Taiwan's Market Intelligence Center's Institute for Information Industry (MIC/III) cited in Tanner (2007, pp. 88–89).

ence, and enormous financial resources to mitigate the short-term deliberate disruption that China has repeatedly inflicted on the exchange over the past decade. However, a long-standing dilemma concerns the island's efforts to liberalize the market to attract much-needed additional foreign capital while trying to avoid opening itself up to greater disruption by the PRC. Financial reforms to permit greater mainland investment in Taiwan will weaken these defenses.[7]

Selective Harassment or Intimidation of Taiwanese Businesspeople

Since 2000, Beijing has repeatedly engaged in selective harassment of *taishang* to put political pressure on the Taipei government, and this remains one of Beijing's most accessible options for exercising its economic leverage. On the other hand, political countermeasures are available to Taiwan to blunt the effect of this pressure. Beijing had surprising difficulty in converting this weapon into effective political influence against Taipei during the Chen Shui-bian years, in large part because pro-independence politicians were often able to undermine the influence of *taishang* by painting them as untrustworthy puppets or hostages of China's will (a tactic called "red-hatting").[8]

Taken all in all, Beijing has often found that the cross-strait economic relationship is potentially a very powerful political weapon, but one that has been tricky to use effectively. Beijing's frustration was dramatically illustrated in the 2004 presidential election. Like many outside observers, Beijing calculated that Taiwan's voters—worried about the state of the island's economy and anxious for expanded cross-strait economic relations—would combine to defeat Chen. Thus, Beijing zeroed in on the *taishang* as its chief "conduit of influence" toward swaying the election. But Beijing's assessments of their impact proved to be either mistaken or badly exaggerated (Tanner, 2007, pp. 103–134).

A major reason Beijing had trouble exploiting its economic leverage is that many Taiwanese businesspeople have become politically

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[7] Hung (2008); Tanner (2007, pp. 91–96) summarizes some of the policy measures Taiwan has used to protect its stock markets.

[8] For a detailed description of these tactics, see Tanner (2007, esp. pp. 103–130). The following paragraphs draw on this research.

adept at "flying below the radar." Most work hard to keep their true political inclinations and activities hidden from political leaders in *both* Taiwan and mainland China, thereby frustrating Beijing's efforts to convert them into a ready-made "lobby" for its interests. Taiwanese businesspeople have been largely successful in encouraging their government to loosen *economic* restrictions on cross-strait ties, but the business community has been far less willing and able to pressure Taipei into making significant concessions on the *political* issues of greatest interest to Beijing, most notably Taipei's acceptance of Beijing's formulation of the one-China principle and willingness to negotiate with China on that basis. Political leaders, including Chen Shui-bian, have also frequently shown themselves fairly adept at counterattacking many advocates of a more rapid cross-strait political opening (Tanner, 2007, pp. 103–134).

But Beijing's difficulty in translating economic leverage into political leverage is not necessarily good news for either Taiwan or the United States. To be sure, these levers of economic coercion have won Beijing few, if any, major concessions on the political issues of greatest importance to it. At the same time, though, they have provided China's leaders with a politically satisfying method of signaling displeasure with Taipei that falls short of employing military threats or coercion. If China came to believe that these tools had completely lost all utility, it might be inclined to ratchet up the use of military pressure in the event of a crisis, if only because of a perceived lack of effective alternatives (Tanner, 2007, pp. 103–134, esp. p. 123).

Indeed, there is evidence that, in the wake of China's unsuccessful bid to use economic pressure to influence the 2004 Taiwanese presidential election, mainland policy advisors who remained optimistic about the long-term efficacy of economic influence found their position undermined at the expense of those who felt that more nakedly coercive measures against Taiwan were needed. These tensions eased somewhat in later years, as Chen encountered numerous political setbacks at home that eroded his position; it remains to be seen how Beijing will ultimately react in the longer term to the policies and initiatives of the newly elected Ma (Tanner, 2007, pp. 103–134, esp. pp. 126–127).

Taiwan's Evolving National Identity

At the most profound levels of social structure, there is perhaps no prospect that worries Beijing more than the emergence of a "Taiwanese" national identity that might permanently supplant any sense of "Chinese-ness" among the Taiwanese people. Put simply, Beijing fears that if Taiwan delays unification too long, pro-independence leaders will have cultivated such a powerful sense of distinct "Taiwanese-ness" that the people of Taiwan will never accept unification. National identity evolves slowly, and its emergence is unlikely by itself to produce any pivotal incident that might spur Beijing to action. But Beijing's rising anxiety could provide a backdrop to cross-strait destabilization if the CCP concludes that these trends forecast a future in which Taiwanese become hostile to any arrangement that formally subsumes them within a mainland-dominated state.

Before the succession of the ethnically Taiwanese Lee Teng-hui to the presidency, the KMT government actively fostered a Chinese national identity among its citizens—most of whom had lived all their lives as subjects of the Japanese empire—and repressed any efforts to promote a Taiwanese identity.[9] After taking over in Taiwan, the KMT virtually eliminated all indigenous Taiwanese political organizations and purged educated Taiwanese from public institutions. Until the late 1970s, the KMT tightly limited Taiwanese participation in the party and government and denigrated local language, culture, and customs.

Beijing, for its part, regularly charges that the emergence of a Taiwanese national identity is the result of indoctrination by pro-independence leaders. To be sure, after 1993, President Lee abandoned traditional KMT efforts to promote Chinese nationalism and began cultivating a "New Taiwanese" identity open to all island residents regardless of ethnic background (Chu, 2004, p. 499). The government wrote new school textbooks and funded Taiwanese literature and arts programs. Still, there is strong evidence that the roots of a separate and unique Taiwanese identity date back before 1895 and strengthened

[9] Formosa (Taiwan) was ceded to Japan as part of the treaty ending the first Sino-Japanese War in 1895, in which China was humiliated by the region's then-rising power. It was returned to China after Japan's defeat in World War II.

in response to repression first under Japanese occupation, then KMT rule (Morris 2002, pp. 3–24; Edmondson 2002 pp. 26–27).

Surveys underscore the magnitude of the change. By December 2008, survey data indicated that roughly 20 percent more of Taiwan's citizens identified themselves as *exclusively* Taiwanese (51 percent) than as both Taiwanese and Chinese (41 percent). By far the most troubling statistic, from Beijing's perspective, must be that fewer than 5 percent described themselves as exclusively Chinese (Election Study Center, no date). In other words, the overwhelming majority of the island's residents now embrace either a mixed Chinese-Taiwanese identity or an exclusively Taiwanese one.

Despite Beijing's worst fears, the rise of this Taiwanese identity has not yet produced a rabidly pro-independence majority on the island. However, it has been coupled to modest changes in public attitudes that must appear disquieting to the China's leaders. In a series of surveys on cross-strait policy conducted for Taiwan's Mainland Affairs Council between autumn 1999 and autumn 2005, the overwhelming majority on Taiwan consistently supported some option that preserves the status quo for at least the foreseeable future. The proportion of Taiwan's citizens who support immediate formal independence rose during that period, though, from 4.6 percent to 10.3 percent, and those who supported immediate unification with the PRC dwindled to a mere 2.1 percent (Mainland Affairs Council, no date).

An early public indication of Chinese concern about trends in Taiwanese national identity came in 1995, when Jiang Zemin delivered his "Eight Point Proposal" for peaceful unification. Addressing Taiwanese as "compatriots," Jiang insisted that all Taiwanese are Chinese and counseled them to "inherit and carry forward the fine traditions of Chinese culture" (Jiang, 1995). Five years later, an official white paper stepped up criticism of Taiwan's efforts at promoting and affirming local culture. Beijing interpreted the *bentuhua* ("nativization") campaign as a Taipei-led conspiracy to "obliterate the Chinese awareness of Taiwan compatriots, especially young people, and their identification with the motherland" (Taiwan Affairs Office, 2000, p. 6). Beijing's assessment of the speed and spontaneity with which Taiwanese national identity is changing will have a powerful impact on its assessment of the overall

state of its "Taiwan problem," its willingness to use force, and its estimate of the Taiwanese people's likeliness to resist an attack.

The Legacy of Chen Shui-bian

The years of Chen Shui-bian's presidency left Beijing very suspicious of Taiwan's leadership. Although Chen has been out of office since May 2008, his eight years in power strongly shape Beijing's attitude toward Taiwan going forward and are worthy of recapping.

As a result of its mistrust of and distaste for President Chen and his allies, China felt obliged to muddy its publicly announced "red lines" for using force, raising new challenges for those planning Taiwan's defense. The Chinese saw Chen and his political allies as pathological "envelope-pushers" who would seize on any opportunity to promote independence or erect permanent barriers to unification. Consequently, many in Beijing believed China had to be ready to respond to or deter a far wider and less-well-defined array of potential challenges than in the past.[10] It is unclear how rapidly or completely Ma Ying-jeou will be able to reverse this erosion of Beijing's confidence in the relative stability of the cross-strait status quo.[11]

When Taiwan was ruled by the Chiang family and a KMT authoritarian government, Beijing could, to a great degree, rest assured that the island's leaders were ultimately committed to unification *some* day under *some* set of circumstances. So long as China's leaders believed that time was ultimately on its side, it could feel reasonably safe trying to deter a fairly narrow set of easily defined, low-likelihood behaviors.

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[10] These views about Chen and his supporters and their impact on the mainland's potential responses were voiced in many interviews by some of the authors with mainland experts on cross-strait relations in 2004–2007.

[11] Indeed, a year after Ma's election, and despite all the progress in cross-strait relations, mainland experts still state that one reason they are hesitant to grant Taiwan greater international diplomatic space is the mainland's residual fear that a future "green" Taiwan government will abuse any compromises Beijing makes today. Author's interviews with mainland political analysts.

Thus, for many years, China's list of unacceptable behaviors that might prompt an attack seemed reasonably clear and concrete. More importantly, Beijing probably knew that, at least *most of the time*, the KMT government found Beijing's stated conditions relatively easy to comply with and was minimally concerned about Taipei sparking a sudden crisis. The most famous four conditions under which Beijing threatened considering force were

- a formal declaration of independence
- Taiwan's acquisition of nuclear weapons
- a breakdown in social order on the island
- a foreign attack upon Taiwan.

U.S. analysts have pointed out that Beijing never meant by these conditions to imply that Taiwan could resist reunification forever (Cliff, 1996). And, until the latter years of Lee Teng-hui's presidency and the Chen Shui-bian administration, Beijing had never authoritatively spelled out the real meaning of these "red lines"—in particular which actions by Taiwan might unambiguously constitute an effort to achieve independence that China would feel it had to suppress by force. Nor did the Chiang governments make a sustained effort to probe or challenge the meaning of "independence." Beijing was therefore apparently relatively confident that none of these actions was very likely to occur at any given time.

But for at least the past decade—most notably from President Lee's July 1999 characterization of cross-strait relations as a "special" form of "state-to-state relations"—Beijing has believed that Taiwan's leaders were engaged in a long series of what it regarded as deliberately provocative acts and statements designed to peel back or redefine the boundaries of "independence."[12] Beijing's anxiety over these statements took a powerful toll on its confidence that Taiwan understood China's true "red lines" and would, by and large, respect them. Virtually every mainland expert interviewed for this study in 2005–2006

[12] On Lee's statement, made in a Deutsche Welle interview, see Bush (2005, pp. 220–224).

was convinced that Chen could not be dissuaded from trying to secure Taiwan's independence from China, or at a minimum pushing proposals designed to bait Beijing into overreacting, thereby strengthening Chen at home. In private conversations, many characterized Chen as "obsessed," "desperate," "unstable," and even "irrational." Others emphasized that Chen was in his final term and seeking to establish a powerful legacy. These analysts appeared convinced that, no matter how he was constrained politically, Chen would continue searching for new paths to obstruct unification, encourage independence, and infuriate Beijing.

Some Chinese experts portrayed Chen's "deep green" followers as even more desperate. Several cited a widespread expression: "Even if it means they go hungry, they would still rather vote for Chen Shui-bian." These analysts feared that these DPP and Taiwan Solidarity Union (TSU) supporters might even resort to violence, unrest, or conspiracy to upset the 2008 presidential election rather than hand over power to the KMT. While this scenario did not come to pass, it raised the specter of another classic Chinese "red line," albeit one that Beijing has not publicly invoked for many years: the threat to attack in the event of a breakdown in order on the island. Somewhat easier to imagine, however, is a scenario in which Beijing overreacts to some random, destabilizing political event that seems to strengthen the "green" forces—such as the ill-timed death of a top "blue" (pro-independence) leader, or a major violent antigovernment uprising—and CCP leaders conclude, regardless of any evidence, that it was a deliberate provocation by the "greens," much as they did after the 2004 assassination attempt on Chen Shui-bian. An enduring legacy of the late Lee and Chen years is that Beijing's considerable paranoia about the "greens" is an important factor that needs to be considered when considering the prospects for cross-strait instability, regardless of which party holds power in Taipei.

Convinced of Chen's skill and commitment to finding new avenues to promote independence, some mainland experts came to question the value of Beijing laying down clear "red lines" that Chen should not be allowed to cross. They betrayed a perverse sort of respect for Chen's dedication and political cleverness, arguing that deterring him

from specific behaviors was as futile as squeezing a balloon or, in the American idiom, "nailing Jell-O to the wall." Many were convinced that, no matter how carefully Beijing spelled out the kinds of behaviors it found unacceptable, Chen would probe the edges until he found a way out of the box, as was observed by several Chinese experts:

> "It's hard to say what they might do. Chen always finds a way to surprise us. He creates 'situations.'"[13]

> "They can find some way to do something. Anything is possible in the next two years. . . . He still controls the government."[14]

> "So far, I have no idea what Chen will do in his second term. I can't read his mind. But it is his second term. He has nothing to lose. Look at the '3/19 incident.' You can't predict him."[15]

One senior analyst pithily summed up the thoughts of many: "Chen Shui-bian is the sort of person who, if you give him a list of 20 things and tell him he cannot do them, he will somehow think up number 21."[16] Some mainland experts noted several prospective reforms that they considered especially objectionable, though they did not necessarily consider them to be "red lines":

- changing the name of the country from the "Republic of China" to "Taiwan"
- promulgating an entirely new constitution whose sovereignty is exclusively Taiwan-based
- redefining the territory of the "ROC" so that the basis of the government's sovereignty is limited to the 23 million people of Taiwan and excludes mainland residents

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13 Interview, mainland Chinese expert on international relations, 2005.

14 Interview, mainland Chinese expert on international relations, 2005.

15 The "3/19 incident" refers to the 2004 election eve assassination attempt on Chen, which many mainlanders believe was stage managed by Chen himself. Interview, mainland Chinese expert on U.S.-China relations.

16 Interview, mainland Chinese expert on international relations, 2005.

- changing the "ROC" national flag
- abolishing the National Unification Council or rescinding the National Unification Guidelines.

Certainly, these mainland analysts felt powerfully vindicated just weeks after some of these interviews were conducted in late 2005, when President Chen suddenly announced in his 2006 New Year's speech that Taiwan should consider, among other actions, abolishing the National Unification Council and Guidelines. At the end of February, Chen signed a presidential order that the council would "cease to function" and that the guidelines would "cease to apply" (quoted in Kahn and Bradsher, 2006). Although U.S. officials drew a clear distinction between the National Unification Council "ceasing to function" and being "abolished," China saw no useful distinction and reacted sharply, labeling the action "a grave provocation" and "a dangerous step on the road toward Taiwan independence" (quoted in Kahn and Bradsher, 2006).[17] A senior mainland expert echoed the earlier concerns of his colleagues, arguing "The reality is that even under heavy American pressure, Chen Shui-bian is determined to provoke a big response from China." His remarks underscored an apparent sense of doubt that the United States had the power and will to restrain Chen (Professor Huang Jiashu of People's University, quoted in Kahn and Bradsher, 2006).

As a result, several mainland experts stressed the importance of not defining unacceptable pro-independence activities too precisely, for fear that Chen would exploit omissions and ambiguities and leave Beijing stuck in a reactive position: forced to choose between constantly laying down new "red lines" or accepting what it considers unacceptable behavior. "Instead of drawing clear red lines, China must be ready. Chen will never abandon his objectives. So we can't take it for granted that he will be restrained."[18] The source of this quote, as well as several

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[17] In his announcement, Chen avoided the term *feichu* (abolished) in favor of another meaning "to cease functioning" or more literally "to end and stop" (*zhongzhi*). The distinction in meaning between the two Chinese phrases is very thin, at best.

[18] Interviews with Chinese analysts of cross-strait relations, 2006.

other experts, argued that a major advantage of the ASL was precisely that its definition of the circumstances under which Beijing could use force against Taiwan was left deliberately vague. The law defines these circumstances in Article 8:

> In the event that the 'Taiwan independence' secessionist forces should act under any name or by any means to cause the fact of Taiwan's secession from China, or that major incidents entailing Taiwan's secession from China should occur, or that possibilities for a peaceful reunification should be completely exhausted, the state shall employ non-peaceful means and other necessary measures to protect China's sovereignty and territorial integrity. ("The Anti-Secession Law of the People's Republic of China," 2005)

This line of reasoning—spawned by Beijing's distrust of Chen Shui-bian—is potentially problematic because it encourages the Chinese leadership to define its "red lines" *situationally* and *reactively*. It also raises again the possibility that Beijing might treat Taiwan's prolonged resistance to "reunification" as a potential cause of war. The vague conditions contained in the ASL may also provide future advocates of military force with a rhetorical advantage in internal discussions. In case of a significant debate among top leaders over how Beijing should react to some "provocation" from Taiwan, hard-liners could put more moderate elements on the spot by forcing them to argue in the heat of the moment that some action Beijing finds odious does *not* constitute a "major incident entailing Taiwan independence" as mentioned in the law. For many Chinese leaders, the challenge of asserting and striving to prove such a logical and political negative might spell the end of their political careers.

By the end of Chen's second term, China's deteriorating assessments of Taiwan's political dynamics may have prompted a shift in Beijing's notion of what kinds of behavior it was attempting to deter or halt. Beijing apparently believed that it must try to anticipate and prevent a much larger set of actions that were ill-defined, and possibly much more likely to occur, than had been the case in the early 1990s. Put another way, its "red lines" had been transformed into a much less well-defined red *zone* of objectionable behaviors, ranging from "pink"

to "crimson." More disturbingly, Beijing's periodic threats against indefinite stalling during the Chen years raised a further danger: that the cumulative effect of what Beijing perceived as prolonged "salami slicing" or of some dramatic political change in Taiwan might be to persuade Beijing that such negative trends had become clear and irreversible, and therefore that the time for decisive action had arrived.[19] But exactly which action by Taiwan might prove to be the straw that breaks the camel's back has become extremely difficult to forecast.

It remains to be seen how enduring the effect of the late Lee and Chen years will be on Beijing's long-term perceptions of cross-strait stability. Chen Shui-bian's 2008 indictment on corruption charges was greeted with undisguised glee on the mainland, and the first months of the Ma Ying-jeou administration have seen a resumption of cross-strait talks and important statements by both Beijing and Taipei intended to reassure the other.[20] Some Chinese analysts, however, continue to express fear that the DPP will return to power some day, or may foment unrest while out of power, or that the residuum of Chen and the DPP's influence in the Taiwan military's officer corps and other sectors of government will remain enduring obstacles to improved cross-strait relations.[21]

The Politics of the Shifting Cross-Strait Military Balance

For decades, stability across the strait was reinforced by a balance of military power that favored Taiwan's defense or, at a minimum, raised

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[19] One plausible example of such dramatic political change might be DPP victories in national legislative and presidential elections.

[20] These include Ma Ying-jeou's November 2008 meeting in Taipei with unofficial Chinese representative Chen Yunlin, and Hu Jintao's December 31, 2008, message to "Taiwan compatriots" in which he raised the prospect of a "military security mechanism of mutual trust" and making "proper and reasonable arrangements" for Taiwan's participation in international organizations" ("Mainland Marks 30th Anniversary of Major Taiwan Policy Change," 2008).

[21] For a particularly strongly worded recent version of this argument, used as a justification for China not undertaking certain military confidence-building measures, see Wei (2009).

serious doubts in the minds of Chinese strategists that an assault on Taiwan could succeed before U.S. forces arrived to decisively tip the scales. The PLA lacked the necessary offensive capabilities—naval and amphibious forces, advanced fighter aircraft, short- and medium-range conventional missiles, special operations forces, etc.—needed to guarantee a successful conventional strike. Likewise, because the PLA lacked the necessary forces to prevent or slow a U.S. response, Taiwan could feel confident that its forces could hold out until help arrived.

For about a decade, however, trends on both sides of the strait have conspired to cause a shift in this balance. This shift, in turn, seriously threatens cross-strait stability by improving Beijing's chances of success in an attack against the island.

Taiwan's budgetary commitment to maintaining and upgrading its defenses, measured as a percentage of gross domestic product (GDP), declined for more than a decade. Official defense expenditures as a percentage of GDP, which routinely averaged more than 5 percent under the KMT dictatorship, declined nearly every year from 1990 (5.1 percent) to 2006 (2.2 percent).[22] Beijing, meanwhile, has ramped up its investments in defense and initiated the necessary reforms and training to modernize its military in ways that are explicitly aimed at prevailing in any of several scenarios against Taiwan. This includes attempting to deter or prevent U.S. forces from successfully riding to Taiwan's rescue before the island could be compelled to surrender.[23]

The roots of Beijing's renewed commitment to developing the military capacity to coerce Taiwan lie in China's response to U.S. military-technological prowess demonstrated in the 1991 Gulf War. But Beijing's drive to modernize the PLA has been propelled most powerfully by frustration over its lack of options for responding to Taiwan's "provocative" behavior in the late 1990s. Western analyses indicate that in the wake of the 1996 Taiwan Strait crisis, when President Clinton's

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[22] Data on Taiwan defense spending as a percentage of GDP are from Ministry of National Defense of the Republic of China (2008) and Stockholm International Peace Research Institute (2009). While the general trends in these data are very similar across the two sources, there are some differences in calculated level of defense spending and percentage of GDP and trends in that level in 2006–2007.

[23] For an analysis of China's emerging "antiaccess" capabilities, see Cliff et al. (2007).

deployment of two carrier battle groups left China with few realistic response options, Jiang Zemin and the PLA leadership have strengthened their efforts, begun in the early 1990s, to devote the resources necessary to modernize its forces and develop coercive options for future Taiwan scenarios.[24] These efforts have continued since Hu Jintao's ascent power in 2002.

Taiwan, by contrast, has suffered from a failure of leadership on both defense matters and fiscal policy that dates back more than a decade. This leadership failure was abetted by partisan politics and a fragmented constitutional power structure that creates incentives for underspending on defense and other national priorities. Under this system, the incentives for Taiwanese politicians were to emphasize domestic, especially local, spending.[25]

While the decline in defense spending fundamentally represents a failure of leadership, structural factors in Taiwan's democratic system also encouraged this failure. In Taiwan, as in any democracy, the system for electing legislators creates powerful incentives for lawmakers to adopt certain policy positions to keep their constituents happy.

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[24] See Freeman (1998). The political origins of China's military modernization and its efforts to develop military options to deal with a Taiwan contingency over the past decade are complex and an object of continued analysis among experts. David Finkelstein, Director of China Studies at the CNA Corporation, drawing on recently available authoritative materials, documents that China's "Military Strategic Guidelines for the New Period," as annunciated in a pivotal January 13, 1993, speech by Jiang Zemin, "demand that the PLA develop credible capabilities vis-à-vis Taiwan for deterrence and coercion as well as actual military operations, if need be" (Finkelstein, 2007). Chas Freeman, former Deputy Chief of Mission at the U.S. Embassy in Beijing, draws upon extensive discussions with Chinese officials in stressing the political impact of the 1995–1996 crisis on Beijing's resolution:

> The major lesson most American observers, including most members of Congress, have drawn from the crisis is, however, that the prospect of U.S. military intervention can deter a Chinese attack on Taiwan. Beijing reached a different conclusion. China's leaders have always said they would go to war to prevent the permanent division of China. They now believe that they are likely to have to do so. China's armed forces have begun a decade-long effort to acquire the capabilities and do the planning required to have a serious chance of overwhelming Taiwan's formidable defenses. (Freeman, 1998, p. 7).

For an analysis that emphasizes the impact of China's 1998 defense industrial reforms, see Crane et al. (2005, esp. pp. 138–175).

[25] That much defense spending is done overseas has amplified these incentives.

The voting system that had heretofore been used for the LY (a new system adopted in 2005 entered effect in 2007) encouraged legislators to focus on appealing to relatively small, narrow, local constituencies, and discouraged attention to national security affairs. The saga of the 2001 U.S. arms sale package is illustrative of how the process worked, or failed to work.

The Bush Administration approved a package of weapons for Taiwan in April 2001, but it was not until July 2003 that Taiwan informed U.S. officials that they intended to seek $15 billion in funding for three categories of weapons through an extra-budgetary special appropriation from the LY.[26] The Chen administration presented the legislature with the special funding request in June 2004 ("MND Could Finalize U.S. Sub Purchase by Mid-2004," 2003; "U.S. to Woo Delegates on Arms Visit," 2004).

The saga of how this arms purchase became a political football between Chen and the DPP and the "pan-blue" coalition led by the KMT is well known. Taiwan's failure to move promptly to complete the proposed acquisitions also increased tensions between Taipei and Washington at a time when Chen's behavior was also seen by many in U.S. policy circles as unnecessarily provocative toward China. These effects must be added into the balance, along with the overall downturn in Taiwan's defense spending, when assessing the impact of the last ten years on the cross-strait military balance.

In the mid- to long term, there is some cause for optimism. The KMT has recognized that it must put forward an alternative, positive proposal for force modernization and is reportedly working on its own initiatives. Moreover, the U.S. focus on the failure of the special procurement package should not completely divert attention from significant improvements in many other areas of Taiwan's defense, including restructuring of the armed forces themselves and a number of procurement and research and development projects.[27]

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[26] The package offered included, among other items, four guided missile destroyers, eight diesel electric submarines, and 12 refurbished P-3C maritime patrol aircraft.

[27] These include radar systems, KIDD-class destroyers, early warning aircraft, cruise missiles, and a variety of aircraft.

Recent electoral reforms also appear likely to ameliorate some of the incentives for legislators to underspend on defense. Under reforms that took effect with the 2007 LY election, Taiwan has shifted to a system similar to those in Germany and Japan in which the vast majority of legislators are selected in "single-member districts" (as in the United States).[28] The total number of seats in the LY was also cut in half, from 225 to 113. In other systems that have adopted similar reforms, the result has been strong pressure for political parties to consolidate toward a two-party system (versus approximately five in Taiwan today), and legislative candidates have had an incentive to appeal to a broader range of voters by engaging major issues of national policy.[29] Many political analysts in Taiwan hope that these changes will encourage the development of a more accountable political system and a stronger commitment by both parties to issues of national importance, including national defense.

Security Implications of the Changing Political Landscape

The factors described in this chapter present something of a mixed bag, and their collective impact, in terms of the future stability of the cross-strait relationship, is somewhat unpredictable. But we believe that, in general, the "tense stability" that characterized the cross-strait confrontation prior to the mid-1990s is suffering from gradual erosion.

The debate concerning sovereignty over Taiwan has evolved dramatically. Today, this dispute pits a Beijing government that insists there is only one China of which Taiwan is a part against a Taiwan that still retains many formal trappings of being a Chinese state but increas-

[28] More precisely, the downsized LY will consist of 73 seats chosen in single-member geographical constituencies and six seats set aside for the island's indigenous population, plus 34 seats chosen at-large. The at-large seats will be distributed according to the proportion of votes each party obtains nationwide, and as in Germany, a party must obtain at least 5 percent of the total vote to win at-large seats. Moreover, the term of office for members of the LY will be increased from three to four years.

[29] On the relationship between legislative electoral district type, number of political parties in a system, and governance, see Quade (1996, pp. 181–186) and Shugart and Carey (1992).

ingly develops an independent national identity. Notwithstanding the collapse of voter support for the DPP, nearly all significant political parties in Taiwan now accept the notion that any future arrangement with China must receive the separate approval of Taiwan's 23 million voters.

For Beijing, the emerging Taiwanese national identity raises the profoundly worrisome prospect that if unification is delayed for too long, the Taiwanese people will be unwilling to accept any arrangement that subsumes them within a "Chinese" state or confederation. Gradual changes along these lines seem unlikely to provide the spark for conflict, but they could provide a backdrop for crisis if Beijing concludes that long-term trends are turning powerfully against them.

The rapidly growing cross-strait economic relationship means that Beijing can now inflict significant pain on Taiwan if it so chooses. But, to date, Beijing has had difficulty translating this economic leverage into meaningful political results, other than as a device for signaling its irritation with Taipei. If Beijing loses hope that economic and social maneuvers can slow or reverse forces on Taiwan that run athwart of at least eventual reunificaton, the attractiveness, in a crisis, of military options is likely to increase. In Taiwan, meanwhile, advocates of greater independence fear that growing economic ties will mean "time is not on their side," and they may feel the need to push more provocative measures when political circumstances give them the chance.

Beijing's anger at what it saw as Chen Shui-bian's provocative behavior encouraged a dangerous shift in the PRC's "red lines" for threatening force against Taiwan. Beijing sees Chen and his allies as pathological "envelope-pushers" constantly looking for ways to promote the island's independence, and the perceived need to keep Chen boxed in caused China to shift away from the four clear, relatively easy-to-follow "red lines" that it warned Taiwan not to cross in the past. Instead, China has gravitated toward more vague, ambiguous "red areas" and it is more likely to define (or redefine) these situationally and reactively during periods of crisis. This ambiguity and improvisation could become dangerous sources of misperception during a crisis.

The combination of more than a decade of PRC military modernization and flat Taiwanese defense spending have transformed the

balance across the strait away from one that had long favored Taiwan. In the heat of any future cross-strait crisis, this shift in the perceived balance of forces seems to remove an important impediment to Chinese use of force.

The Dangers of Disappointment

Recent political and leadership trends on Taiwan have likely increased Beijing's self-confidence about the long term, and reinforced a patient attitude of acceptance of the status quo and refraining from threats of force against Taiwan. Chen's administration ended with two miserable years politically, marked by a debilitating scandal involving corruption on the part of himself and family members, a growing sense that he was a lame duck, and even protests calling for his resignation by erstwhile DPP allies. On the surface, even the suspicious leaders in Beijing would seem to have little reason to fear now that a solidly entrenched KMT government controls both Taiwan's executive and legislative branches.

However, it is in these very expectations of a new and more accommodating Taiwanese government that the seeds of disappointment and future crisis may lay. While the KMT is not the DPP, the political center in Taiwan has shifted during the democratic era. Although only a relatively small proportion of Taiwan's citizens desire immediate independence, the changes in the political, social, and cultural identity of the island's population described in the chapter are genuine, significant, and enduring. This growing sense of "Taiwan-ness" puts real limits on the ability of the KMT to make the kinds of concessions to China that would permanently ease Beijing's worries about the eventual denouement of the cross-strait drama. The realities of Taiwan's political and social development strongly suggest that even the most flexible Taipei government will reach the limits of possible accommodation well short of Beijing's desired position; there are, simply, irreducible and irreconcilable differences between a China that seeks unification and a Taiwan that will not voluntarily accept it. The unbridgeable distance between these two positions is not likely to shrink in the coming decade; the opposite may indeed be the case, regardless of which party rules Taiwan.

Further, China's growing military power—which will be discussed in greater detail in the next three chapters of this report—may convince its leaders that the mainland possesses credible options that go beyond rhetoric and economic harassment if—more likely, when—the next cross-strait crisis erupts. Finally, even after the recent LY reforms, Taiwan remains a "young" democracy, and although Beijing (and Washington!) may hope that the volatility of politics in Taipei will be reduced, it is not unlikely that island politics will retain an eccentric and erratic edge that from time to time will prove irritating to Beijing.

Taken together, all of these factors suggest that U.S. defense planners would be imprudent to assume that the passing of Chen Shuibian from Taiwan's political scene means an end to the possibility of sudden, deep crisis in the Taiwan Strait. It is to the task of assessing how a military confrontation arising from such a crisis might play out in several key dimensions that our pens now turn.

CHAPTER THREE

Missiles over the Strait: China's Short-Range Ballistic Missile Force

This chapter describes a way in which China's growing force of short-range ballistic missiles (SRBMs) might be employed in a cross-strait conflict. We focus on attacks against air bases, first, because these are targets against which China's SRBMs may prove particularly effective. Second, if the PLA can substantially degrade the sortie-generation capability of U.S. and Taiwanese air bases, it will go a long way toward shifting the balance of air power in Beijing's direction. [1]

There are no definitive data in open-source material regarding such important factors as SRBM accuracy, the kinds of warheads available for the missiles, the size of salvo launches that the Chinese can execute, or the reload time for China's launchers. To cope with these unknowns, this analysis treats many factors parametrically, with the goal of providing a sense of Chinese capabilities under a range of plausible assumptions about SRBM quality. This approach will allow the reader to make judgments about the potential impact of China's SRBMs not just today but over time, as more information about the missile force becomes available, and as the force itself continues to evolve.

[1] In the appendix, we briefly consider the effectiveness of these weapons against key economic targets in an effort to gain some insights into the kinds of damage China might be able to inflict on Taiwan in a coercive campaign.

China's Short-Range Ballistic Missile Force

China continues to enlarge and modernize its force of SRBMs.[2] According to the U.S. Department of Defense (DoD), "by November 2007, the PLA had deployed between 990–1,070 [SRBMs] to garrisons opposite Taiwan. It is increasing the size of this force at a rate of more than 100 missiles a year." The report also notes that China is fielding SRBMs "with improved ranges, accuracies, and payloads" (DoD, 2008, p. 2).

The two primary Chinese SRBMs, the CSS-7 and CSS-6, are shown in Figure 3.1.

Several versions of the CSS-7 (also designated the DF-11, and the M-11 for export) exist with differences in range, payload, and accuracy. The earliest variant of this weapon has a single warhead of 800 kg (1,760 lb), a range of 280–350 km (150–190 nm), and a circular error probable (CEP) of 600 m (1,968 ft).[3] Later models—often called the DF-11A (CSS-7 Mod 2)—have an increased range of 350–530 km (190–285 nm) and a smaller warhead of 500 kg (1,100 lb). More importantly, these newer CSS-7s reportedly have greatly enhanced accuracy, with CEPs of 20–30 m (65–100 ft).[4] The CSS-7 is reported to have several warheads options, including high-explosive (HE), nuclear, chemical, fuel-air explosive (FAE), and submunition. DoD estimates that the

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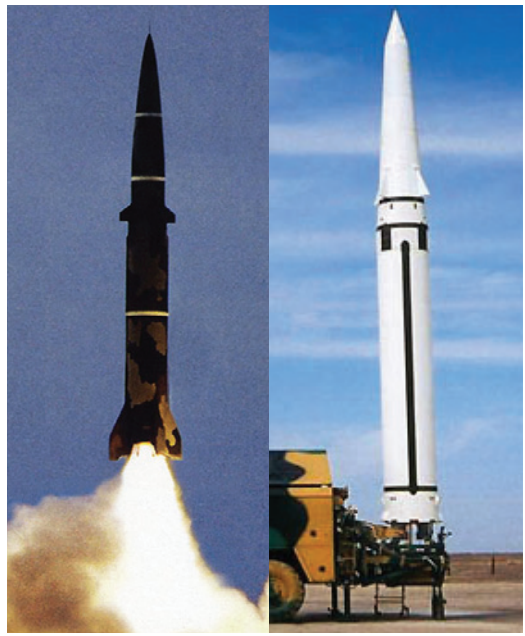
[2] Joint Publication 1-02 defines an SRBM as having a range "up to about 600 nautical miles" (JP 1-02, 2001, p. 490). China also fields longer-range missiles that could be used against Taiwan, but, given the number of SRBMs available, it is likely that China would either employ these on more distant targets (for example, U.S. bases in Japan and on Guam) or reserve them as a deterrent.

China is also deploying a number of land-attack cruise missiles (LACMs) capable of striking targets on Taiwan. To simplify our analysis, we do not explicitly include LACMs in the discussion in this chapter. LACMs could, of course, undertake many of the missions we assign to SRBMs. As will be seen, however, China appears to possess adequate stockpiles of ballistic missiles with which to carry out the attacks described in this chapter, so not incorporating the LACMs seems defensible. In Chapter Four, on the air war, we do employ the LACMs against targets on Taiwan and elsewhere.

[3] CEP is a standard measurement of a weapon's accuracy. Technically, it is defined as the radius of the circle within which 50 percent of some number of weapons fired at a specific aimpoint will land. Smaller CEPs are associated with more accurate weapons.

[4] All missile characteristics are from Jane's (2009b).

Figure 3.1
CSS-7 (DF-11A) and CSS-6 (DF-15B) SRBMs



SOURCE: Left: SinoDefence.com, 2009a; right: SinoDefence.com, 2009b.
RAND *MG888-3.1*

Chinese have 120–140 mobile launchers and 675–715 missiles (DoD, 2008, p. 56).

The CSS-6 (also designated the DF-15, or M-9 for export) has also been improved over time, with considerable capability enhancements in later versions. The most modern type, the DF-15A/B, is reported to have a 600kg (1,329lb) warhead of one of several varieties, including HE, nuclear, and submunition. The CSS-6 has a range of 600 km (325 nm), with a CEP reported as ranging from a mere 5 to 300 m (16–1,000 ft), depending on the variant.[5] DoD reports that the

[5] To achieve a 5m CEP, the warhead would almost certainly have to be maneuverable and incorporate some sort of seeker.

Chinese have 90–110 mobile CSS-6 launchers and 315–355 missiles (DoD, 2008, p. 56).

Both missiles are reported to carry submunition warheads, which can drastically increase weapon effects against certain types of targets. Submunitions are ideal for attacking soft area targets, including, for example, aircraft parked on an open ramp. A specially designed runway-penetrating submunition would be the weapon of choice for cratering operating surfaces. Finally, the wide dispersal pattern of submunition warheads can help compensate for poor missile accuracy by creating a damage footprint far larger than that produced by a unitary warhead of similar weight.

A Simplifying Assumption

Table 3.1 lists the key characteristics of the CSS-7 and CSS-6; it shows that the two SRBMs are fairly similar in a number of respects. To simplify and enhance the transparency of our analysis, therefore, we created a notional missile type to represent both the CSS-6 and CSS-7, which is shown in the far right column of the table.

For both range and warhead size, our notional missile uses the smallest value attributed to any variant of the two referent SRBMs. As appropriate for the targets being struck, we will use either a unitary HE warhead or a submunition version. Because missile effectiveness is

Table 3.1
Characteristics of CSS-7, CSS-6, and Notional SRBM

	CSS-7		CSS-6			Notional
Characteristic	DF-11	DF-11A	DF-15	DF-15A	DF-15B	SRBM
Range (km)	280–350	350–530	600	600	600	>280
Warhead (kg)	800	500	500	600	600	500
CEP (m)	600	20–30; 600 for oldest version	300	30–45	5	5, 25, 40, 200, 300
Number of missiles	675–715		315–355			900
Number of launchers	120–140		90–110			200

so sensitive to accuracy and because of the wide range of CEPs associated with the CSS-6 and CSS-7, we parametrically varied the CEP of the notional missile between 5 and 300 m (16–1,000 ft).[6] In terms of the size of the missile force, we used numbers—900 missiles and 200 launchers—slightly smaller than the low end of DoD's 2008 range for both.[7]

Air Base Attack

How effective would China's SRBM force be at disrupting operations at Taiwan's air bases? In our analysis of the air war described in the next chapter, we parametrically vary the Republic of China Air Force's (ROCAF's) ability to generate combat sorties; here, we wish to dig more deeply into the threat to its ability to operate.

Figure 3.2 shows Tainan Air Base and a map showing its location. Tainan is home to the 443d Tactical Fighter Wing (TFW) of the ROCAF, which consists of 60 F-CK-1 *Ching-Kuo* Indigenous Defense Fighters (IDFs) (TaiwanAirpower.Org, 2008).

Tainan is a fairly typical and well-developed modern fighter main operating base. It has two runways, each approximately 3,050 m (10,000 ft) long by 46 m (150 ft) wide. The air base also has a parallel taxiway that may be usable as an emergency operating surface in the event of damage to the main runways. Tainan also has a number of shelters and revetments that reduce the vulnerability of aircraft on the ground to attack, along with several aprons where aircraft could be parked.[8] Finally, there are several large structures east of (toward the top of the image) the runways that are likely used as maintenance facilities and hangars. We use Tainan as an exemplar air base and will

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[6] This range of accuracies is used to cover an interesting but not outlandish range of the possible current or near-term performance of Chinese SRBMs. It should not be interpreted as reflecting the precise CEP of any specific missile.

[7] As will be seen, the total number of SRBMs is not a limiting factor on the missiles' ability to devastate Blue air bases.

[8] See Stillion and Orletsky (1999) for an analysis of the vulnerability of parked aircraft to ballistic missile attack and the benefit of shelters and less-dense parking.

Figure 3.2
Tainan Air Base on Taiwan

SOURCE: Left: Central Intelligence Agency; right: Google Earth.
RAND *MG888-3.2*

examine how SRBMs might be employed against it and similarly configured facilities.

We begin our assessment by looking at how SRBMs might be employed to attack runways. Since a competent and prepared defender can repair runways and restore flight operations in a matter of hours to a day or two, we expect that China would take advantage of the window opened by the missile attack to attempt air raids against the suppressed bases, using precision-guided munitions (PGMs) and penetrating weapons to destroy sheltered aircraft and other critical targets.[9] We will also explore the likely results of using ballistic missiles to attack the large maintenance building and hangars, as well as to damage or destroy aircraft parked in the open. While we do not assess the probable effects of these attacks on air base operability, these SRBM strikes,

[9] If Taiwan's ability to repair operating surfaces is inadequate or overwhelmed by the missile attacks, it would be possible for China to effectively ground the ROCAF with one or two salvos, obviating the need for follow-on attacks on other airfield targets. In order to be appropriately conservative in our assessment of the efficacy of the PLA's SRBM force, our analysis assumes that Taiwan has very strong rapid runway repair capabilities.

We thank James FitzSimonds of the Naval War College for this insight.

if successful and especially if followed up by fixed-wing attacks, would appear to stand a fairly good chance of reducing sortie-generation capability for a prolonged period of time.

Cutting Runways

The first step in assessing China's ability to close down ROCAF bases with SRBMs is to determine the level of destruction needed to prevent combat-loaded aircraft from taking off.[10] The smallest runway dimensions required to conduct operations is called the minimum operating strip (MOS); USAF planning documents suggest that a surface 1,525 x 15 m (5,000 x 50 ft) is the MOS for fighter operations (U.S. Air Force, 1997, p. 26). Although a sizable missile attack on an air base will likely reduce sortie-generation capability at least some, if an area the size of the MOS remains undamaged and can be accessed by one or more taxiways, sorties can still be flown.

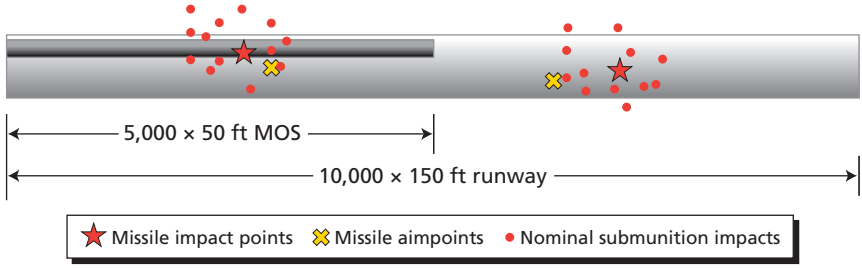
We used a stochastic model to determine the probability that a given number of missiles of a given accuracy would cut the runway in a way that there was no undamaged portion adequate to serve as a fighter MOS. Against runways like the two at Tainan, we assigned two missile aimpoints equally spaced along the length of each runway. If both of these cuts are successful, the operating surface will not offer an undamaged MOS and no sorties can be launched from that runway. This is depicted schematically in Figure 3.3.

We made several simplifying assumptions. First, we treated this as a binary problem—either the runway is cut or it is not. We did not credit the attacker for damage that would require only minor repairs.

Second, we did not consider damage to taxiways, which could affect our results in two ways. First, a large enough stretch of runway might survive at a base but be inaccessible to aircraft due to damage inflicted on the taxiway(s) connecting parking areas with operating

[10] Combat aircraft are considerably heavier on takeoff than landing, due to the full load of fuel and munitions they carry at the start of a mission. Hence, the takeoff distance for a fighter is longer than its landing roll, assuming it is undamaged when it returns.

Figure 3.3
Runway Attack Schematic



RAND *MG888-3.3*

surfaces.[11] On the other hand, a taxiway long and wide enough could be used for at least limited operations if it were intact. Assuming that the Chinese have some form of even fairly crude battle-damage assessment (BDA), however, it seems likely that they could target subsequent missiles against any taxiway being used as an improvised runway.

Third, we did not consider unexploded ordnance. Some number of submunitions from each warhead will be duds. While we accounted for this by assigning a reliability factor to the warhead (which will be explained shortly), we assumed that the dud bomblets would have no impact on operations. In reality, of course, unexploded submunitions would almost certainly be treated as potentially dangerous items to be safely cleared away before sortie generation resumed.

By and large, these assumptions will lead us to slightly underestimate the effectiveness of China's missile strikes, but we believe that they are not far from the assumptions that a prudent PLA planner would make if tasked with plotting these kinds of attacks.

We assumed that the PLA would employ missiles equipped with specially designed submunition warheads to attack Taiwan's runways, which would be more effective than missiles with unitary payloads. Again based on USAF planning figures, we assume that a penetrating warhead with a 2.25kg (5lb) HE charge would create a crater about

[11] Although we did not explicitly model missiles fired at taxiways, it is reasonable to assume that some wayward warheads or submunitions would in the event hit and damage them.

1.5 m (5 ft) across on a typical runway (U.S. Air Force, 1997, p. 15). Because the submunition would need to penetrate some distance into the concrete of the runway, we assume that heavy metals will be used in its design, both to enhance its strength and maximize its kinetic energy on impact. This results in a total weight of about 4.5 kg (10 lb) for each submunition.

As shown in Table 3.1, our representative missile has a payload of 500 kg (1,100 lb). We assume that 25 percent of this total must be devoted to structure, packaging, post-boost systems, if any, and a mechanism to dispense the submunition payload. Therefore, a single missile will carry 82 of our notional 4.5kg (10lb) anti-runway submunitions.

Rounding out our assumptions, we assume 85 percent reliability for both the missile and each submunition. That is, there is an 85 percent chance that the missile, once launched, will arrive and dispense its submunitions at the targeted air base. Once released, each submunition itself then has an 85 percent probability of detonating. Taken together, these reliabilities mean that for every missile carrying 82 bomblets aimed at a ROCAF operating surface, only about 59 can be expected to arrive and explode.

The submunition dispenser in the warhead will be programmed to achieve a pattern of a certain size and shape; the optimal pattern configuration depends on the runway dimensions, missile CEP, and MOS. Accurate missiles would benefit from a smaller dispersal radius as long as the submunition pattern is at least large enough to cover the required area on the runway (essentially its width, as will be explained below), while less-accurate missiles require larger patterns to ensure that at least some submunitions hit the target. Like CEP, we considered this spread parametrically, choosing three cases for dispersal radius: 25, 45, and 90 m (75, 150, and 300 ft). The most effective dispersal radius for each CEP was used for the data presented in the results.[12]

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[12] For the technically minded: The analysis assumed that submunitions are dispersed in a circular uniform random distribution calculated using a Monte Carlo simulation. We first determined the "impact" point of the warhead bus (taking into account the 85 percent bus reliability); impact patterns were based on a Gaussian distribution centered on the impact point. For each functional bus, we considered each submunition individually. We first determined if the submunition would function using a random draw and assuming 85 percent

The runway damage methodology assessed each cut individually. Then, we calculated the probability cutting the entire runway (e.g., damaging it so that no portion as large or larger than the MOS was undamaged) based on the number of cuts required and the expected probability of achieving each runway cut. Further, since the length of the MOS is large relative to the CEP of the missile and pattern radius (1,525 m versus on the order of 45 m; 5,000 ft versus about 150 ft), we need only consider the width of the runway in our calculations. In other words, if we have determined that sufficient damage has been inflicted on the runway so that an undamaged width of the MOS (15 m, or 50 ft) cannot be found, we can identify the runway as cut. It does not matter if this damage is spread over as much as a couple of thousand feet along the length of the runway, as long as the damage occurs across the *width* of the runway.

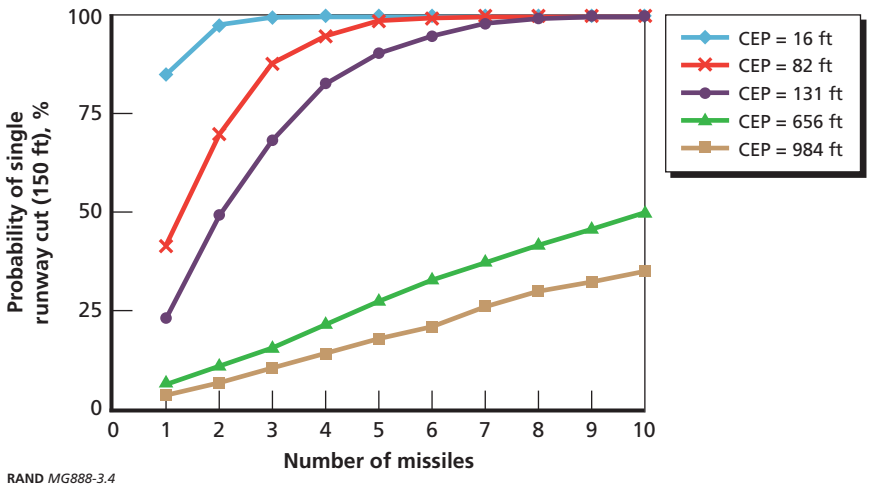
Table 3.2 presents the parameters of the warhead we modeled. Based on these factors, Figure 3.4 shows the probability of a single

Table 3.2
Characteristics of Notional Anti-Runway SRBM Warhead

Characteristic	Value(s)
Delivery CEP (m)	5, 25, 40, 200, 300
Warhead weight (lb)	1,100
Missile reliability (%)	85
Number of submunitions	82
Submunition weight (lb)	10
Submunition HE weight (lb)	5
Submunition lethal radius (ft)	2.5
Submunition reliability (percent)	85
Submunition pattern radius (ft)	75, 150, 300

submunition reliability. For each functional submunition, we then determined its impact point using two random draws (one for the radius from the bus impact point and the other for the angle) within the dispersal pattern, with all points within the pattern being equally likely to be struck.

Figure 3.4
Probability of a Single Runway Cut, Given Number of Missiles and CEP



RAND *MG888-3.4*

runway cut resulting from targeting a given number of missiles of various accuracies. Not surprisingly, CEP has a large impact on the number of weapons required to achieve runway cuts. Using accurate missiles, a 90+ percent probability of cutting the runway can be achieved with a few missiles (two missiles with 5m [15ft] CEPs have a 99 percent probability of cutting the runway, for example) while accomplishing the mission with weapons in the 200–300m (650–1,000ft) CEP range requires 30–40 missiles. We will therefore focus the remainder of this discussion on missiles whose CEPs are within the range defined by the three smaller CEP values, which the reader will recall are broadly consistent with the accuracies attributed to the most modern versions of the CSS-6 and CSS-7. With these CEPs, only a small number of missiles are needed to cut a runway the size of those at Tainan. How many weapons would be needed, then, to attack all of the operating surfaces at Taiwan's fighter bases?

Table 3.3 lists the fighter bases on Taiwan, along with information about each runway at those bases. As at Tainan, all of these runways are just about 45 m (150 ft) wide, which makes our modeling

Table 3.3
Military Air Bases and Runways on Taiwan

		Runway	
Base	**Unit**	**Length (ft)**	**Width (ft)**
Cha Shan (Hualien new)	401 (5) TCW	8,000	150
		8,000	150
Chiayi	455 (4) TFW	10,007	148
Taitung	737 (7) TFW	11,055	147
Ching Chaun Kang	427 (3) TFW	12,000	148
Hsinchu	499 (2) TFW	11,955	148
Hualien (old)	Military/civilian	9,022	148
Makung	Military/civilian	9,843	148
Pintung North	439 CW	8,000	150
Pintung South	439 CW	7,828	148
Tainan	443 (1) TFW	10,007	148
		10,007	148

NOTES: TCW=tactical composite wing; CW=composite wing.

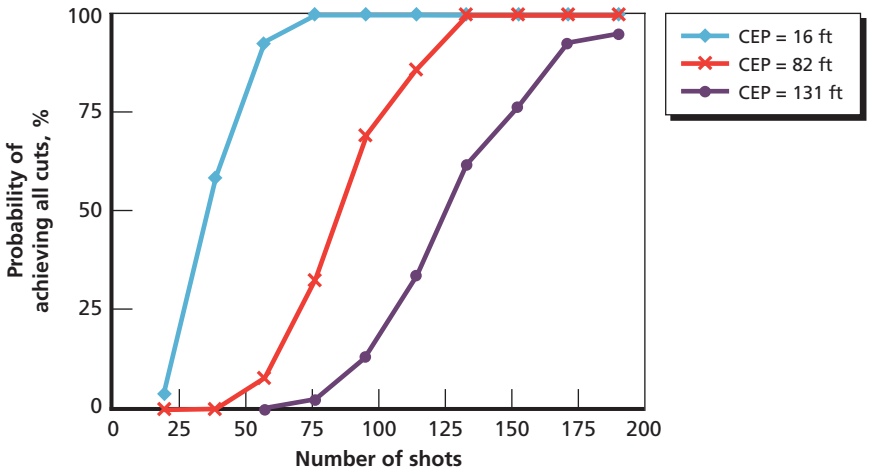
fairly straightforward: We simply have to determine the number of missiles required to cut a dozen runways of this width.

So, how many weapons would be needed to close all 12 of these runways and leave the ROCAF crippled, at least temporarily? To answer this question, we start by identifying the aimpoints for our weapons.

Examining the runway lengths in Table 3.3, and remembering that a runway is successfully cut if the MOS of 1,525 x 15 m (5,000 x 50 ft) is not available, we need to cut some of these surfaces more than once. Since the weapons we are evaluating are fairly accurate (CEPs of 40 m or less) one arriving weapon will be sufficient to make a single cut and close any runway shorter than about 2,750 m (9,000 ft). Runways longer than this will require two cuts. There are five of these shorter surfaces—we put the runway at old Hualien in this first category—and so will require one cut each, while seven are longer and will require two cuts. So, a total of about 19 runway cuts are required to essentially shut down ROCAF sortie generation, at least for a period of some hours.

Figure 3.5 shows the probability that all 19 cuts will be made by a salvo of a given number of SRBMs of the specified accuracy. The points on this graph are at 19-missile increments representing one, two, three, and so forth missiles fired at each of the 19 aimpoints.[13] The figure is put into perspective when we recall our assumption that China possesses 200 SRBM launchers.[14] This means that if the entire first wave of missiles is devoted to air base attack, a greater than 90 percent chance of cutting all runways could be achieved with 40m (131ft) CEP missiles. If a more accurate missile with a 25m (82ft) CEP is available, using just half of the first salvo would result in about an 80 percent chance of cutting every ROCAF fighter runway and greatly degrad-

Figure 3.5
Probability of Cutting All Runways, Given Salvo Size and CEP



RAND *MG888-3.5*

[13] If Chinese planners confront a situation in which they possessed an inadequate number of missiles to attack all 19 runways—because, perhaps, they could only rely on achieving 40m CEPs and had insufficient launchers to fire more than 100 SRBMs at a time—the PLA could choose to concentrate its fire on a subset of bases while mounting nuisance attacks on the others, with the goal of disrupting overall sortie generation enough to permit fixed-wing attacks on the bases that received the brunt of the missile attack. After reloading launchers and rearming aircraft, the other bases could be struck.

[14] Which, further recall, is slightly *fewer* than DoD estimates are in fact deployed.

ing, or even eliminating, sortie generation for some period of time. As China's SRBM force continues to grow and mature, the vulnerability of the ROCAF's runways will represent an increasingly serious threat to the Taiwanese air force's ability to participate in the island's defense during the crucial first days of any conflict.[15]

Hangars/Maintenance Facilities

There are other possible targets for ballistic missiles on air bases besides runways. Figure 3.6 shows Tainan Air Base again; inside the two boxes are several large, hangar-size structures located just off the parking aprons on the east side of the base (which is at the top of this photo). These buildings might contain aircraft, maintenance shops, or other facilities critical to supporting combat operations from the base. They, too, could be struck by SRBMs.

Figure 3.6
Large Hangar-Size Buildings on Tainan Air Base

SOURCE: Google Earth.
RAND *MG888-3.6*

[15] Although we did not similarly analyze the specific question, it should be clear that if and when China fields missiles capable of mounting similar attacks on Kadena or other forward bases in the vicinity of Taiwan, the USAF's sortie-generation capability will be put similarly at risk absent appropriate countermeasures.

For simplicity, we consider two hangar sizes in this analysis: 45 x 30 m (150 x 100 ft) and 45 x 60 m (150 x 200 ft), which are the approximate sizes of several of the buildings pictured at Tainan, and are fairly typical of the kinds of structures generally found along flight lines. These calculations were made using a simple Monte Carlo computer simulation.[16] The weapon was required to strike the building; no damage was credited for near misses. As in the assessment of runway attack, we assumed a missile reliability of 85 percent, and unitary warheads were employed in the attacks.[17]

Figures 3.7 and 3.8 present the number of weapons required to achieve various levels of damage against a single structure of each of the two sizes examined. They show that accurate weapons are required to attack these targets. Two or three SRBMs with CEPs of 15 m (50 ft) are needed to achieve a 90 percent probability of hit. Achieving this level of damage probability against each of the six or eight hangar-like buildings found at Tainan structures could therefore be done with about 20 missiles. On the other hand, a weapon with a CEP of 30 m (100 ft) requires two to three times as many missiles to achieve the same damage probability. Recalling that Tainan is just one of about ten bases that would need to be attacked, the number of weapons needed to comprehensively target these installations could get very large if anything other than very accurate missiles were used.

Attacking Aircraft Parked in the Open

Another potentially lucrative target on air bases would be parked aircraft. Although aircraft in hardened shelters are safe from the near-term ballistic missile threat—penetrating shelter roofs requires a combination of warhead size, construction, and accuracy that is difficult to

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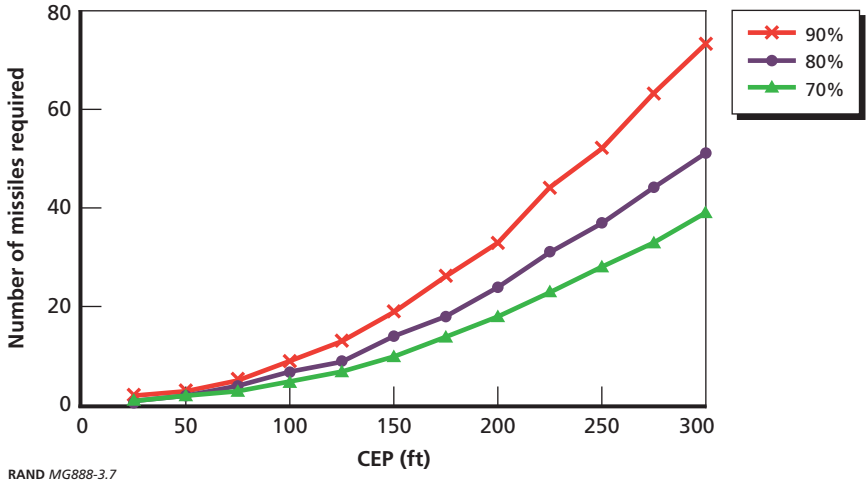
[16] We employed a Monte Carlo simulation with 20,000 runs. The stochastic nature of the results accounts for the "waviness" of the curves in Figures 3.7 and 3.8. Additional runs would result in smoother curves, but the level of accuracy presented here is sufficient for our purposes.

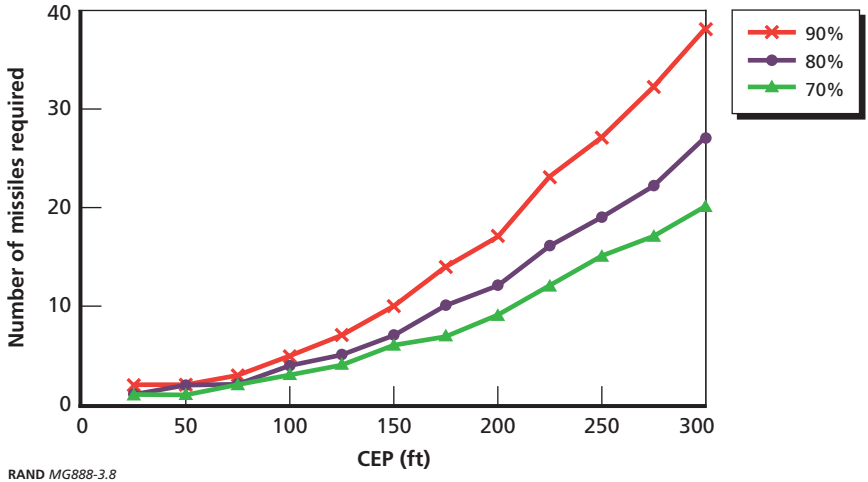
[17] Although submunitions could be used to dramatically increase the lethal radius of the missiles, the smaller explosive charges in the bomblets might not inflict the desired damage on the building and contents.

Figure 3.7
Missiles Required to Hit 150 x 100 ft Structure, as Function of CEP



RAND *MG888-3.7*

Figure 3.8
Missiles Required to Hit 150 x 200 ft Structure, as Function of CEP



RAND *MG888-3.8*

achieve within the constraints of contemporary missile design—not all ROCAF aircraft appear to have shelters available.[18]

Figure 3.9 shows a close-up of the aircraft parking area at Tainan. For analytic purposes, it can be approximated as three rectangles of (from left to right in the picture) approximately 105 x 305 m (350 x 1,000 ft), 215 x 380 m (700 x 1,250 ft), and 245 x 245 m (800 x 800 ft). How many missiles with submunition warheads would it take to

Figure 3.9
Aircraft Parking Ramps on Tainan Air Base

SOURCE: Google Earth.
RAND *MG888-3.9*

[18] The Google Earth image of Tainan, for example, reveals about 45 shelters for the roughly 60 fighters based there as part of the 443d TFW. During combat, some aircraft would likely be in the air at almost all times, so there does not need to be a one-to-one correspondence between jets and shelters. However, as this analysis will show, any aircraft that are either parked outside or too large to shelter—such as tankers or airborne early warning platforms like the ROCAF's E-2 *Hawkeyes*—will be at grave risk. See also Stillion and Orletsky (1999).

lay a large number of bomblets onto these parking areas, damaging or destroying many of the aircraft sitting on them?

For this analysis, we assumed that China would use versions of its existing missiles equipped with a payload of small bomblets, probably optimized for use against parked aircraft (e.g., emphasizing fragmentation and incendiary effects versus armor penetration). Employing the same weight and volume factors used in our analysis of runway attack, we estimate that our notional missile could carry on the order of 800 such submunitions.

To assess effectiveness, we used the same basic process described for the runway-attack assessment: Missiles were launched at aimpoints with their actual impact points determined using a Monte Carlo simulation. Those whose impact points were within the area of the target ramp were assessed to have arrived and dispensed their payload (as before, given an assumption of 85 percent missile reliability). If the impact point fell outside the ramp, the missile was assessed a miss.[19]

Figures 3.10, 3.11, and 3.12 show the results of our analysis. We computed the number of weapons required to achieve various probabilities of the missile dispensing submunitions over each size of ramp for CEPs ranging from 8 to 90 m (25–300 ft). Only a handful of even fairly inaccurate missiles are needed to spread bomblets over each ramp.[20] If Tainan is typical of the number and size of ramps at Taiwan's other air bases—and it appears to be, according to an initial evaluation using unclassified imagery—two or three dozen SRBMs with appropriate submunition warheads would likely wreck any aircraft parked outside on all of them.

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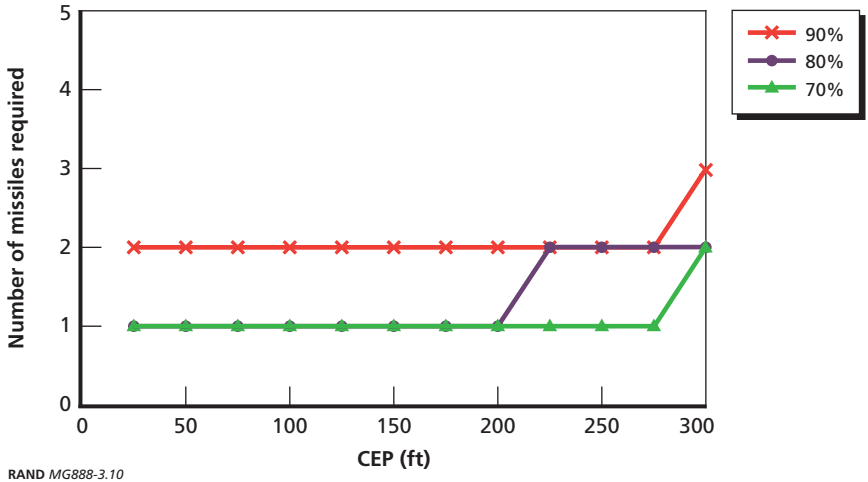
[19] This is an attacker-conservative approach, since it is very likely that some, perhaps many, submunitions from "near misses" would land on the targeted ramps.

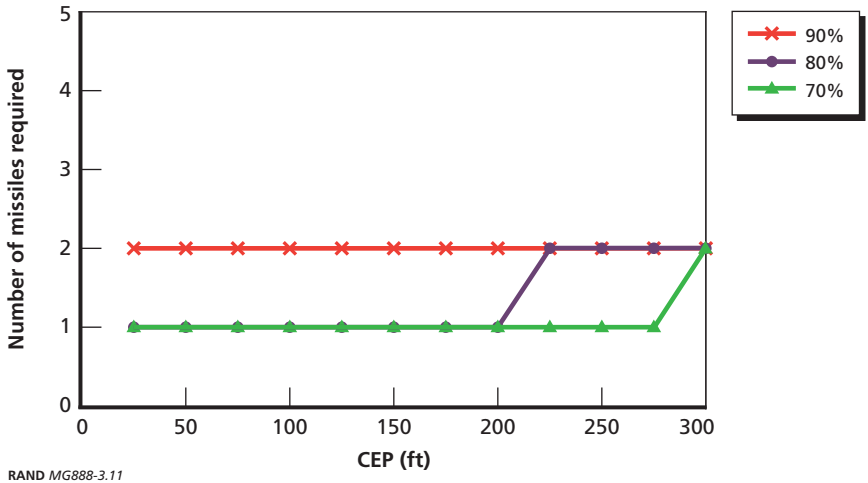
[20] We assume that the distribution pattern of the submunitions is more or less commensurate with the area of the ramp. Given the small number of missiles required to ensure hitting these large area targets, only a few more would be needed to ensure total coverage of parking areas if in fact the missile bus had a dispersal pattern substantially smaller than a particular apron.

Figure 3.10
Weapons Required to Cover a Single 800 x 800 ft Ramp



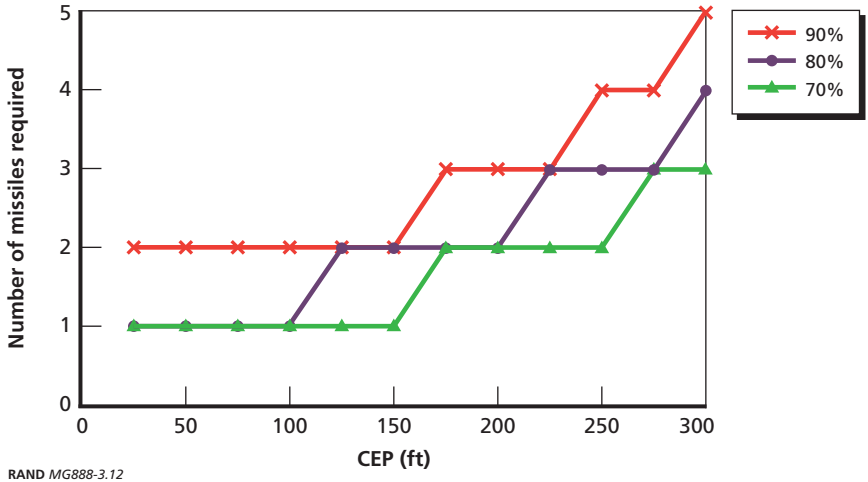
RAND *MG888-3.10*

Figure 3.11
Weapons Required to Cover a Single 700 x 1,250 ft Ramp



RAND *MG888-3.11*

Figure 3.12
Weapons Required to Cover a Single 800 x 800 ft Ramp



RAND *MG888-3.12*

Air Base Attack Observations

This analysis confirms the conventional wisdom that achieving a high probability of cutting runways with ballistic missiles takes a sizable number of weapons. However, the kinds of attacks required to cut most or all of the operating surfaces at Taiwan's fighter air bases—60 to 200 (depending on accuracy) SRBMs with runway-busting submunitions—could be at China's disposal in the near future as their force structure continues to grow in numbers and develop in quality.

Other air base targets can also be damaged with a relatively modest number of missiles. Thirty or forty reasonably accurate SRBMs with submunition payloads could damage or destroy nearly every aircraft parked outside of shelters or revetments on every ROCAF base.

Unless very accurate weapons are used, even large buildings can be difficult to destroy with unitary warheads. However, if sortie generation can be even temporarily suppressed through attacks on runways and parking ramps, fixed-wing aircraft with laser- and satellite-guided precision munitions could follow up and strike not just hangars but shelters, hardened command and control centers, fuel storage, and

other targets. This level of destruction could cripple the ROCAF's ability to play its role in defending Taiwan.[21]

Concluding Observations

The threat to Taiwan from Chinese ballistic missiles is serious and increasing. Beijing continues to add missiles to its inventory, and the PLA appears to be improving the accuracy of its SRBMs and developing warheads that could be highly effective against a variety of targets on Taiwan. In the near term, China's ability to use missile attacks to seriously degrade Taiwan's self-defense capabilities will likely reach a dangerous level.

Although literally thousands of missiles might be needed to completely and permanently shut down Taiwan's air bases, about 60–200 submunition-equipped SRBMs aimed at operating surfaces would seem to suffice to temporarily close most of Taiwan's fighter bases. If China can launch a single wave of this size, which seems consistent with the number of SRBM launchers the PLA deploys, those missiles could suppress ROCAF operations sufficiently to allow PLA Air Force (PLAAF) strike aircraft to attack air bases and other military and industrial targets with modern precision weapons. The result could be a Taiwan with a profoundly reduced ability to defend itself, left open to a range of follow-on actions intended to coerce or conquer it and its people.

It is unclear how prepared the Chinese are to execute at least the second half of this concept of operations—there is little evidence in the open press of substantial PLAAF training with or acquisition of air-delivered PGMs—but it merits further examination and close tracking by U.S. and Taiwanese intelligence. It is clear, however, that China's SRBM force presents a most serious threat to Taiwan's security.

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[21] This is essentially the attack strategy we employ for the PLA in Chapter Four's discussion of the air war.

CHAPTER FOUR

Assessing the Air War

As already noted, in 2000, three of the present authors published an earlier report on the cross-strait military balance, using as our analytic baseline a China-Taiwan conflict fought in the then-distant year of 2005. That report focused on the battle for control of the air, which it characterized as "an absolute prerequisite for a successful amphibious or airborne assault" (Shlapak, Orletsky, and Wilson, 2000, p. 11). While our current study has a wider aperture and deals with other aspects of the China-Taiwan security competition, we felt it important to return to the topic of the air war; air superiority, or the lack of it, is and will likely remain a critical factor in any large-scale use of force over the Taiwan Strait, whether China's ultimate goal is invasion and occupation or coercion.

The PLAAF's continued modernization is reflected in our projections for the 2013 time frame, which are shown in Table 4.1. The main changes we expect in coming years include

- A further increase in the size of the PLAAF's fourth-generation fighter fleet of between 90 and 300+ percent. Figure 4.1 shows a photo of a Chinese FLANKER aircraft.
- The addition of a number of "generation 3½" J-8 fighters: older model airframes equipped with updated avionics and able to employ modern "fire-and-forget" beyond visual range (BVR) missiles
- China's continued fielding of advanced electronic warfare systems, such as jammers.

Table 4.1
Projected PLAAF Inventories

	2013 Projection	
Aircraft Type	**Base**	**Advanced**
Su-30	73	150
Su-27/F-11	116	130
J-10	100	250
J-8 (advanced)	62	100
J-8	280	0
Total fighter/multi-role	*631*	*630*
JH-7	40	40
Q-5	200	0
H-6 (advanced)	46	60
H-6	50	40
Total attack/bomber	*336*	*140*
Grand total	*967*	*770*

NOTES: Projections include only those aircraft notionally allocated to the Taiwan campaign. Table does not include PLA Naval Air Force assets.

- The addition to the inventory of nearly 50 advanced H-6 bombers to be carriers for the YJ-63 and DH-10 LACM.
- A reduction in the numbers of the oldest combat aircraft (the J-7 fighter, Q-5 attack aircraft, and earlier versions of the J-8 fighter).[1]

Both the baseline and advanced Chinese forces are considerably larger than we projected for 2005. However, as in the previous study, we assumed that the number of operational bases within unrefueled fighter range of Taiwan would limit the number of aircraft that the PLAAF could keep in action at any one time to around 600. Fighters

[1] It's worth noting that some unclassified estimates suggest that, as of 2008, the PLAAF already fields a fleet essentially as modern as that we project for five years hence. Jane's Online (2009a), for example, shows the PLAAF equipped with about 390 modern fighters (3½ and 4th generation); our 2013 baseline only credits China with about 350.

Figure 4.1
Chinese FLANKER Fighter

SOURCE: U.S. Department of Defense Photo by Staff Sgt. D. Myles Cullen.
RAND *MG888-4.1*

above that limit are held in reserve, and flowed forward daily to replace combat losses.[2]

In all cases, we gave the Chinese an unlimited number of PGMs and 200 cruise missiles for use in this theater of operations. We did not distinguish between ground- and air-launched cruise missiles, and we assumed that all were capable of reaching targets on either Taiwan or Okinawa.

While the PLAAF has been substantially upgraded over the past decade, the ROCAF has not. Table 4.2 shows that our baseline 2013 estimate for the ROCAF fighter order of battle is roughly the same size and composition as today. The "advanced" case shows a larger Taiwanese fighter force, reflecting a completed purchase of the 66 F-16C aircraft requested by Taiwan in 2006 but as of this writing not yet authorized by the United States. In either case, the results of our analysis indicate the potential consequences of the two sides' divergent modernization trends.

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[2] China's H-6 bombers are assumed to be based deeper inside China and are not affected by restrictions on basing.

Table 4.2
Projected ROCAF Inventories

Aircraft Type	Base	Advanced
F-16	132	198
Mirage 2000	57	57
IDF	128	128
Total	317	383

Analytic Approach and Scenario Variables

As in our prior study, we employed the Joint Integrated Contingency Model (JICM), a theater simulation first developed at RAND almost 25 years ago and continually upgraded since then.[3] JICM's representation of air warfare is sufficiently high-level to permit the construction of an appropriate open-source database while remaining flexible enough to permit extensive parametric analysis.

Any large-scale air war over the Taiwan Strait is likely to be intense and to play out rapidly. If the results of our 2000 study are to be believed, losses will be very high on both sides, which will cause the action to wind down in fairly short order, due to exhaustion if nothing else. So, as in the prior work, we play the air war out for only four days.[4]

In both our previous work and this, the overall analytic approach is to establish a base case and choose a set of scenario variables that captures the important uncertainties, both in effectiveness and in operations. We choose a range of values for each scenario variable, typically two or three. Then we run the model, permuting all of the scenario variables, with the result of each permutation expressed according to our chosen measures of merit.

The previous study used the following scenario variables:

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[3] For a description of JICM, see Fox and Jones (1998).

[4] This should not be interpreted as meaning China would invade on the fifth day; the PLA might spend weeks "softening up" Taiwan. We look at the first four days because the air superiority fight as we model it is basically decided by that time.

- the size and composition of the air forces committed to the attack by both the PRC and Taiwan
- each side's possession of BVR "fire-and-forget" medium-range air-to-air missiles (AAMs)
- the number and quality of short- and medium-range ballistic missiles (SRBMs and MRBMs) and cruise missiles used by the Chinese
- the number of advanced PGMs, such as laser-guided bombs (LGBs) and satellite-guided weapons in the Chinese inventory
- the ability of ROCAF bases to generate combat sorties
- the quality of the PLAAF aircrew
- the extent, if any, of U.S. air forces, both land- and sea-based, committed to Taiwan's defense.

For the current effort, we have updated the values of some variables, removed some, and added a few as new issues of interest have arisen:

- the size and composition of the air forces committed to the attack by the PRC (detailed above)
- The relative quality of the PLAAF's aircrew
- the ability of the PLAAF to coordinate massed air raids and generate multiple sorties per day with its advanced aircraft
- the presence or absence at Taiwan and U.S. air bases of defenses against PGMs and cruise missiles
- the size and composition of Taiwan's air force (discussed above)
- the ability of both the ROCAF and the United States on Okinawa to generate combat sorties from air bases under heavy attack
- the survivability of Taiwan's surface-to-air missiles (SAMs)
- the number of shelters at ROCAF and U.S. air bases
- the extent, if any, of U.S. air forces, both land- and sea-based, committed to Taiwan's defense.

We will detail each in turn.

Chinese Aircrew Quality

It has long been the case that PLAAF fighter pilots were assessed to be substantially inferior to Taiwanese or U.S. flyers. The number of flying hours Chinese pilots receive has historically been much lower than their counterparts in Taiwan and the United States, and they practiced tactics that were judged crude and stereotyped in comparison with those flown in the West. China is seeking to improve in these areas, and the PLA has promulgated new guidelines calling for more realistic training (DoD, 2008, p. 5).

What effect on operational capability these changes will make in the next decade is difficult to predict; the deficiencies the PLA is seeking to correct are serious and of long standing. It will take time simply to develop and implement new training curricula, and more still to put enough aircrews through them to see large-scale improvements in front-line regiments. Because of this uncertainty, we parameterize the variable fairly broadly: We look at outcomes if PLAAF pilots are 40, 60, and 80 percent as good as their USAF counterparts.

Chinese Air Operations

Another major uncertainty affecting China's air-combat potential is the PLAAF's ability to launch and control the large number of aircraft that operations against the United States and Taiwan will demand. Including bomber missions and allowing multiple sorties each day from advanced aircraft, the PLAAF can mount nearly 1,200 sorties on the first day of combat in the JICM air war representation. This surpasses by a considerable margin the average daily number of combat sorties flown by the USAF in Operation Desert Storm, which was roughly 900.[5] Can the Chinese plan, generate the sorties for, and control air operations on this scale?

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[5] At peak, the USAF in the first Gulf War deployed about 650 fighter-bomber type aircraft in the combat zone, about the same number with which we credit the PLAAF in our scenario. But, the USAF was able to operate from bases that were not under attack, its aircraft suffered little combat damage and few losses, and they had had substantial experience in planning for and rehearsing large-scale air operations in the context of the NATO-Warsaw Pact staredown. None of these apply to PLAAF operations in a Taiwan scenario. For numbers of USAF aircraft in the Gulf War, see Cohen (1993, Table 5, p. 27).

To explore the potential consequences of China being unable to exploit fully the potential of its combat fleet—due to command-and-control or logistics problems—we ran cases wherein we limited Chinese aircraft to one sortie each day; this allowed the PLA to generate about 900 sorties on the first day, roughly consistent with the average number flown by USAF fighters during Desert Storm in 1991. Further, in this case we also limited China's ability to conduct large raids by spreading these sorties evenly over the daylight hours. In the enhanced operations cases, we allow the advanced aircraft to fly multiple sorties each day, with the majority of those sorties concentrated in two massive daylight strike packages.[6]

Defenses Against Chinese PGMs

Although the Chinese continue to develop and acquire PGMs, there is little evidence in the open literature to suggest that they have yet fielded them in large quantities. Nonetheless, in comparing our previous and current base cases, the Chinese in 2013 are given nearly 200 additional modern aircraft capable of delivering PGMs, and the new advanced case puts nearly 400 added modern aircraft in China's hands. It seems appropriate to project that munitions could be fielded to match this much-improved fleet. Therefore, we did not use the number of PGMs as a scenario variable.

Instead, we added one that placed short-range defenses—local Global Positioning System (GPS) jammers, laser-guided bomb blinders, rapid-fire radar-guided guns, quick-reacting short-range SAMs, and decoys—at ROCAF bases and at Kadena and Iwakuni on Okinawa. We assumed that these defenses reduce the effectiveness of PGMs and cruise missiles by 75 percent.

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[6] We are aware that even the more limited case we examine represents a much larger and more complex set of operations than the Chinese have ever executed in wartime or, at least as far as can be seen in the open literature, training. Our purpose here is not to exaggerate the threat, but to examine the potential impacts of substantial improvements in Chinese capabilities.

Blue Sortie Generation

As was argued in the last chapter, China appears to be fielding modern SRBMs with the accuracies and warhead types needed to damage operating surfaces, parking areas, and other facilities on any air base within range. In the post-2010 period, the Chinese will almost certainly have enough SRBMs properly configured to mount sustained and damaging strikes on both ROCAF fighter bases and U.S. bases on Okinawa. With short times of flight from launch areas to targets across the strait or on Okinawa, China could—with real-time intelligence, surveillance, and reconnaissance (ISR), perhaps provided by covert operatives in Taiwan or Japan—also attempt to disrupt runway repair and other air base recovery processes by firing additional missiles. Unless Taiwan has extreme confidence in its ballistic missile defense (BMD), warning of even a single incoming missile could cause personnel to abandon their duties and seek cover.

The variable of interest for our purposes, then, becomes the number of sorties that can be generated from an air base under persistent attack. There are substantial uncertainties about how resilient an air base might prove to be, so we ran cases in which 20, 40, or 60 sorties are generated each day from each base, representing roughly one-sixth, one-quarter and one-half, respectively, of the number that a fully operational base could produce. This limit is applied to ROCAF fighter bases and to the U.S. bases on Okinawa.

ROC SAM Survivability

For our base case, we assume that Taiwan's current medium- and long-range surface-to-air defenses, which appear to be mainly dependent on fixed radar and launcher installations, would not prove survivable in the face of a sophisticated attack involving jamming, anti-radiation drones such as the Israel-supplied Harpy, air-launched anti-radiation missiles, and area-effect warheads for ballistic missiles.[7]

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[7] These SAM systems are important if the Chinese seek to exploit their PGMs, as the USAF and others have done in recent conflicts, by flying attack missions at medium to high altitudes, beyond the reach of other, shorter-range air defense (SHORAD) weapons. To the extent that PLAAF aircraft are forced for any reason to ingress or egress Taiwan airspace at

Taiwan could make a number of improvements to increase the survivability and effectiveness of its air defenses, including adding more mobile SAMs and radars; fielding short-range air defense systems that could shoot down PGMs and cruise missiles (see above); employing camouflage, concealment, and deception to complicate Chinese targeting and BDA; and improving data-linking across missile batteries and command centers to add robustness in the face of attack.

Because of uncertainties as to how Taiwan's air defenses might perform, we modeled SAM survivability parametrically, as shown in Table 4.3.

Shelters at Blue Bases

While China's SRBMs do not have sufficient accuracy or payload to effectively attack aircraft shelters, if the missiles can suppress sortie generation and defeat Taiwan's surface-to-air defenses, the door will be opened for PLAAF fighter-bombers, such as Su-30s and J-10s, to deliver PGMs against these and other hardened targets. In addition, the inventory of 200 Chinese cruise missiles could destroy up to 70 shelters, given our assumed probability of kill.[8] If the air bases are suppressed for even a few hours by missile strikes, aircraft not already air-

Table 4.3
ROC SAM Effectiveness

	Effectiveness (%)			
Case	Day 1	Day 2	Day 3	Day 4
Base	50	0	0	0
2	75	50	25	0
3	90	80	70	60

low level, these SHORAD systems—which have proven to be very hard to suppress in such places as Serbia and Kosovo—could exact a toll.

[8] Low-flying, accurate cruise missiles can be effective against aircraft shelters because, absent deliberate precautions on the part of the defense, they can be targeted on the shelter's doors. The doors must, of course, move and are therefore lighter and more vulnerable than the shelter's thick concrete walls and roof. Even if the missile cannot penetrate the door, it can achieve a "functional kill" on the shelter by jamming it closed, preventing the aircraft inside from getting out.

borne or dispersed will be pinned on the ground and vulnerable to follow-up attacks. So, the number of shelters on the defender's air bases becomes an important variable.

From open source counts of shelters and examination of unclassified imagery, our base case credits each ROCAF main air base—except Hualien and Taitung—with 50 shelters. Aircraft were not attacked on the ground at Hualien or Taitung in our scenario, as we assumed they would be kept safe in the large underground hangars that have been reported at each location. We also placed 15 shelters at Kadena, but credited Iwakuni with no shelters in the base case. In our "high-shelter" case, we increased the number of shelters to 66 at each ROCAF base, 73 at Kadena, and 36 at Iwakuni, enough to protect all of the deployed fighters

Finally, we ran cases where the U.S. deployed "super shelters" at its two bases, employing barrier walls and other measures to render the vulnerable shelter doors impervious to even very accurate cruise missiles.

U.S. Forces Engaged

We used six levels of U.S. forces and one variant of basing for them. We assessed cases in which two, one, or no U.S. carrier strike groups (CSGs) were engaged, as well as cases with no fighters operating out of Okinawa, one wing of 72 F-15Cs, or one wing of 72 F-22s. To investigate a U.S. strategy that pulls forces out of Okinawa and relocates them further out of harm's way, we also ran a case with 72 F-22s operating from Andersen Air Force Base on Guam.

In all cases where there were U.S. fighters at Kadena, we also flew 36 USMC F/A-18C/D aircraft from Iwakuni Air Base in Japan. These aircraft were committed in the fight over Taiwan; we assumed that Japanese Air Self-Defense Forces (JASDF), while not participating in the cross-strait war per se, nonetheless would protect the national territory of Japan, including Okinawa.

Laying Out the Scenario Space

Fully permuting all of these variables resulted in a total of over 31,000 separate cases being run in the JICM for our set of scenarios. The outcome of each case was scored according to two measures of merit that we will describe shortly. For now, we would like to suggest how these results should most usefully be interpreted.

We chose scenario variables that prior research and analysis—both our own and others'—suggested would be important in determining which side would prevail in air combat over the strait. Likewise, we attempted to choose parametric settings for each variable that were plausible and covered a reasonable range of values. However, the sheer number of variables, values, and therefore, cases, should indicate how fraught with uncertainty these issues are. Other analysts would undoubtedly have chosen some different variables, or used different settings than are employed here, and they would not have been "wrong." What is most important about the results presented here is not the absolute number of cases in which one side or the other fares better or worse; these proportions would almost certainly change if the same analysis were repeated using a different range of values for the scenario variables, or different variables entirely. Instead, what should be looked for is *where changes to the scenario space—particular settings of particular variables—lead to significant differences in outcome, and where they do not.* This will identify factors that appear to influence the simulation results and so are perhaps worthy of further analytic attention and some attention from planners and policymakers.

Character of the Air War

Taken together, the improvements with which we have credited China's military—improved missiles and larger numbers of advanced fighters in particular—have changed the character of the air war. In our previous analysis, the PLA's SRBM force was largely limited to suppressing Taiwan's surface-to-air defenses, enabling China's air force to engage the ROCAF and any U.S, fighters in a battle for air supremacy. Owing

to substantial qualitative inferiority, it was a battle that Beijing usually lost.

In the present assessment, however, the size and accuracy of Red's missile force has increased to the point that it can deliver something approaching a "knock-out punch" on Taiwan's air bases, creating an opportunity for the PLAAF to gain at least limited control of the air in the first hours of conflict. Under these new and decidedly unfavorable (for Taiwan and the United States) circumstances, the question of interest changes from determining what factors might allow the Chinese air force to eke out a win in air-to-air combat to identifying those that may allow the defenders to take back air superiority, or at least prevent China from achieving or exploiting it, while flying from severely degraded air bases on both Taiwan and Okinawa.

The Base Case Battle

As an example, we will discuss the first day's air strikes for an example case:

PRC forces :	Base
PRC aircrew quality:	80 percent
PRC air operations:	Low
ROC/U.S. PGM defenses:	No
ROC forces:	Base
Blue sortie generation:	20 per base per day
ROC SAM survivability:	50 percent
ROC/U.S. shelters:	Low
U.S. CSGs available:	2
Fighter type at Kadena:	F-22

Table 4.4 shows the sortie rates achieved by U.S. fighters along with the air-to-air exchange ratio achieved by each type in our base case. Overall, Taiwan's fighters achieved a 2.3 air-to-air exchange ratio; their sorties were limited by a scenario parameter as discussed above. All Chinese aircraft flew at a 1.0 sortie rate except in the "high" Chinese air operations cases, in which FLANKERs flew at 2.0 and J-10s at 1.5.

Table 4.4
Sortie Rates and Exchange Ratios

Aircraft/Base	Sortie Rate	Exchange Ratio
F-15/Kadena	1.8	4.5:1
F-22/Kadena	1.5	27:1
F-22/Guam	1.0	27:1
F/A-18/Iwakuni and CSG(s)	1.5	2.6:1

As with all cases, the initial ballistic missile strikes on ROCAF air bases and Kadena were assumed to have degraded sortie production, in the base case to the lowest of the three values in use: 20 sorties per day. Ballistic missiles with cluster munitions are also fired to sweep parking areas of all unsheltered aircraft, followed by a cruise missile attack on shelters.

With 72 F-22s based at Kadena and only 15 shelters, 17 unsheltered fighters were killed in the missile attack on parking areas. Missiles also destroyed 22 of the 36 USMC aircraft based at Iwakuni. JASDF fighters shot down 12 of 50 Chinese cruise missiles fired at Kadena; the remainder destroyed 10 shelters containing an additional 10 F-22s. Ballistic missile attacks on all of Taiwan's fighter air bases killed 50 unsheltered aircraft on the ground, for a total of 99 Blue aircraft (49 on Okinawa and 50 on Taiwan) destroyed on the ground in the initial wave of Red attacks.

In the low air operations ability cases, the Chinese fly 80 percent of their sorties during daylight hours and 20 percent at night; this distribution is matched by the Taiwanese and U.S. aircraft based on carriers and flying from Okinawa. The total sorties flown over the first day are shown in Table 4.5. Table 4.6 shows sample engagement rates—the average number of air-to-air missiles fired per sortie—for one simulated four-hour time period in the base case. These numbers do not appear unexpectedly large for the number of advanced aircraft committed into the fairly small battlespace of the strait. The result is a lethal struggle for air control.

Table 4.5
First-Day Sorties Flown

Country	Mission	Type	Sorties	PGMs Delivered
China	Air base attack	Su-30	82	328
		J-10	115	330
		JH-7	44	88
		H-6	50	Iron bombs
		H-6K	46	92
	Other attack	J-8 (adv)	54	108
		J-8	20	40
	Escort	J-8	97	Non-BVR
	Sweep	Su-27/F-11	118	R-77/PL-12
		J-8	172	Non-BVR
	Red Total		*798*	
Taiwan	Air defense	Various	100	AMRAAM, MICA
United States	Air defense	F-22	20	AMRAAM
		F/A-18C/D	96	AMRAAM
	Blue Total		*216*	

NOTES: AMRAAM = advanced medium-range air-to-air missile; MICA = missile d'interception et de combat aérien, or "interception and aerial combat missile."]

Table 4.6
Example Air-to-Air Engagement Rates

	Sorties	Shots per Sortie
Red mission		
Ground attack	76	0.05
Escort	24	0.05
Sweep	72	0.40
Blue fighters		
F/A-18	22	1.70
F-22	4	1.50
ROCAF	19	0.70

The effects of China's missile barrage are dramatically apparent: On the first day, *the PLAAF generates about 3.7 times as many sorties as do the United States and Taiwan combined.* Without any analysis beyond this, we can conclude that China's ability to suppress Blue air bases redefines that nature of the air war and puts the defenders at a severe disadvantage from the outset of the conflict.

The first day's air-to-air losses are 141 aircraft for the PLA, 30 for the ROCAF (30 percent per-sortie attrition), and 18 for the United States (16 percent).[9] An additional 70 Chinese aircraft are lost to Taiwan's surface-to-air defenses, making a total of 241 PLA jets lost (30 percent per sortie), while the Blue side loses 147 jets in all (48 in the air and 99 on the ground).[10]

Measures of Merit

In the previous study, the sole measure of merit was the ratio of Red to Blue losses compared with the initial force ratio between the two sides. We scored a case a "win" for Blue if the Red-to-Blue loss ratio was at least 1.5 times the original force ratio (e.g., if the Chinese outnumbered the United States and Taiwan by 2:1, an exchange ratio at least 3:1 in Blue's favor was needed for Blue to "win"). If the exchange ratio failed to meet this threshold but was at least equal to the opening force ratio (a 2:1 exchange ratio for a 2:1 initial Red advantage), we scored it as a "marginal" Blue win, which we assessed as insufficient to allow a credible invasion attempt. Any exchange ratio less than the initial force ratio

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[9] Seventeen F/A-18s from the carriers and Iwakuni and one F-22 are lost in the air. This is a very intense air war, and these loss numbers may overstate the attrition on both sides. For our analytic purposes, however, the key is ultimately the number of sorties each side can fly against the other. With Kadena, Iwakuni, and Taiwan's fighter bases suppressed, Red enjoys a quantitative edge of 3.7:1. Even when Blue defenses—fighters and SAMs—are killing Chinese jets at a very high rate (excluding those Blue fighters lost on the ground, the exchange ratio here is 5:1), the defender simply cannot put enough missiles in the air to keep large numbers of Chinese penetrators from getting through. This would not change were the air war either less or more bloody, provided the kill ratio did not grow absurdly one-sided in Blue's favor.

[10] As noted, in the base case, we assume that a heavy Chinese defense suppression campaign reduces the effectiveness of Taiwan's SAMs to 50 percent on the first day of the war and eliminates them entirely as a factor for the last three days.

meant that the PLA was increasing its numerical advantage over time and was credited as a Blue "loss." This attrition-based metric was useful when the question was whether or not the Chinese air force could hold its own in an air-to-air fight with the United States and Taiwan.[11] We employ that same metric here, but, but taking into account the change in the character of the air war between 2000 and 2009, we also add a new measure.

If China's SRBMs and other long-range strike weapons perform as expected, Taiwan's airfields and SAMs will largely be suppressed by the opening salvos, and the PLAAF will enjoy a substantial numerical advantage in the air. Our assumption that China's stocks of PGMs are unconstrained means that this edge could be exploited to attack targets on the ground in Taiwan. We therefore need some representation of how the number of available Red air-to-ground sorties varies across our scenario space.

The metric we use simply counts the number of attack sorties the PLAAF would have at its disposal for invasion preparation.[12] We calculate this number by looking at the total number of Chinese air-to-ground sorties that JICM reports as successfully penetrating Taiwan's defenses in each attack, then subtracting from it those that are devoted to suppressing air bases. What is left is the number of sorties available for striking other targets as part of an invasion-preparation campaign.

As its derivation suggests, there are two ways to drive down this number. First, Blue can reduce the total number of sorties that penetrate by shooting down or chasing off more Chinese aircraft.[13] And, by making its air bases more robust, Taiwan can compel the PLA to

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[11] As our colleague Paul Davis informed us when we used this metric in our 2000 study, this calculation generates what is known as a "ratio of fractional loss rates," which "determines who wins the battle in a deterministic drawdown" according to the Lanchester square law.

[12] We do not specify what the targets of these strikes might be, but conceptually they could include Taiwan's ground forces, coastal artillery, antiship missile batteries, naval bases, logistics infrastructure, and command and control systems, among others.

[13] In certain circumstances, JICM imposes "virtual attrition" on an attacker, representing aircraft forced to jettison ordnance or otherwise abandon their mission before reaching their targets.

commit a larger percentage of its available ground-attack sorties to attacking them, which means fewer are free to go after other targets. So, while most of the ROCAF is destroyed in many of the cases we examine, Taiwan's air power can at least contribute to the anti-invasion defense by absorbing as much of China's air effort as possible in the process of being put out of action.[14]

In the discussion that follows, we present this metric as the number of these sorties that China flies in the first four days of the war.[15]

Overall Outcomes and Driving Factors

Figure 4.2 shows the results of the total set of cases that we ran in terms of our two measures of merit, Chinese air-to-ground sorties delivered and the ratio of Red to Blue aircraft losses. Good Blue outcomes on the air-to-air measure are shown as green, poor outcomes as red, and intermediate results as yellow.

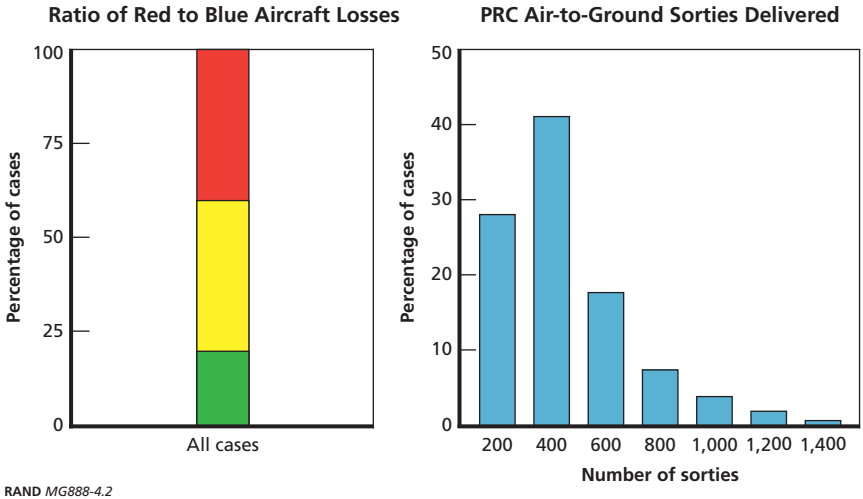
The picture is a sobering one. In our 2000 study, between 40 and 70 percent of the cases were scored as green—clear Blue victories—on the loss ratio metric, depending on the size and composition of the Red force thrown against the defenders. In the current work, using the same metric, only about 20 percent of all cases reach the "green" threshold, and about 40 percent are outright Chinese wins.

On the air-to-ground question, in about 90 percent of all cases 600 or fewer Chinese ground-attack sorties are flown over the four days that we model. There is substantial variation in this measure across the cases, so 600 is something of a benchmark; cases where China

[14] Going forward, whenever we refer to "air-to-ground" or "ground-attack" sorties, we are talking about these "invasion-preparation" sorties; that is, we are not counting sorties attacking air base targets.

[15] As the reader peruses the air-to-ground charts, perhaps the simplest way to compare one case with another is to look at where the tallest columns are for each value of the variable in play. If changing that value moves those columns toward the right, that by and large means that more Chinese sorties are getting through; to the left, fewer sorties.

Figure 4.2
Outcomes of All Cases



RAND *MG888-4.2*

achieves more than 600 are one where the defense is faring worse than average; fewer is better.[16]

Table 4.7 shows the weight of each variable in determining Blue "wins." Entries printed in bold highlight our base case assumptions. The number in each cell represents the percentage of all "green" outcomes on the loss ratio metric that are associated with the specified value of the named variable. So, for example, the very first entry shows that 70 percent of "winning" Blue outcomes occurred in cases incorporating the base PLAAF force.

The four variables highlighted in gray show at least a 3:1 spread in outcomes across their range of values. That is, the percentage of wins associated with one value is at least three times that associated with at least one other value. We'll discuss each of the ten variables in turn.[17]

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[16] Once again, we want to be clear that we attach no decisive operational significance to 600 or any other number of Red air-to-ground sorties. But—up to some point of diminishing returns at least—more is better for the PLA.

[17] In focusing on decisive Blue victories—outcomes colored green in the figures—we're examining a very small set of cases. We built similar tables of the ten variables using "green"

Table 4.7
Impacts of Scenario Variables on Outcomes

Variable	Value	% Green
PRC forces	***Base***	70
	Advanced	30
PRC aircrew quality	40	68
	60	25
	80	7
PRC air operations	***Low***	43
	High	57
ROC/U.S. PGM defenses	***No***	27
	Yes	73
ROC forces	***Base***	46
	Advanced	54
Blue sortie generation	***20***	43
	40	30
	60	27
ROC SAM survivability	10	55
	25	30
	50	15
U.S./RoC shelters	***Low***	12
	High	34
	Super	54
U.S. CSGs available	0	20
	1	32
	2	48
Fighters at Kadena	None	10
	F-15	21
	F-22	27
	Guam	42

NOTES: Bold italic font indicates base-case values. Variables highlighted in gray show at least a 3:1 spread in outcomes across their range of values.

results, "yellow" results, all three colors, and "green plus yellow" versus "red." All approaches identified essentially the same set of variables as the most interesting; we ultimately chose to use "green" because it made for the most straightforward depiction.

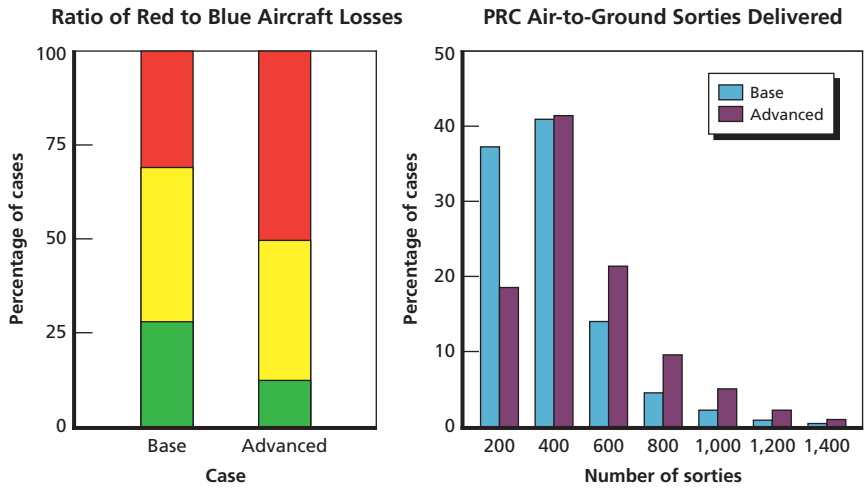
Chinese Air Force Modernization

The upgrade between the baseline force we gave to the PLAAF in this study is proportionately smaller than the gap between the two variants of the Chinese air force we used in the previous analysis.[18] Still, the changes in outcomes are fairly substantial. As Figure 4.3 shows, the number of Red "wins" on the air-to-air metric increases from around 30 to about 50 percent, while the air-to-ground metric shows that the proportion of cases in which the number of penetrating sorties is 600 or more grows from about 25 percent to over 40 percent. As one would expect, the better the PLAAF's aircraft, the more successful China's air offensive.

Chinese Aircrew Quality

As we see in Figure 4.4, both the air-to-air and air-to-ground metrics are strongly influenced by the competence level assumed for China's

Figure 4.3
Effects of PLAAF Modernization



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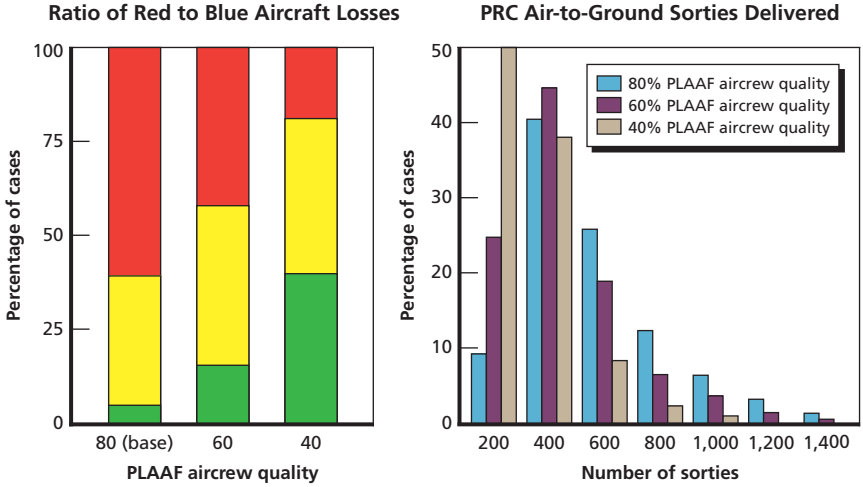
[18] In terms of fighters capable of carrying BVR missiles, the difference between the 2000 study's base and advanced cases was 225 percent; in the current work, it is "merely" 180 percent.

Figure 4.4
Effects of PLAAF Aircrew Quality



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aircrew. On the air-to-air loss ratio side, the number of Red "wins" drops from about 60 percent to 15 percent as Chinese aircrew quality falls from 80 to 40 percent. Almost 90 percent of cases with the low-quality aircrew saw 400 or fewer air-to-ground sorties successfully penetrating, versus 50 percent with 600 or more sorties against the best PLAAF pilots.[19]

[19] Other than counts of flying hours and observation of training and exercise activity, the quality of a country's aircrew is difficult to judge, let alone express quantitatively. In the history of air warfare in the jet age, combatants have more than once been surprised at the skills of their adversaries. The United States did not expect the level of performance it encountered over North Vietnam, and the British likewise underestimated the caliber of their Argentinean opponents in the Falkland Islands campaign. On the other hand, it is safe to say that the performance of the Iraqi air force in 1991 fell below what was expected, let alone feared. With this in mind, we have chosen to make the PLAAF's pilots very—probably unrealistically—capable in our base case (while also presenting two lower-quality depictions). We did this to account for the possibility of an unpleasant surprise and also to allow for the possibility that Chinese skills will begin to improve substantially over the next few years as their hardware, doctrine, training, and experience begin to mesh.

Chinese Air Operations

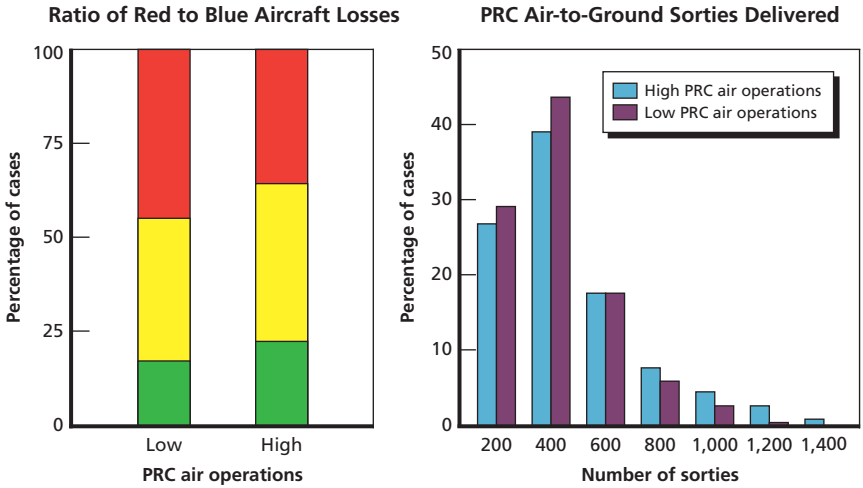
We expected to see a substantial difference in results when we constrained the PLAAF's ability both to generate sorties and mass them in space and time. But, as both Table 4.7 and Figure 4.5 show, the change had a surprisingly modest impact. This is explained by Blue's inability to exploit the postulated Chinese limitations because, once again, of the damage done to Taiwan's air bases and the U.S. bases on Okinawa. Even at the lower level of Red operational tempo, the PLAAF can still put overwhelmingly superior numbers of fighters into the air.

The loss ratio metric shows a slight improvement for Blue when the PLAAF generates more sorties because the JICM applies a modest diminishing return effect as a side's numerical advantage grows—at some point, larger numbers of jets in the air stop proportionately increasing air-to-air kills due to the relative paucity of targets for the additional fighters.

Defenses Against Precision-Guided Munitions

Aircraft destroyed on the ground constitute between 20 and 90 percent of all Blue losses in our simulations. We therefore decided to explore

Figure 4.5
Effects of PRC Air Operations



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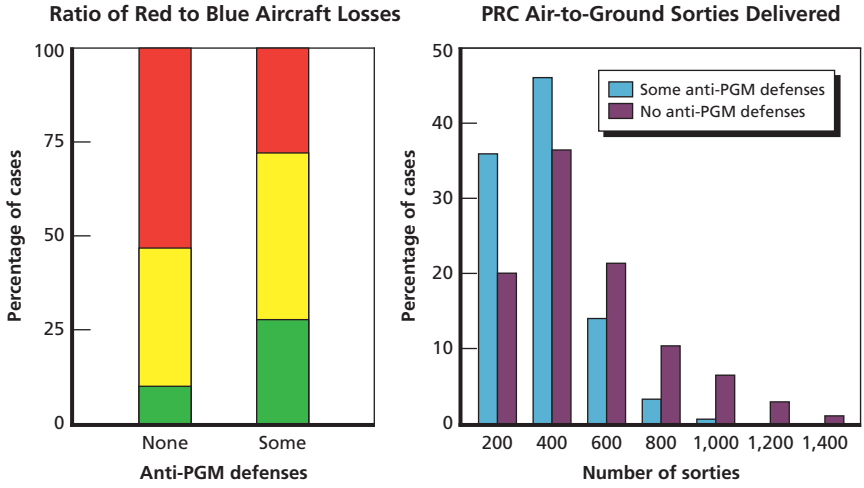
the effects that defenses against PGMs and LACMs—systems such as quick-reacting rapid-fire guns, and short-range SAMs—could have in reducing this attrition.[20] The results can be seen in Figure 4.6.

These defenses—which we posited as reducing the effectiveness of Red's PGMs by 75 percent—reduced Blue's outright losses on the loss ratio measure by about half, from 50 percent to 25 percent. On the air-to-ground metric, 80 percent of the cases that had the defenses resulted in 400 or fewer air-to-ground sorties attacking targets on Taiwan, versus over 70 percent with 400 or more when no PGM defenses were included.

Taiwanese Air Force Modernization

In Table 4.7, we see that the size and quality of the ROCAF's fighter force appear to have a modest impact on the outcomes of our cases. This does, however, obscure a fairly sizable difference on the air-to-ground measure until we break these cases out further by the ROCAF's success in generating sorties.

Figure 4.6
Effects of Anti-PGM Defenses



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[20] These defenses had no effect on the aircraft delivering the PGMs, nor on SRBMs.

Figures 4.7, 4.8, and 4.9 show the difference between the base case ROCAF fighter force and the advanced variant when Taiwan's bases are producing 20, 40, and 60 sorties, respectively. While the loss ratio results do not differ appreciably, the number of air-to-ground sorties does. In the 60-sortie case, about half of all cases resulted in 200 or fewer attack sorties getting through against the advanced ROCAF, versus about 25 percent with the base-case ROCAF. Similar differences can be seen in the 40-sortie case.

Blue Sortie Generation

Figure 4.10 shows the impacts of different levels of sortie generation from U.S. and Taiwanese land bases. As can be seen, the effects across the three cases on the loss ratio metric are modest; the PLAAF enjoys a sufficient numerical advantage even in Blue's best case. Couple this numerical edge with the rough qualitative parity between the two sides, and the loss ratio outcomes will not change much.

The air-to-ground measure shows a larger differential. When Blue is flying 60 sorties per day out of its bases, 40 percent of cases result in 200 or fewer air-to-ground sorties reaching their targets. On the other

Figure 4.7
Effects of ROCAF Modernization, with 60 Sorties a Day per Base

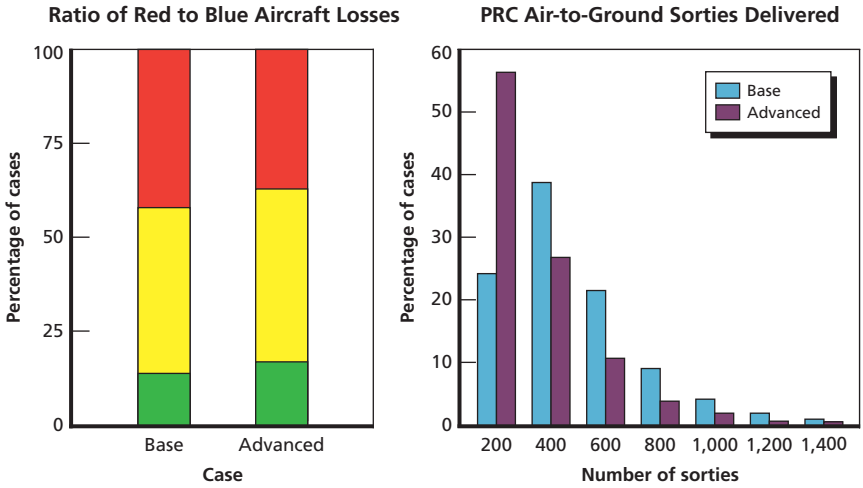

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Figure 4.8
Effects of ROCAF Modernization, with 40 Sorties a Day per Base

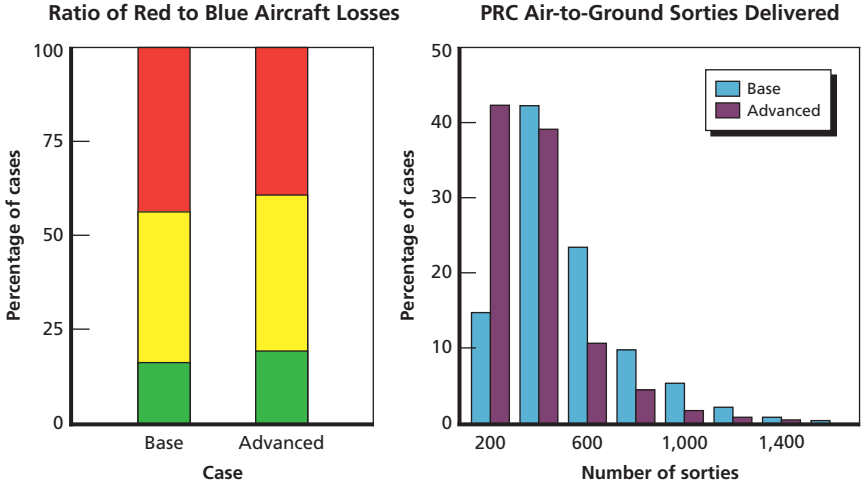

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Figure 4.9
Effects of ROCAF Modernization, with 20 Sorties a Day per Base

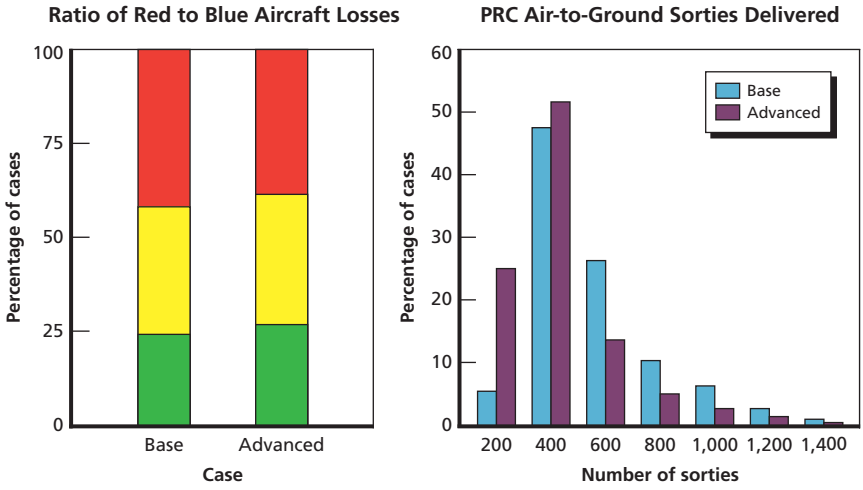

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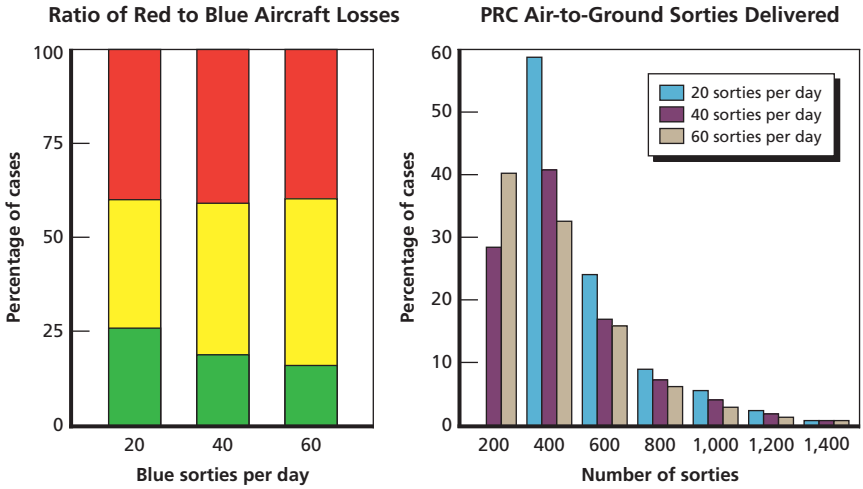
Figure 4.10
Effects of Blue Sortie Generation



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hand, with only 20 sorties getting airborne from each base each day, no cases show fewer than 200, and about 40 percent see 600 or more penetrators.

It is worth recalling that we argued in Chapter Three that between 150 and 250 SRBMs—the exact number would depend on their accuracy and warhead configurations—could cut every runway at Taiwan's fighter bases and destroy any aircraft parked in the open. Faced with this magnitude of threat and absent very effective BMD, it would seem that a plausible number of sorties for Taiwan's air force could well be zero, at least for the first few days of a conflict.

Twenty sorties per day per ROCAF base—a total of 100–120 each day—may be achievable if the ROCAF took advantage of warning to disperse its fighter force to civilian airfields and highway strips. Dispersal would complicate operations and slow sortie generation relative to flying from a fully functional main operating base, but would nonetheless be far preferable to having Taiwan's fighters reduced to flaming wreckage on the ramps or pinned in by closed runways. In a matter of days, China could almost certainly locate and attack the dispersal sites, putting an end to these operations. Thus, dispersal is likely

a useful but hardly a permanent or total solution to the ROCAF's base survivability problems.

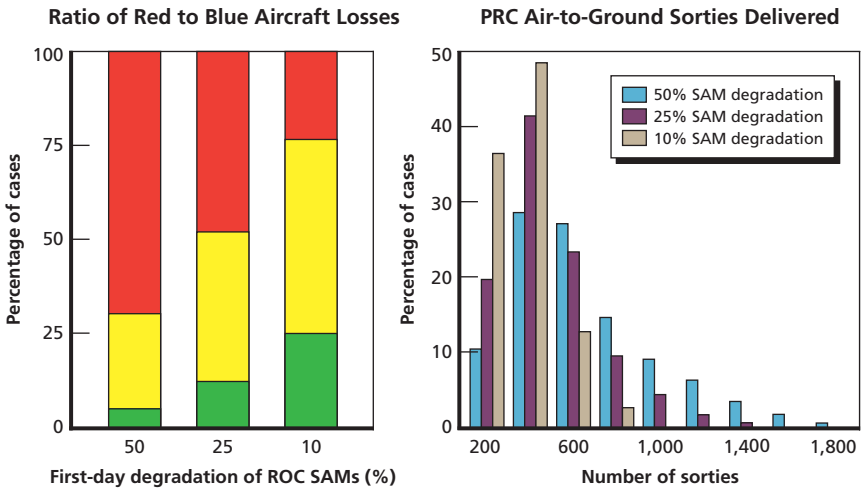
ROC SAM Survivability

The survivability of Taiwan's longer-range surface-to-air defenses in the face of serious attack is highly questionable. Our results show, however, that they have the potential to significantly influence the outcome of the air campaign if they can avoid being suppressed.

Figure 4.11 shows how heavily the performance of Taiwan's SAMs impacts results. Red wins the loss ratio fight almost 70 percent of the time when the surface-to-air defenses are rapidly and effectively suppressed, but Red wins in fewer than 25 percent of the cases when the surface-to-air defenses degrade by only 10 percent of their original strength one the first day.

Similar effects can be seen on the air-to-ground metric. With maximum suppression—our base case—about 80 percent of cases result in 400 or more sorties penetrating, versus between 60 and 90 percent with 400 or fewer when the defenses are reduced more gradually. This

Figure 4.11
ROC Surface-to-Air Missile Survivability



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suggests that deploying a capable and survivable surface-to-air defense network—relying on mobility, redundancy, and hardening—could offer substantial leverage to Taiwan.[21]

Number of Shelters

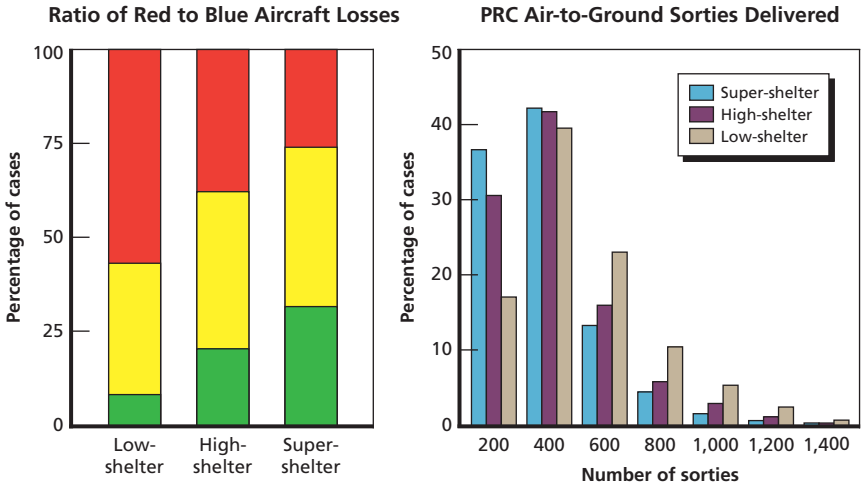
In our base case, which puts 50 shelters at each ROCAF air base (except for the two with underground hangars), all shelters are usually occupied, especially if sortie generation is suppressed by SRBM strikes. Each shelter destroyed by a Red PGM or LACM therefore kills a fighter. Up to 30 other aircraft at each base are parked in the open, and most are destroyed by SRBMs with submunition warheads. The 15 shelters at each of Kadena and Iwakuni likewise leave many aircraft on the tarmac, leading again to heavy losses. Building enough shelters on all bases to house all of the assigned fighters reduces the number of jets destroyed on the ground when the first missiles hit. "Super shelters" on Okinawa—designed to defeat cruise missile attacks—further protect U.S. fighters.

Figure 4.12 shows that each increment of protection improves the outcomes for the defense. Red "wins" on the loss ratio measure drop by about half, from over 50 percent in the "low" case to roughly 25 percent with the cruise-missile-proof shelters. Regarding the air-to-ground measure, over 75 percent of the "super shelter" cases result in 400 or fewer Red sorties getting through; in the low-shelter case, roughly the same proportion are 400 or higher.

Once the PLAAF gains control of the air over Taiwan, of course, shelters would be vulnerable to direct attack with aircraft-delivered penetrating PGMs. To reap more benefits from aircraft shelters, they would probably need to be combined with anti-PGM point defenses, survivable SAMs, and big improvements in air base operability. Such a suite of capabilities could offer Taiwan the opportunity of maintaining an aerial "fleet in being"; combined with the ROCAF's mountain shel-

[21] For the purposes of this analysis, we did not alter Chinese tactics to devote more air-to-ground sorties to attacking these more survivable SAMs. While this would potentially reduce Chinese losses, it would also directly reduce the number of air-to-ground sorties delivered on other targets and thus result in a similar reduction under our air-to-ground sortie metric.

Figure 4.12
Effects of the Number of Shelters



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ters at Hualien and Taitung, this could offer Taipei a viable second line of air defense if the initial fury of the PLA's attacks can be weathered.

U.S. Contributions

Recall that we ran a half-dozen variants of U.S. involvement in the cross-strait conflict: none; zero, one, or two CSGs, and a wing of USAF fighters at either Kadena or Guam. When fighters were flying out of Kadena, we also use the 36 Marine F/A-18s based at Iwakuni. We also tested the advantage offered by replacing F-15s with F-22s. Figures 4.13, 4.14, 4.15, and 4.16 show the results.

In the absence of land-based air power, Blue fares poorly even with two CSGs in the fight from its outset; although the addition of two carrier air wings does improve performance on both measures, Blue is still playing a losing hand, especially according to the loss ratio (Figure 4.13).

Figure 4.14 shows that the addition of 108 fighters based on Okinawa improves Blue's prospects, but again, not in a decisive way. Substituting F-22s for the F-15s doesn't change the situation very much, either (Figure 4.15). In both cases, the impact of the USAF and USMC fight-

Figure 4.13
Effects of U.S. Contributions: Carrier Strike Groups Alone

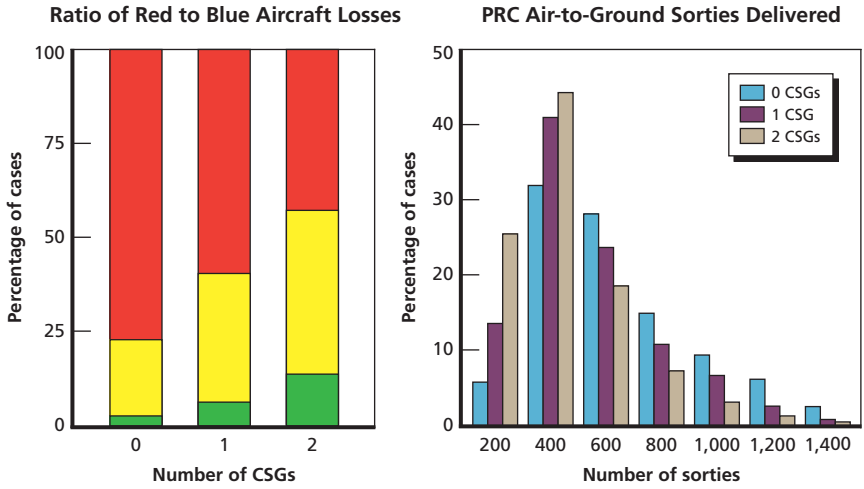

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Figure 4.14
Effects of U.S. Contributions: Carrier Strike Groups and F-15s, F/A-18s on Okinawa

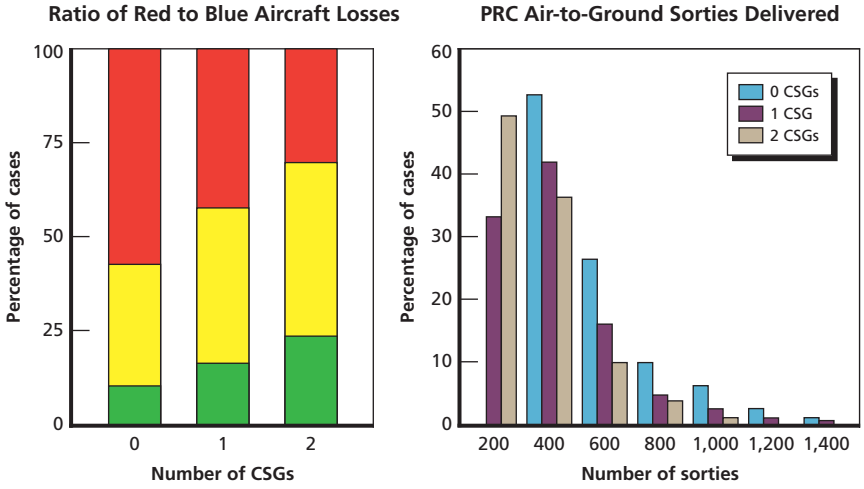

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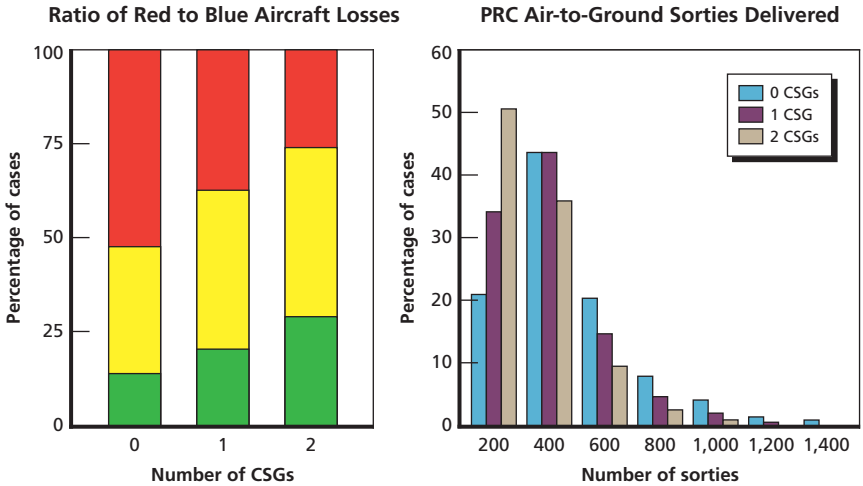
Figure 4.15
Effects of U.S. Contributions: Carrier Strike Groups and F-22s, F/A-18s on Okinawa



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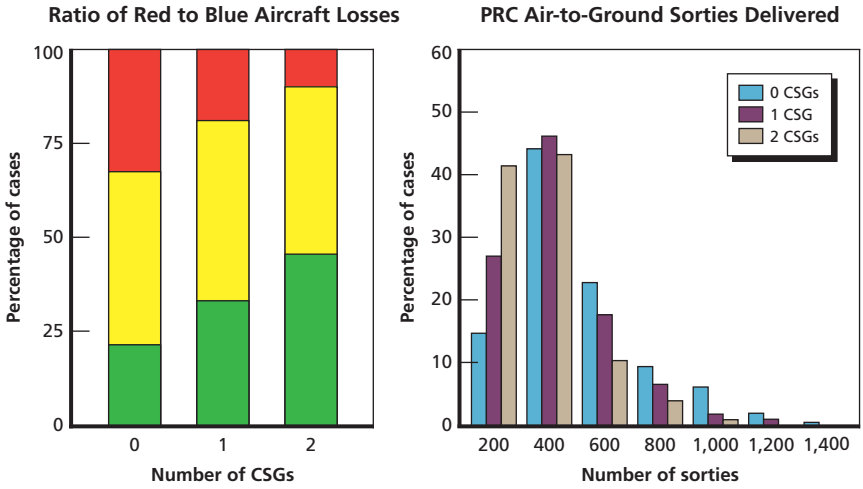
ers is reduced by their on-the-ground vulnerability to China's ballistic and cruise missiles. As we saw above, building more and better shelters on Okinawa can reduce the number of aircraft lost on the ground, but in all the other cases, more—often many more—Okinawa-based jets are destroyed on the ground than in the air. These losses—many of which occur at the very beginning of the conflict, before the doomed aircraft have managed to fly even a single mission—severely reduce the total number of fighter sorties flown out of Okinawa.

Interestingly, flying F-22s from Guam—about three times as far from the combat arena as Kadena—has little negative effect on outcomes; in fact, Blue does appreciably better on the loss ratio metric (see Figure 4.16).[22] This is because, although the sortie rate is substantially reduced by the much longer mission times, Guam is not attacked and

[22] Andersen Air Force Base on Guam is about 1,550 nm from the centerline of the Taiwan Strait; Kadena, about 450 nm. For purposes of this analysis, we assume that Guam is immune from attacks heavy enough to disrupt operations. The deeper one peers into the future, the more questionable this assumption will likely become.

Figure 4.16
U.S. Contributions: CSGs and Guam F-22s



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no USAF fighters are lost on the ground. Over four days, the additional aircraft available more than make up for getting fewer sorties out of each; over a longer campaign, the pendulum would swing more dramatically in favor of basing the jets on Guam—if Guam remains immune to serious attacks.[23]

Concluding Remarks: Not Your Father's Air War

The changes that just a handful of years have made in this scenario are striking, to say the least. Ever since the Nationalists' retreat to Formosa, air power has been reckoned an advantage for Taiwan versus the mainland. For years after the last KMT soldier withdrew from China proper, the Nationalist air force was still able to conduct small but nettlesome bombing raids over coastal cities in China. Even as the PLAAF

[23] This all assumes that adequate tankers are available to support these very long-range missions, enough crews are available to absorb all of the flying hours, and sufficient fuel can be pumped into and out of Andersen's tank farm to keep everybody in the air.

developed—slowly—from the 1950s onward, the ROCAF's qualitative superiority was seen as counterbalancing Beijing's commanding edge in numbers. When U.S. air power was added to the balance, the disparity appeared almost insurmountable. Although warning signs were clear in our 2000 study—that a more aggressively modernized PLAAF equipped with effective weapons could challenge Blue air superiority, for instance—they resided in a "what-if" future. Today, they represent clear and impending dangers to the defense of Taiwan.

Two principal developments account for this transformation. First, in recent years, China has substantially accelerated the pace of its air force modernization. While we may be overgenerous in our assessment of how well China's pilots can fly, ground crews can maintain, and commanders can control these assets, we believe that our baseline estimate for the overall size and composition of the PLAAF in 2013 is not unreasonable. The deployment in quantity of much more capable fighters and weapons—FLANKERs and J-10s, AA-12s, PL-12s, PGMs, and LACMs—brings the PLAAF up to major-power standards in terms of the hardware it can line up on the ramp. Only the most recent generation of stealthy U.S. fighters—the F-22 and the still-to-come F-35—can expect to offer meaningful aircraft-on-aircraft technological advantages over what the PLAAF will bring to the fight. This is radically different from the situation in 2000, and radically troubling.

Even more important and worrisome, however, is the threat that is emerging to the principal operating locations for land-based U.S. and Taiwanese air power.[24] It seems likely that China will soon deploy hundreds of SRBMs with the warheads and accuracy needed to impede or even halt high-tempo combat operations from air bases within 500–750 nm of China—the bases that both the ROCAF and USAF would depend on to defend Taiwan. Without improbably effective BMD on the Blue side, China can probably soon expect to be able

[24] This study did not assess the potential vulnerabilities of U.S. aircraft carriers. We will not attempt to cover this important and complex topic in a footnote, but suffice to say that China appears to be very interested in threatening U.S. carriers, and its progress in various realms of antiship warfare, including innovations such as medium-range antiship ballistic missiles, will, over time, likely pose an increasing challenge to the U.S. Navy.

Would China Attack Japan?

In our analysis, we assumed that China would initiate its campaign with massive air and missile strikes against military targets on Taiwan and on the Kadena and Iwakuni air bases on the Japanese island of Okinawa. We based this assessment on our understanding of contemporary Chinese military doctrine, which emphasizes the importance of dealing a powerful first blow in a war against a "superior" adversary. The lack of ready and accessible alternatives to the Okinawa bases—most other bases in Japan are much farther away from the strait but no further from China, making them less productive but just as vulnerable to attack—makes going after the installations something of a "no-brainer" from an operational perspective.

By expanding the war to include Japanese territory, albeit not "mainland" Japan, China would be crossing something of a strategic Rubicon. While any PLA combat with U.S. forces involves China's tacit acceptance of the risks of fighting a nuclear-armed superpower, we would not expect Beijing to casually choose to expand the war. While the operational logic behind going after Kadena and Iwakuni is undeniable, having a profoundly hostile and potentially powerful Japan as a next-door neighbor might not comport well with China's image of postwar East Asia.

We will not attempt to settle the debate here. As prudent planners, we believe it is appropriate for us to assume that China will follow the course of action that offers the PLA the best chance of success in the conflict being undertaken; hence, the attacks on the two bases. Recognizing, however, that there is a not-incredible case to be made that Beijing would be extremely reluctant to begin the war, at least, with a preemptive attack on Japan, we ran a set of cases without any attacks on Japan (hence, there was no need to run the cases where the USAF retreated to Guam, and those were excluded).

Figure 4.A shows the overall results. In loss ratio combat, the number of outright Chinese victories drops from about 40 percent (as shown in Figure 4.2 on p. 70) to around 30 percent. On the air-to-ground measure, the proportion of cases where 400 or fewer sorties get through increases to about 70 percent from roughly 60.

Figure 4.A
Overall Results, No Attacks on Okinawa

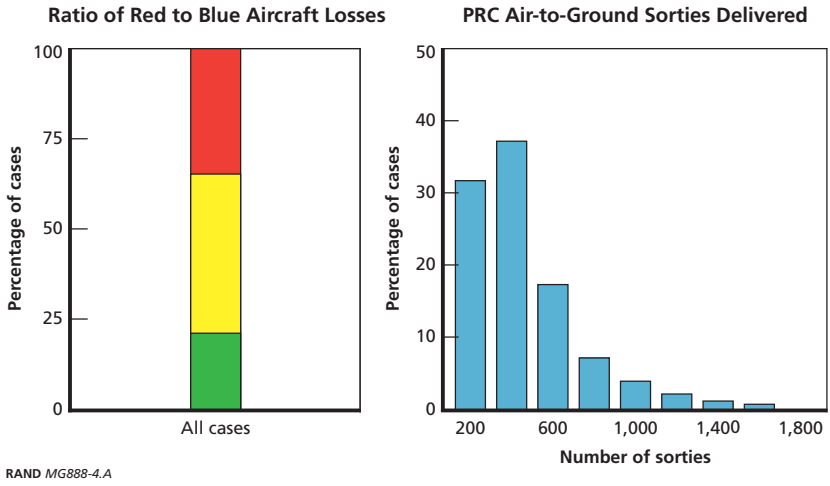

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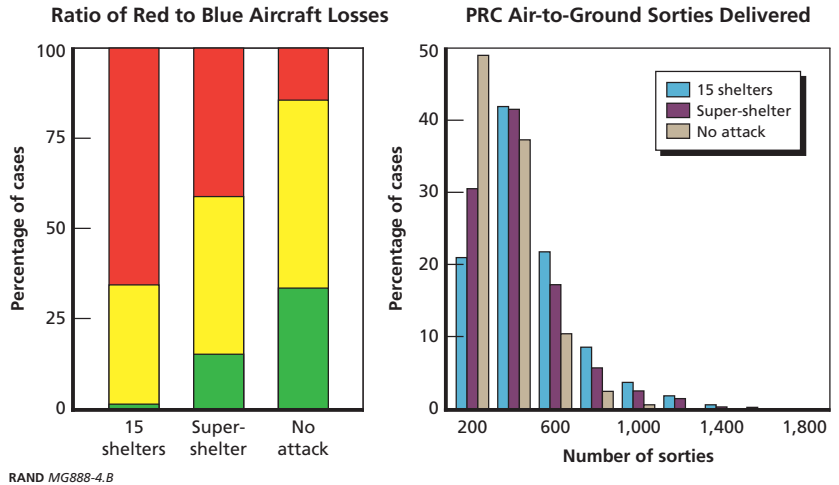
Figure 4.B compares results when Kadena is not attacked versus two cases—different numbers and kinds of shelters—in which it is. With no attacks on Kadena, the number of Blue "wins" in the loss ratio exchange increases to about 40 percent, compared with virtually zero when only 15 jets can be sheltered and China does strike the bases. As discussed earlier, building "super shelters" somewhat reduces the impacts of Kadena being hit, but these effects are modest seen against the outcome if Okinawa is a sanctuary. These results indicate why attacking Kadena (and Iwakuni) would be so operationally attractive to the PLA should war come.

Figure 4.B
Effects of Attacks on Kadena, F-22 Cases



to cut operating surfaces and destroy soft targets, including aircraft parked in the open (which many will be, since neither the ROCAF nor USAF appears to have provided adequate protection to its fighter force). While runways can be repaired, smashed aircraft cannot be replaced within the time frame of a rapid, modern war. And, if the PLAAF can follow up these initial missile attacks with a wave of accurate LACMs and fighter-bombers carrying PGMs, even hardened targets—aircraft shelters and command bunkers, for example—may be endangered. If U.S. and Taiwanese sortie generation is seriously impaired by Chinese attacks, the quantitative disparity between the number of jets each side can put in the air greatly disadvantages the defender; in this case, quantity indeed has a quality all its own.

We are intrigued by the surprising level of success enjoyed by Guam-based F-22s in this analysis. The demand for air refueling tankers to support such a concept would be substantial, and the basing of fighters on Guam could prompt the Chinese to more urgently seek

ways of threatening it.[25] In the near term, however, Andersen Air Force Base is immune to the kinds of intense and repeated attacks that could befall bases in Okinawa. This prospect might merit further study.[26]

However, our analysis on the whole suggests that a credible case can be made that *the air war for Taiwan could essentially be over before much of the Blue air force has even fired a shot*. Threats to Blue air bases and a more evenly matched qualitative balance combine to paint a very troubling picture.

This image is reinforced when we dig more deeply into precisely which cases produced the best Blue outcomes. Three of the scenario variables—the survivability of Taiwan's SAMs and Blue fighters as measured by the numbers and kinds of shelters on ROCAF and USAF bases, and the presence or absence of defenses against PGMs at those bases—have powerful effects on results, but Blue's successes mainly come in cases that feature what are probably unrealistic values for each of these. Blue thrives when

- Taiwan is credited with heroically survivable medium- and long-range SAMs
- literally hundreds of new aircraft shelters are constructed on Taiwan and Okinawa
- improbably effective—75 percent effective, to be precise—terminal defenses against cruise missiles and PGMs are deployed at every Blue air base.

In reality, however, Taiwan's longer-range surface-to-air defenses are based on Patriots and similar weapons that are deployed in fixed sites and are unlikely, therefore, to survive any concerted Chinese attack; we

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[25] Unlike Okinawa, a Chinese strike against Guam would be an attack on U.S. territory. It is unclear what impact this fact might have on decisionmakers in Beijing— especially if the United States is hitting targets on the ground inside China. It is, however, a consideration.

[26] Our analysis may have overstated the sortie rate for F-22s flying from Andersen, although we only assumed one sortie per aircraft per day. Provided the achievable rate is not significantly less than that—and there's not much room to go down from 1.0—the inefficiency could be "bought down" by deploying extra fighters. Given the currently planned size of the USAF's F-22 force, those might have to be F-15s rather than Raptors.

are aware of no plan in Washington or Taipei to spend the billions of U.S. dollars it would take to construct the kinds and numbers of aircraft shelters featured in our "high-shelter" and "super-shelter" cases; and no combination of existing or near-term short-range defenses seems likely to achieve anything like the effectiveness—intercepting three of every four PGMs—called for here. With each passing year, meanwhile, China increases its capabilities for striking air bases and fixed air defenses merely by continuing to add to its stocks of advanced missiles, munitions, and aircraft. This race between China's extant capabilities and Blue's hypothetical ones is both unequal and highly unfavorable to Taiwan's defenders.

CHAPTER FIVE

The Ultimate Roll of the Dice: A Chinese Invasion of Taiwan[1]

> Liberation of . . . Taiwan is an extremely big problem and will involve the biggest campaign in the history of modern Chinese warfare.
>
> —*PLA General Su Yu, February 1950*[2]

Ultimately, there is only one military course of action that guarantees China control of Taiwan: a successful invasion and occupation of the island. But what General Su observed almost 60 years ago remains true today: Any invasion of Taiwan would be by far the most challenging military operation ever undertaken by the PLA.[3] As one report on the cross-strait balance observes, "large-scale amphibious invasion is one of the most complicated and logistics-intensive, and therefore difficult, military maneuvers" (DoD, 2008, p. 44), and for years, analysts and scholars have assessed China's ability to conduct an invasion as limited, at best. Our analysis of the air war indicates that China's growing military power has changed the nature of the fight for air superiority;

[1] Elements of the quantitative analysis of a putative Chinese invasion of Taiwan presented in this chapter owe a substantial conceptual debt to work performed by one of the authors under the direction of Alan Vick for a project sponsored by the U.S. Air Force.

[2] Whiting (1960, pp. 20–21).

[3] We contrast here an "invasion"—a forced entry of Chinese troops against organized resistance from the Taiwan military—with an administrative "occupation" that might result from a political agreement on unification between Beijing and Taipei.

have the PLA's burgeoning capabilities also changed the calculus for an invasion attempt?[4]

Amphibious assaults—attacks across a body of water by land, sea, and air forces against an enemy-occupied shoreline—trace a history back into antiquity: The battle of Marathon in 490 B.C. followed what may have been the largest amphibious landing undertaken until the 20th century, when perhaps 15,000 Persians mounted the beach at the base of the Cynosura promontory near Athens.[5] The history of the West was changed again in 1066, when William of Normandy accomplished what remains the most recent invasion of England, using 700 ships to land his army of about 11,000 near the town of Hastings on Britain's southeast coast (Barclay, 1983). Throughout the age of sail, troops (and horses, although the latter often with great difficulty) were embarked on ships, conveyed across the seas, and landed on hostile shores, with technological progress enabling a slow but steady increase in operational sophistication. One commentator finds, in the Spanish marines' 1583 landing on Terceira Island in the Azores, evidence of "detailed planning . . . previous reconnaissance of the beaches . . . special equipment and training, ship-to-shore movement, [and] naval fire support" (Wikipedia, 2009c). In other words, many of the defining elements of a modern amphibious assault are at least faintly visible already in a 16th-century campaign.

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[4] In this chapter, we focus on the amphibious portion of any Chinese campaign to conquer Taiwan. Certainly, airborne and airmobile troops would also have roles to play in such a scheme. However, airborne operations are very high-risk and, in any event, could only serve as adjuncts and enablers to the seaborne component; solely via amphibious landing can the large numbers of troops, quantities of fighting vehicles, and stores of supplies needed to conduct a major offensive reach Taiwan from the mainland.

Neither do we assess here Beijing's options for limited, *coup de main* or "decapitation" attacks on Taiwan; our subject is conquest, not coercion. Such smaller scenarios are important and potentially dangerous, but their outcomes would be driven mostly by factors of shock and psychology that are difficult to objectively analyze.

[5] So remarkable and renowned was this Athenian triumph over their Persian enemies that the great playwright Aeschylus considered his participation in the battle of Marathon more worthy of noting on his tombstone than his artistic accomplishments. See Rodgers (1983) and Wikipedia (2009a).

Even acknowledging this rich and deep history, it is still safe to say that "modern" amphibious warfare did not emerge until Gallipoli in 1915, and it reached maturity, and perhaps its zenith, in Allied—especially U.S.—operations during World War II. In Europe, invasions of North Africa, Sicily, and Italy led up to the largest amphibious operation ever seen, the D-Day assault on Normandy. The Pacific theater saw the famous "island-hopping" campaign, consisting of a series of usually pitched battles between dug-in and fiercely motivated Japanese defenders and U.S. Marines and Army soldiers equally intent on securing the island or atoll in question. Japanese exhaustion, brought on by a strangling naval blockade, the razing by fire of city after city on the Home Islands, and the use of the atomic bomb, rendered unnecessary Operations Olympic and Coronet, the planned two-stage invasion of Japan, which, had they occurred, would have dwarfed the 1944 attack on "Fortress Europe."

Early in the postwar era, the United Nations forces' attack on the Korean port of Inchon transformed the Korean War and was the last of Douglas MacArthur's many amphibious operations. France and Britain attacked Egypt in 1956 in a campaign that was tactically successful but strategically disastrous. The most recent amphibious attacks of any scale were in the 1980s, when Great Britain recaptured the Falkland Islands, which had been occupied by Argentina in what was essentially an administrative landing, and the U.S. invaded the Caribbean island of Grenada.

We will have occasion to refer back to some of these historical examples as we discuss the factors figuring in and prospects for a Chinese invasion of Taiwan. First, however, it is worth reviewing the PLA's own track record with amphibious operations.

The Last Campaign of the Civil War: PLA Amphibious Operations, 1949–1955[6]

From the late 1940s through the mid-1950s, the PLA conducted or planned a number of amphibious operations aimed at gaining control of various offshore islands controlled by KMT troops and, ultimately, at capturing Taiwan itself.

In the summer of 1949, Chinese troops occupied a number of islands off the coast of Zhejiang province. These successes seem to have led the PLA's leadership to underestimate the willingness of the KMT to defend its positions, with the result that Chinese landings on Jinmen and Dengbu islands failed, with the loss of two divisions and more than 10,000 troops.

These setbacks appear to have instilled a greater realism about the difficulties of amphibious operations into the minds of Mao Zedong and the Chinese military leadership, and major efforts were undertaken to prepare for the conquest of Taiwan in 1950, a campaign that would have involved around a half-million PLA troops. The plan envisioned a phased approach, with offshore islands being captured to erode Taiwan's defensive perimeter, trap and destroy the KMT forces defending them, and serve as staging bases for the final assault on Taiwan.

KMT leader Chiang Kai-shek refused the Chinese gambit, however, withdrawing large numbers of troops from doomed garrisons on Hainan, Dongshan, and Zhoushan islands to save them for the ultimate defense of Taiwan itself. These maneuvers nearly doubled the KMT's military manpower on Taiwan and made the PLA's challenge in taking the island that much more daunting. The PRC's problem became even more difficult when the U.S. Seventh Fleet began deterrent patrols in and around the strait after North Korea's invasion of the South in June 1950.

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6 The English-language literature on China's early planning for capturing Taiwan and the PLA's island campaigns of the 1940s and 1950s is quite sparse. Much of what follows is drawn from Ryan, Finkelstein, and McDevitt (2003), an invaluable resource for anyone interested in China's post-1948 military history. Of special value on this topic are the chapters by He Di, Xiaobing Li, and Alexander C. Huang.

In 1954 and 1955, the PLA undertook a second series of attacks against Nationalist-controlled islands. In May 1954, Chinese troops attacked and occupied three small islands of the Dongji group, off of the Zhejiang coast, then held them against KMT air and naval counter-attacks. After a prolonged period of preparation and political indecision, Yijiangshan Island in the Dachen group was the next target. On January 18, 1955, about 3,000 Chinese troops came ashore on the heels of heavy air and naval bombardment. In less than a day, the KMT garrison of over 1,000 soldiers was wiped out. The PLA was prepared to move on to the other islands in the Dachens, and even began air bombardment on January 19, but U.S. pressure convinced the KMT to abandon the entire group to the Communists.

What is notable about these operations is less their success or failure but the progress that the PLA made in its thinking about its approach to amphibious operations in a little over five years. The failed 1949 assault on Jinmen was mounted using an improvised fleet of "more than 200 fishing boats and junks," whose civilian crews failed to deliver troops to the proper beaches, grounded their vessels ashore, or were lost to KMT gunboats. Those forces that were delivered to Jinmen in the first wave were cut off and left to be destroyed in detail by the island's Nationalist defenders (Huang, 2003, pp. 250–251).

By the time of the 1955 attack on Yijiangshan, the Chinese employed about 40 dedicated amphibious landing ships and utilized "PLA Navy [PLAN] ships . . . air force and coastal artillery units in a coordinated bombardment" of the island prior to the landing (Huang, 2003, p. 259). It may have been on a small scale, but the Yijiangshan operation bears the faint but still recognizable hallmarks of a modern joint amphibious operation. Even the Yijiangshan attack, however, was microscopic in scale and rudimentary in complexity relative to the challenges the PLA would encounter in attempting a large-scale invasion of Taiwan. And the Chinese military's entire experience of actual amphibious combat—versus training and exercises—is over a half-century old, which in realistic terms means that the PLA's institutional knowledge of these complicated and high-risk ventures is, for all intents and purposes, zero. This certainly should not be encouraging to any Chinese planner contemplating an assault on Taiwan.

The Falklands Campaign: Amphibious Warfare in the Age of the Antiship Missile

If the first half of the 20th century—from Gallipoli to Inchon—was the heyday of amphibious warfare, the years since have been a period of relative eclipse. The U.S. Marine Corps, long the global gold standard for amphibious forces, has not undertaken an opposed landing since 1950.[7] In fact, the only serious amphibious assault in the last 40 years—what might be called "the age of the antiship missile"—was the liberation of the Falkland Islands by troops of the United Kingdom in 1982. Although there are of course dramatic differences between that encounter between a nuclear-armed NATO member and what was then a relatively poor Latin American dictatorship, there are also important insights into the nature of modern amphibious warfare to be teased out.

The biggest difference between the two campaigns is that the distances between attacker and objective are wildly at variance. Taiwan lies at most 250 nm or so from China, while the Falklands are over 6,500 nm from the British Isles, and about 3,400 nm from Ascension Island, the nearest British territory. Among other things, this meant that, except for a handful of largely ineffectual raids by Royal Air Force (RAF) Vulcan heavy bombers, Britain's enormous advantage in land-based airpower could not be brought to bear. Instead, the British forces relied roughly two dozen Royal Navy (RN) FRS.1 Sea Harriers and a few RAF Harrier GR.3 vertical/short takeoff and landing (VSTOL) fighters flying from the short-deck carriers HMS *Hermes* and *Invincible*.[8]

Between 380 and 520 nm from Argentina's mainland air bases, the Falklands were reachable by aircraft of Argentina's air force (the

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[7] Possibly the nadir of the USMC's post-Korea amphibious experience came in 1992, when Marines and SEALs came ashore in early-morning darkness in Somalia. Clad in full battle array, the commandos were greeted by an army, not of armed and hostile Somalis, but reporters and cameramen who blinded the troops' night-vision devices with their camera lights and flashes. See Gordon (1992).

[8] Tallied using the detailed aircraft-by-aircraft information provided in Burden et al. (1986, pp. 230–235 and 382–385).

Fuerza Aerea Argentina, or FAA) but distance still posed a problem for the defender. The FAA in 1982 possessed only two KC-130H aerial refueling tankers, which meant that the short-ranged fighter-bombers of both the FAA and Argentina's naval air arm (the *Comando Aviacion Naval Argentina*, or CANA) were for the most part operating at the extreme limits of their operational range on missions to the Falklands, affording them only a few minutes of combat before lack of fuel compelled pilots to head for home. As shown in Table 5.1, the FAA operated about 65 fighter-bombers in the campaign, CANA about 12.

The British enjoyed an advantage in air-to-air weaponry, their Harriers being equipped with the latest AIM-9L version of the U.S. Sidewinder infrared-guided air-to-air missile (IR AAM), which was far superior to the older French and Israeli missiles used by the Argentines. Neither side possessed airborne early warning (AEW) aircraft, and the CANA's two superannuated SP-2H Neptune maritime surveillance aircraft were actually retired in the midst of the conflict due to their extreme age and chronic unreliability. This left Argentina without any ability to perform wide-area search and tracking of the British task force, hindering both the FAA and CANA's strike operations.[9]

The fearsome losses suffered by Argentina's air arms are also shown in Table 5.1. Thirty-five of the 77 engaged aircraft—45 percent—were destroyed in the campaign. Attrition on the British side was lower, though still startling: 10 of 35 Harriers and Sea Harriers (29 percent) were lost.

The Argentine losses reflect the determination with which CANA and FAA pilots carried out attacks against the ships of the British task force, and Table 5.2 shows the fruits of their courageous labors. A total of 33 RN surface warships—25 combatants and eight amphibious assault vessels—entered the war zone around the Falklands before the cessation of hostilities on June 14. Of these, nearly half suffered some damage, and five—15 percent—were sunk. A civilian ship pressed into

[9] The Argentine Navy proper, which included the ex-Royal Navy aircraft carrier *Veinticinco de Mayo*, sortied only briefly against the British task force. After the sinking of the cruiser *General Belgrano* by the British nuclear attack submarine *Conqueror* on May 2, the Argentine surface fleet retired to port without having fired a shot in anger.

Table 5.1
Argentine Fighter Aircraft: Numbers and Losses

Aircraft Type	Total	Used in Combat	Lost
CANA			
Super Etendard	5	4	0
A-4Q Skyhawk	10	8	3
FAA			
A-4P	41	34	19
Dagger	25	21	11
Mirage III	16	10	2
Totals	95	77	35

SOURCE: Data from Burden et al. (1986).

NOTE: The Dagger is an Israeli-manufactured version of the Mirage V, known as the "Nesher" in Israeli service.

Table 5.2
British Ship Losses

Type	Number	Sunk	Damaged
Aircraft carrier	2	0	0
Destroyer	8	2	3
Frigate	15	2	6
Amphibious/support	8	1	2
Total	33	5	11

SOURCE: Hastings and Jenkins (1983, Appendix A, pp. 346–351).

service to ferry equipment and supplies for the task force, the *Atlantic Conveyor*, was also sunk, taking with it all but one of the heavy-lift helicopters that the landing force was to have used for tactical mobility once ashore, and its entire stockpile of tents.[10] The tenacity of the Argentine air attacks also forced operational compromises on the British; some ships were ordered out of harm's way before they had finished unloading much-needed supplies, and naval gunfire support was limited to the hours of darkness to prevent the FAA and CANA catching

[10] A second ship taken up from trade, the *British Wye*, was also damaged, and a landing craft from *Fearless* was sunk.

a frigate or destroyer in confined, inshore waters and separated from the combined defensive strength of the task force (Speller and Tuck, 2001, p. 117).

It was, of course, the Falklands war that made "Exocet" a household word; the French-made antiship cruise missile (ASCM) was the most feared weapon in Argentina's arsenal. What is not as widely known is that, when the war began, Argentina had a total of only *five* air-launched Exocets on hand. With these five missiles, they sank the Type 42 destroyer *Sheffield* and the aforementioned *Atlantic Conveyor*.[11] Had Argentina a mere dozen or so more Exocets, some additional Super Etendard aircraft to carry them, and a handful more tankers, a larger, coordinated strike might have overwhelmed the task force's defenses and inflicted sufficient damage to force the British to reconsider their landing plans.[12]

But the Exocet, legendary as it may have become, was hardly the only, or even the principal, weapon employed against the Royal Navy. In fact, old-fashioned "dumb" bombs inflicted most of the damage absorbed by British ships in the Falklands. FAA and CANA pilots, pressing home their attacks at mast-top level to avoid the medium- and high-altitude SAMs fitted to the British warships, sank four ships and damaged ten others.

The toll would have been much worse had the Argentines re-fused their bombs, which for the duration of the war remained configured for medium-altitude delivery. Dropped instead from extremely low altitudes, the bombs' fuzes had insufficient time to arm themselves before impacting their targets, resulting in a large number of "duds." But even unexploded bombs could prove deadly; Figure 5.1 shows the frigate HMS *Antelope* exploding in the waters off of San Carlos after

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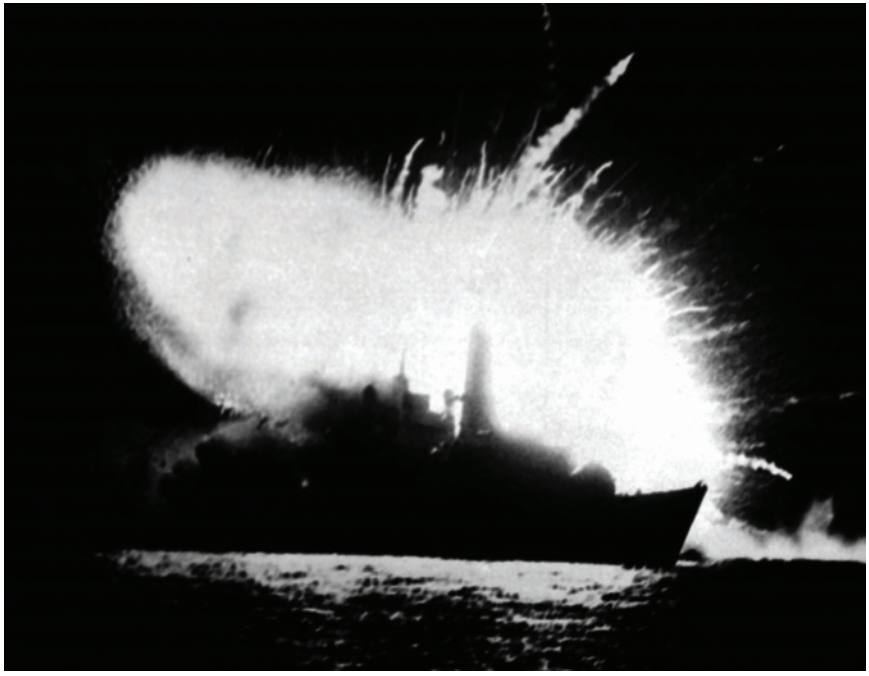
[11] A sixth Exocet, removed from an Argentine destroyer and deployed to the Falklands aboard an improvised truck-mounted launcher, was also fired and heavily damaged the County class destroyer *Glamorgan* on June 12.

[12] Or, at the very least, the progress of the war would have been quite different. An interesting "what if" debate can be had over how the British public, and their prime minister, Margaret Thatcher, would have reacted to an attack that resulted in the destruction of multiple warships and the death and maiming of hundreds—perhaps thousands—of British soldiers, sailors, and marines.

Figure 5.1
HMS *Antelope* Explodes in San Carlos Water, May 24, 1982



SOURCE: Associated Press.
RAND *MG888-5.1*

one of two unexploded bombs in the ship's hull detonated while being "safed." The resulting fires crippled the ship and eventually set off *Antelope*'s missile magazines, providing this dramatic photograph.

Looking Forward: The Lessons of "Operation Corporate"

Britain's recapture of the Falkland Islands was clearly a close-run thing. A few more Exocets, or a handful of properly fused bombs, and history might have recorded a very different outcome.[13] What can we take

[13] The outcome might also have changed had the Argentine Navy's commanders or the ill-supplied and poorly trained Argentine conscripts defending the Falklands possessed a fraction of the courage and determination displayed by the pilots of the FAA and CANA.

away from this campaign to shed light on the conduct of any future Chinese attempt to assault Taiwan?

First, *there is no place to hide in amphibious warfare*. Ultimately, the attacker's ships must approach the hostile coastline to unload troops and supplies. In the Falklands, the Argentines failed to defend on the beach; nevertheless, their limited air power extracted a heavy price from the task force, a price that, but for the simple oversight of re-fusing a few dozen bombs, almost certainly would have been higher, perhaps prohibitive. In the end, no amount of electromagnetic trickery or clever deception can conceal the two sides' forces from one another on that last approach from the visual horizon to the shoreline. If the opponents possess any means of extended-range surveillance, that "risk horizon" can extend well beyond the six or so nautical miles that a beach-bound observer can see.[14]

Even without assets like Airborne Warning and Control System (AWACS) aircraft or long-range maritime patrol aircraft (MPA), the British and Argentine forces in the Falklands managed to maul one another severely. Of the 20 incidents in which British warships were damaged during the campaign, nearly two-thirds (13) occurred while the victim was operating close ashore in support of the landing or follow-on ground operations, and four more were inflicted during pre-invasion "softening up" shore bombardment missions.[15] A struggle in the confined waters of and skies above the Taiwan Strait, with both sides fielding advanced surveillance assets, could be a bloody brawl.

Second, *modern weapons are deadly to warships*. Nearly half of the surface combatants and assault ships in the British task force were damaged in the Falklands campaign by an adversary possessing no armaments more sophisticated than a literal handful of ASCMs and

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[14] As an example, an unmanned aerial vehicle (UAV) operating 200 km east of Taiwan at an altitude of 60,000 ft would have radar line-of-sight all the way to the Chinese coastline. Whether it would have a sensor with the capability to exploit that viewpoint is of course another matter.

[15] Three ships were each damaged twice in separate attacks, and one loss—a landing craft from the LPD HMS *Fearless* that was bombed to the bottom of Choiseul Sound on June 8—are not included in the total of 16 given in Table 5.2. So, 16 warships were sunk or damaged in 20 separate attacks in which damage was incurred.

some World War II vintage "dumb" bombs, many of which failed to detonate due to an easily corrected technical oversight.

Unlike their ancestors of the dreadnought era and World War II, modern warships are not heavily armored, and they rely on a wealth of sophisticated electronics to function and to fight. Even damage that is not fatal to such a ship's ability to stay afloat—the mangling of radar aerials, for example, or the disabling of a missile launcher or the ship's control room (often called a "combat information center" [CIC])—can cause a "mission kill" that renders the vessel operationally useless until repairs can be made, often requiring a return to a friendly port.

There would seem to be special dangers for amphibious assault ships, which by the nature of their job must at some point approach fairly close inshore and will often sail into confined waters offering little space for evasive maneuvering. In addition, these ships are usually packed with combat-loaded vehicles—tanks, fighting vehicles, and trucks fully fueled and carrying live ammunition—that put them at risk of the same kind of secondary explosions that so spectacularly doomed the *Antelope* in 1982. A tank landing ship (LST) heading toward shore will have a very uncomfortable passage against a defender plentifully supplied with modern antiship weaponry.[16]

Third, *distance matters*. Had the British and Argentine militaries squared off on neutral ground or in European skies and waters, the outcome would have been a rout for the UK: In every dimension, Great Britain's armed forces were far superior to those of Argentina in 1982. However, the enormous distance that lay between Britain and the operational theater, which lay near the Antarctic Circle, meant that a mere fraction of the UK's military power—which was, by 1982, mainly configured for a short, violent war on the plains of nearby Western Europe—could be brought to bear in the Falklands. So, while much of the Royal Navy's surface fleet did sail to the South Atlantic, with

[16] Probably fewer than 100 modern ASCMs have been employed in combat in the last 40-odd years. Although the authors have not been able to compile a list of every incident in which these weapons have been used, we have reviewed most and perhaps all of the known cases wherein an antiship missile struck a warship. In *no case* reviewed to date has the victimized ship remained combat-effective. Many have not sunk, but all have been damaged sufficiently to require hours to days to months of repairs.

the exception of the seven Harrier GR.3s hastily deployed to reinforce the jumpjets on the *Hermes* and *Invincible* and five sorties by Vulcan bombers against targets on and around Port Stanley's airport, no RAF combat aircraft were engaged. The geographical advantage enjoyed by Argentina allowed its otherwise outnumbered and outclassed armed forces to make a go of it against the British.

Of these three lessons, one—the relative proximity of Taiwan to China versus not just the United States proper but also the bulk of its Western Pacific military bases—would seem to weigh in the PLA's favor in the event of a war in the strait. The vulnerability of amphibious forces in the run-up to and during the actual landing operations would appear to favor the defender. The third lesson—the demonstrated lethality of modern ASCMs to warship—will put all participants' surface forces at greater risk than has been seen at least since World War II, and possibly since the great battles between ships of the line during the Age of Sail. We will now turn to assessing how these and other factors could affect the prospects for a successful Chinese invasion of Taiwan.

Assessing the Odds: Could the Chinese Invade Taiwan?

To invade and occupy Taiwan, the PLA must be able to establish a secure lodgment on Taiwan, then subsequently resupply and reinforce it until adequate combat power is available to break out from the beachhead, defeat defending forces, and establish control over the island.[17] While stated simply, this would in fact be a complicated, choreographed, and risky operation. The analysis here will focus on the main element that the first two phases—invasion and buildup/breakout—have in common: the need to safely and repeatedly transit the Taiwan Strait with amphibious assault ships and other vessels. We will use simple "zeroeth-order" calculations to explore how effective

[17] This resupply need not be limited to over the beach if China can capture a working port early on.

defending forces might need to be in order to adequately interdict the flow of Chinese troops and equipment into Taiwan.

First, we need to estimate the total number of transport vessels the Chinese might employ in an invasion attempt. Table 5.3 shows the PLA's near-term fleet of amphibious transports. This number has been increasing slowly over the past five to ten years, and could number about 100 ships by early next decade.[18] If we assume that the carrying capacity of the fleet increases in proportion to the number of hulls, that force could be expected to carry about 31,000 troops and about 600 tanks or other armored fighting vehicles (AFVs) in a single transit if all vessels were available and employed. Given that the Chinese naval

Table 5.3
Major PLAN Amphibious Vessels: ~2010

Class	Type	Number (Building)	Capacity	
			Troops	Tanks
Yuzhao	LPD	1 (+?)	600	~12
Yuting II	LST	10+	250	10
Yuting	LST	10	250	10
Yukan	LST	7	200	10
Yunshu	LSM	10+	~500	6
Yuhai	LSM	13	250	2
Yudao	LSM	1	~500	~9
Yuliang	LSM	32	~300	3
Yudeng	LSM	1	500	9
Zubr	ACVM	0 (+6?)	230	3
Total		85+	25,850	482

NOTE: LPD = amphibious transport dock; LSM = landing ship, mechanized; ACVM = air-cushion vehicle, mechanized.

[18] China is retiring a number of its older amphibious ships as new ones enter the fleet; the PLAN could speed up the growth of its transport capacity simply by keeping the older vessels in service longer. Also, LSTs and similar ships are among the least-complex warships to build, so China could accelerate production if it so chose. We thank our colleague Roger Cliff for these points.

bases likely to be used are mostly about 250 nm away from the island, and many major bases of the East and South Seas Fleets are over 300 nm distant, these figures almost certainly represent an upper bound on what the PLAN could transport across the strait on the first day of an invasion attempt.[19]

As a point of comparison, the U.S. Army put some 55,000 troops ashore on Utah and Omaha beaches on D-Day, not counting the two airborne divisions that jumped from the darkness into France early on the morning of June 6, 1944 (Hastings, 1984, p. 102). The British and Canadians added about 67,000 soldiers on Juno, Gold, and Sword beaches, along with a third airborne division. All told, more than 120,000 Allied troops landed on French soil on June 6, about four times as many as the PLAN could put ashore on its own "D-Day."

Would 31,000 troops be enough to conquer Taiwan? Assuming that Taiwan's government, military, and populace chose to put up a fight, almost certainly not. Taiwan's active-duty army numbers about 190,000, and is being reorganized into a brigade-based structure that integrates combined arms in a more mobile and flexible structure.[20] While little is available in the public domain about Taipei's plans in the event of a Chinese invasion attempt, even a modest amount of warning should suffice to deploy multiple brigades to defensive positions on and near the likely invasion beaches.[21] Taiwan's army fields a fair number of

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[19] If we assume that the assault ships average a speed of 15 kts—a reasonable estimate for ships sailing in formation—the 100nm one-way trip from the nearest PLAN base to the Taiwanese coastline would take about seven hours. Add in time for the ships to maneuver into proper sequence for landing, wait their turn on the beach, unload, and then return to port, and few if any of the transports would likely be able to even begin loading troops or equipment for a second wave of attacks until late in the first 24 hours of an invasion attempt. Ships with longer transits between port and beach would, of course, be even less productive.

[20] Taiwan also has more than 1 million troops in its reserve forces.

[21] There appear to be few good places for an amphibious attacker to come ashore on Taiwan. In 1944, Western Europe (France, Belgium, and the Netherlands) offered over 1,200 miles of coastline to the Allies, and several locations were seen as possible invasion sites, with the Pas de Calais appearing the most attractive. The Germans in general and Hitler in particular expected the assault to come there, across the narrowest stretch of the English Channel. Even after the invasion of Normandy had begun, Hitler insisted that it was a diversion and so delayed—perhaps fatally—redeploying reinforcements from the Calais area.

self-propelled artillery pieces that could bring heavy fire down on any beachhead; being mobile, they should prove difficult to suppress in any pre-attack missile, air, or artillery bombardment. Taiwan's attack helicopters should also be survivable and lethal to PLA troops on the beach and landing craft and assault vessels venturing close to the shore.[22]

Given some days of warning—triggered perhaps by intelligence revealing PLA units moving toward ports of embarkation and the mustering of the PLAN's amphibious shipping in those ports—Taiwan should have or be able to develop the ability to deploy on the order of 60,000 troops, or about one-third of its active force, to defend the beaches, along with supporting artillery and other arms. It is once again difficult to determine from the open literature how robustly prepared likely invasion sites are, but some prepared fighting positions, bunkers, and preregistered artillery targets may exist, or could be created. While a few days might not be enough time to erect a formidable array of beach obstacles such as those that greeted Allied troops in many spots along the Normandy coasts, scatterable mines fired from artillery tubes could be used to create expedient barriers in a few hours if preplanned and prepared for. A fairly short warning period should also be adequate to allow Taiwan to disperse it helicopters to prepared, hidden operating points and perhaps to also move some fixed-wing aircraft away from their main operating air bases to highway strips.

The biggest threats to Taiwan's defenses would arise if China were able to achieve a meaningful degree of local air superiority over the strait. Under these circumstances, PLAAF aircraft could attempt to

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Taiwan's west coast has fewer than 500 miles of coastline and offers a handful of suitable locations. (The eastern half of the island is not ideal for a landing because transit times from Chinese ports would be long, and the further away from the mainland the armada sails, the more exposed it would be to interdiction. The eastern coast of Taiwan is also very rugged, offering few locations appealing to an invader.) However, only the beaches in the northwest, near Hsinchu, combine adequate landing sites with proximity to Taipei, which would be a critical objective, especially in the "quick victory" scenario we are exploring. The analysis presented here should, in any event, be largely robust, regardless of the location of the attack.

[22] The United States has agreed to sell Taiwan 30 AH-64D Apache attack helicopters. When operational, the Apaches will significantly increase the capabilities of the ROC Army's helicopter fleet.

interdict the movement of reinforcements and supplies toward the coast and pummel those defenders that manage to make it to the beach.

The effects of these kinds of attacks are hard to predict. On one hand, bombardments of beach defenses have never proved truly decisive; the German defenders in Normandy endured air and naval bombardment of a scale far beyond anything the PLA could hope to inflict on the soldiers guarding Taiwan's beaches. However, Eisenhower's air forces did not have PGMs, nor is it certain that Taiwan's army will prove as resolute as were the Wehrmacht formations on the French coast in 1944.[23] Taiwan can seek to ameliorate the impact of Chinese attacks by prepositioning stocks of ammunition, fuel, and other consumables in secure locations near likely invasion points. And, more generally, a prudent Chinese planner would not count on his adversary proving to be feckless.

This uncertainty highlights an issue that exists with almost every aspect of this scenario, which is that neither the Chinese nor Taiwanese military have any experience of warfare of the scope, scale, sophistication, and intensity that we are describing. To some extent, this should burden the attacker more severely: If the Chinese cannot organize and execute an effective interdiction campaign, for example, the fact that Taiwan may be unprepared to withstand it will be moot. However, the defender need only fail at one or two critical points or moments for Taiwan's position to be put in grave jeopardy. In the next chapter, we put forward some ideas about what those points and moments might be and how Taiwan can better prepare for them. For now it suffices to say that this "fog of no war" makes risky any definitive pronouncements regarding the likely outcome of the battle on the beaches, or indeed, any other part of a war for Taiwan.

To proceed with our analysis, we need to define a criterion against which China's ability to move troops to Taiwan can be judged. In the

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[23] It is worth noting in this context, however, that many of the ten or so German divisions who absorbed the brunt of the D-Day landings were understrength second-line formations, or the remnants of first-line units that had been broken in combat on the Eastern Front. Though hardly the cream of the Reich's armed forces, these troops nonetheless withstood a preinvasion "softening up" campaign never before witnessed and likely never to be exceeded absent the employment of nuclear weapons against the defenders.

interest of creating the largest plausible reasonable challenge for the defender, we will assume that the PLA need only achieve numerical parity with the defending forces—about 60,000 troops—to establish a sufficiently robust beachhead to threaten the integrity of Taiwan's defenses and thereby "win" the "offshore" battle phase. How much and how rapidly must the defense attrit the PLAN's amphibious force to prevent this?

For analytical purposes, we will spread China's lift capability—31,000 troops and 600 AFVs—out evenly across all 100 of the ships in the projected fleet, so that each vessel carries 310 troops and six AFVs. Doing the math is straightforward enough: The 100-ship PLAN amphibious fleet must achieve about 194 successful landings to get 60,000 troops ashore.[24] This figure naturally scales linearly with the number of troops required; if we were to assume China required a 2:1 manpower advantage, nearly 400 sorties would be necessary, and so forth.

We would like our analysis to avoid results that are obviously absurd, such as a single amphibious ship making all 194 crossings over a period of, say, six months. To avoid this, we need to put a time horizon on the attack. As was the case in the discussion of the air war in Chapter Four, any invasion attempt would probably culminate fairly quickly. If China is able to seize and reinforce a viable beachhead, it eventually should be able to conquer the island, though the campaign could turn out to be protracted. On the other hand, because its air force and navy would take substantial time to rebuild after a failed attack on Taiwan, China has basically one shot at invading the island; heavy initial losses, especially to amphibious shipping, would decide the issue—at least insofar as invasion is concerned—for the time being. We will therefore look at the offshore battle for a period of five days.

How many crossings of the strait can the PLAN assault ships make in that time? Consider the following assumptions:

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[24] In calculating the effects of attrition on the Chinese invasion force, we are disregarding the possible impacts of "lucky shots" that cripple, for example, the leadership cadre of the invading force or—as with the sinking of the *Atlantic Conveyor* off of the Falklands—eliminate crucial equipment such as air defenses or signals gear.

- The entire amphibious force sails from the PLA bases closest to the designated beaches in northwestern Taiwan, a one-way distance of about 100 nm.[25]
- The invasion fleet averages 15 kts, a reasonable speed for an armada of more than a hundred amphibious transports and escorts seeking to remain in good order during the transit. Each one-way crossing therefore takes roughly seven hours.
- Limits on beach frontage and the need to deconflict and maintain organization among the ships heading to and departing from the beach will allow no more than 20 assault ships to be ashore unloading at any given time. So, each *lift* of 100 vessels consists of five *waves*.
- Each wave takes an hour to offload.
- Reloading, refueling, and conducting necessary maintenance on each amphibious transport once back in port takes 12 hours.

Using these assumptions, we see that the first wave of the first lift beaches at H+7 hours, and the last of the five waves leaves the beach at H+12. By H+19, the last ship is home and the armada is ready to set sail again at H+31. The second lift is on the beach between H+38 and H+43; the third between H+69 and H+74; and the fourth between H+100 and H+105. So, the PLA could conduct four lifts in five days, with a few hours to spare.

Four lifts each of 100 assault ships amounts to 400 sorties, well above the 194 we calculated as needed to put 60,000 PLA troops ashore on Taiwan. To defeat the attack, then, the defenders will need to eliminate about 210 sorties.

Here again, the arithmetic is clean, if perhaps tedious. A transport put out of action while making its first crossing cannot be used on any subsequent lift, so an inbound "kill" on the first lift essentially counts

[25] As mentioned earlier, most PLAN bases are at least 250 nm from northwest Taiwan. We use the 100nm number to create a defense-pessimistic case. Obviously, the longer Chinese ships take to sail across the strait, the more opportunities the defenders will have to attack them.

for four sorties eliminated.[26] Eliminating a ship on either the return leg of its first trip or the west-to-east phase of the second would cost the PLA three sorties over the five days. Obviously, there is substantial leverage for the defense in knocking out ships early in the campaign. Killing 52 ships during the first incoming lift is enough, for example, to keep the PLA from successfully completing the necessary 194 landings (400 [possible sorties] – (52 [kills] x 4 [sorties lost per kill]) = 192 [maximum sorties delivered]). If the attrition is instead spread out equally across the four lifts, and equally divided between the inbound and return legs, nearly the entire Chinese amphibious fleet—90 ships—has to be taken out to keep the PLA from achieving its 60,000 troop goal. Intermediate cases produce, unsurprisingly, intermediate results.

This is almost certainly a defense-pessimistic assessment. It seems likely that loss of even a few—perhaps ten or so—of the PLAN's limited number of amphibious transports in the early hours of an attack would greatly disrupt the Chinese plan and put the entire invasion operation in jeopardy. And, it is not clear that 60,000 troops landed in five days would suffice for a successful invasion. As mentioned earlier, the Allies put about twice that many soldiers into the Normandy battle on its first day. If China were to seek the 3:1 numerical advantage often used as a rule of thumb for successful offensive operations, 180,000 troops—600 sorties or six full lifts' worth—would be needed.[27] Also, our assumptions that the entire attack force can sail from the ports closest to Taiwan and that 12 hours would be adequate time to turn the ships between sorties could well be unrealistically favorable to the attacker. Nonetheless, for our purposes, we will proceed on the basis that the defense should seek to render combat ineffective about half of the Chinese amphibious fleet on the first day.[28]

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[26] We use "kill" to mean a "functional" or "mission kill." That is, we do not necessarily care whether the target is sunk or not, only that it is put out of action for the duration of the campaign.

[27] Which, using the assumptions about timing described earlier, would take a minimum of about ten days.

[28] The concepts and weapons we propose for achieving this goal would, we believe, be equally useful in a campaign where a slower kill rate demands a higher level of total attrition. The need to put half of the PLAN's amphibious ships out of action *on their first sortie*

Given the results of the air war analysis presented in the last chapter, we focus our assessment of the defender's options on those that might be viable even with Chinese air superiority. Among the chief effects of Chinese control of the air would be the grave restrictions imposed on the operation of the airborne ISR assets. The United States relies on these platforms, manned and unmanned, for much of the timely and reliable data that underpin its operations. With these capabilities highly degraded, operational concepts relying exquisite ISR or complicated kill chains would be very fragile and prone to collapse. Therefore, our assessment of defensive options will concentrate on those that offer some prospect of success even under such conditions.

Probably the easiest place to attack the amphibious transports is when they are beached, unloading troops, equipment, and supplies.[29] During this time, they are in essence sitting ducks, stationary and exposed to a variety of defensive weapons including artillery, tanks and other AFVs, attack helicopters, and any aircraft-delivered munition suited for attacking fixed targets, including laser- and satellite-guided bombs.[30]

Taking the latter as an example, the Falklands experience strongly suggests that a single, properly fused, 1,000lb- or 2,000lb-class weapon—such as the GBU-31/32 GPS-guided all-weather Joint

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imposes a numerical requirement for firepower delivery that should be more than sufficient in a longer, slower fight.

[29] China could choose to keep its larger amphibious ships further offshore and use landing craft, air-cushion vehicles, and other small vessels to negotiate the last few vulnerable miles. This would change the defender's problem to one of having sufficient firepower to engage these more numerous, but less survivable, targets. It would, however, slow the delivery of men and supplies to the beach and, if the offshore staging areas where the LSTs and other large amphibs are managing the release and recovery of the landing craft can be even roughly located, the larger ships could be engaged during these vulnerable times by longer-range antiship missiles, as we will discuss a few pages from now.

[30] The coordinates for aiming satellite-guided munitions could be acquired through a number of means, including airborne ISR or the radars of the attacking aircraft (assuming they have appropriate air-to-ground modes), if the correct platforms can be brought to bear. However, the combination of a trained observer, an accurate GPS receiver, a compass, and a rangefinder might be more robust. Preregistration of targets on possible invasion beaches would be useful as well.

Direct Attack Munition (JDAM)—delivered onto a warship would do severe damage; two such hits would likely destroy the target. Accurate delivery, then, of about 100 JDAMs onto the first-day Chinese beachhead—roughly four B-1B loads—would meet the damage criterion proposed in this assessment.[31]

However, the threat from Chinese air defenses might prevent large, non-stealthy aircraft such as the B-1 from successfully penetrating to the invasion zone, and smaller fighters might either be pinned in at air bases closed by Chinese missile strikes or occupied in the battle for control of the skies. Under these circumstances, other weapons could be employed. Bombers could employ standoff weapons, such as Joint Air-to-Surface Standoff Missiles (JASSMs). Antitank missiles, such as the Hellfire and TOW, can be fired from attack he1icopter or ground launchers.[32] These weapons have ranges of up to five miles and carry warheads that could do significant damage to small- and medium-sized landing ships.[33] While multiple hits would be needed to have high confidence of disabling a ship, the numbers of possible launchers—attack helicopters, dug-in infantry, armored and light vehicles—would make these missiles a serious threat to the PLAN's amphibious ships and smaller landing craft while they are unloading.[34]

If the Chinese cannot be engaged ashore, the next best place to take them on would be during the amphibious ships' final run in to the

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[31] The B-1B can carry 24 JDAMs. And, fewer weapons than this might in practice suffice. If the bulk of the first wave of ships to reach the shore—20 in our analysis—were left burning on the beach, subsequent waves would have fewer places to land and the pace of the assault—now probably reduced nearly to chaos—would almost certainly slow dramatically, if not halt entirely.

[32] Given China's likely ability to bring fire to bear on the invasion beaches—especially if it has seized even temporary mastery of the air—it would be vital that these weapons be operated from platforms that are either strongly hardened or highly mobile.

[33] Indeed, the Hellfire exists in a shore-based antiship variant deployed by Sweden, Norway, and Turkey and an air-launched antiship version (the AGM-114M) was purchased by Taiwan in 2005 (Jane's Online, 2000).

[34] Just as an example, each of the AH-1W Super Cobra attack helicopters operated by Taiwan can carry eight Hellfires. Even if a full load were needed to disable a single ship, only 50 sorties over a period of five hours by Taiwan's force of 60-plus AH-1Ws (and soon, AH-64s) would be enough to put 50 PLAN transports out of action.

beach. This is because the defender's targeting problem, while harder than that presented by the stationary targets of the unloading phase, remains nonetheless fairly simple. As the transports "shake out" for the last few miles of transit, they will likely leave behind most of their escorts (to reduce risks to those valuable destroyers and frigates) and any decoy ships that were included in the invasion column to complicate the defense's ISR challenges during the open-water portion of the journey. Hellfire missiles, with their range of five miles, would have a nearly 20-minute window in which to engage incoming ships after they had crossed the horizon and could no longer hide from passive line-of-sight optical, infrared, or electronic sensors.[35] As Figure 5.2 shows, the RBS-17 coastal-defense version of the Hellfire is launched from a simple and easily concealed fixed launcher; it could also be mounted on a truck or other small, mobile platform.[36] Augmented by similar weapons launched from attack helicopters and fire from coastal defense artillery, these small and relatively inexpensive missiles would offer an uncomplicated "kill chain" and, if protected and camouflaged or mobile, should prove difficult to suppress.[37] This kind of missile should prove lethal against smaller ships and landing craft; multiple hits could also seriously damage larger vessels.

Attacking the Chinese invasion fleet over the horizon while it transits the strait would be more challenging. First, the closer to the Chinese mainland U.S. or Taiwanese forces venture, the deeper into

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[35] The 20-minute estimate assumes the 15kt speed postulated earlier for the transports. They would need to slow down somewhat as they approached the beach, thereby extending the engagement window somewhat. Air-cushion landing craft can, on the other hand, travel much faster, with top speeds of around 60 kts. However, their carrying capacity is limited, and, even at 60 kts, it would take them about five minutes to pass through the five-mile "kill zone" of a shore-mounted Hellfire-class missile. With a missile flyout time to maximum range of only about 40 seconds, this provides adequate time for multiple engagements even of these relatively fast-moving targets.

[36] Promotional material from Lockheed Martin, Hellfire's producer, claims that "HELLFIRE has also been successfully fired from several wheeled and armored vehicles," and shows a photo of one apparently being launched from a light armored vehicle (Lockheed Martin Corporation, 2008).

[37] One open source cites a price of about $65,000 per missile for the AGM-114K; the AGM-114M is the same missile with a different warhead. See Wikipedia (2009b).

Figure 5.2
Hellfire II Missile and Launcher

SOURCE: Lockheed Martin photo.
RAND *MG888-5.2*

the heart of the PLA's defenses they must go. Shipboard air defense systems, for example, will be more effective against aircraft flying over open water than if forced to engage low-flying, fast-moving targets such as helicopters over Taiwan itself. And, land-based air defenses, such as China's long-range S-300 and future S-400 SAMs, present a threat to medium- and high-altitude targets far out over the strait.

Second, the defense's ISR challenge grows more daunting the farther out it seeks to engage the fleet. For most of the crossing, the invasion force would likely intermix amphibious vessels—the prime targets—with surface combatants, auxiliary vessels (e.g., minesweepers), and possibly even numbers of decoy ships, rigged out to resemble the more valuable assault ships to radar, infrared, and passive electronic sensors. In the absence of friendly air superiority, existing ISR platforms could have difficulty identifying the amphibious ships, sorting

them from the crowd, and keeping track of them long enough to execute an effective kill chain.[38]

While use of long-range ASCMs as the pointy end of a complicated kill chain may not be viable in the context of a Taiwan Strait conflict, they are needed as an outer ring of a layered defense that also included robust capabilities against the "run-in" and ashore phases. The ISR difficulties associated with attempting to precisely pick out high-value targets from the overall fleet can largely be ignored if the task is simply to "thin the herd," inflicting such attrition and imposing such disorganization as possible while setting the stage for the later phases of the defense, should China choose to press the attack.

Long-range ASCMs could be fired from mobile or fortified shore launchers, from small, fast patrol boats operating over the horizon from the leading edge of the PLA force, and—if missiles of sufficiently long range are available—from aircraft operating beyond the envelope within which Chinese fighters and surface-to-air defenses would pose an unacceptable risk.[39] Launched at the mass of Chinese ships moving across the strait and coordinated only insomuch as necessary to ensure that missiles from different land, sea, and air platforms arrive on target at more or less the same time—to complicate the job of the PLAN's antimissile defenses—a single strike with 50 or so missiles could put perhaps a dozen Chinese ships out of action.[40] Granted, lack of dis-

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[38] One option worth considering might be using UAVs to cue more precise targeting for long-range ASCMs. One can imagine several concepts that might work, ranging from large, very high-flying vehicles that have sufficiently powerful sensors to detect, classify, and track ships while cruising well out of the range of China's SAMs to small, more or less "disposable" ones that could "swarm" the strait, relying on sheer numbers to survive. Since these systems don't exist, however, we do not explore these kinds of operations further in this report.

[39] In the 1980s, the United States deployed a version of the Tomahawk cruise missile, the "Tomahawk Anti-Ship Missile," or TASM, with an active fire-and-forget radar seeker, a 1,000lb warhead, and a range of 300 nm. The U.S. Navy's current top-of-the-line antiship missile, the misnamed "Standoff Land Attack Missile" (SLAM), has a range of only 150 nm and requires man-in-the-loop (MITL) guidance to achieve maximum accuracy. See Kopp (2008) and Polmar (2005, pp. 523–524).

[40] Again, we use back-of-the-envelope arithmetic. Assume that the missile has 90 percent reliability, a 50 percent chance of penetrating the Chinese fleet's air defenses and hitting something, a 70 percent chance of hitting a target not already "killed", and a 70 percent

crimination among the targets would mean the losses included a mixed bag of transports, combatants, auxiliaries, and perhaps decoys, but if multiple attacks of that size could be carried out, the invasion force might be stopped in its tracks.[41] At the very least, its defenses would be reduced (by exhaustion of surface-to-air missile magazines, if nothing else) and its organization disrupted if it chose to continue into the inner rings of the defense.

Where would 50 long-range ASCMs come from? The ROC Navy is reportedly scheduled to complete deployment of 30 *Kuang Hua VI* fast missile boats by 2010. Each carries four Hsiung Feng II ASCMs. If half of this fleet can sortie and launch its weapons, 60 missiles would be put into the air by those vessels alone.[42]

In the discussion of the Falklands war, we noted that the Argentines had improvised a land launcher for a naval Exocet that, when fired, nearly sank a British destroyer. Taiwan is reported to have some number of Hsiung Feng ASCMs in fortified coastal positions on both Taiwan and outlying islands, and mobile versions of the Hsiung Feng II are reported. Proliferation of these weapons would help thicken the outer engagement layer.

Tactical aircraft of both the ROCAF and the U.S. Navy can carry antiship missiles, but the relatively short ranges of Taiwan's Hsiung Feng II ASCM—around 40 nm—could put the launching aircraft at

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chance of disabling or sinking what it does hit: 0.9 x 0.5 x 0.7 x 0.7 x 50 ≈ 11. The reader is of course invited to adjust the parameters of this "model" to his or her taste.

41 ISR requirement for this concept would be limited. Most modern antiship missiles have some capacity for autonomous search: Non–line-of-sight attacks can be executed against a precisely located target or by firing the weapon to a location close enough to the target ship(s) that its seeker can acquire a fix. As described here, the concept involves firing a large number of ASCMs into these so-called "baskets" and accepting the more-or-less random attrition that would be inflicted by this PGM version of "unordered fire." Airborne (small, cheap, and expendable UAVs might be ideal), surface, submarine, or space-based ISR could offer sufficient resolution to enable this concept.

42 As Google Earth flies, Taiwan's west coast stretches about 250 nm. Taiwan's Hsuing Feng II ASCM has a reported range of 40 nm, meaning that, in theory, three groups of missile boats, properly spaced, could cover the entire coast. At 30 kts, the vessels could also take advantage of any available warning time (recall that the invasion fleet will need seven hours to cross the strait) to concentrate against the attack corridors once they are identified.

risk from Chinese defenses, should they manage to get off the ground in the face of the kinds of attacks on their airfields we described earlier in this report. The U.S. Navy's SLAM-ER has a long enough range to potentially be useful, depending on the specific circumstances. However, the F/A-18s of the CSG(s) might either be preoccupied with the defense of the group itself, be fully committed to the air war, or have suffered substantial attrition in combat before the Chinese invasion fleet sailed. Further, SLAM-ER, as noted earlier, is an MITL weapon, limiting the numbers that can be simultaneously used to the number of controllers available.

Finally, the USAF formerly maintained the capability to launch Harpoon ASCMs from some of its B-52 bombers. The air-launched Harpoon is obsolescent in the context of the air defense environment it would encounter over the strait in the event of a war, since its range, like the Hsiung Feng II's, is not long enough to allow the carrying platform to be confident of survival. A longer-range, somewhat stealthy weapon, along the lines of the proposed maritime strike version of the JASSM, could restore a credible maritime strike capability to the bomber force. The B-1B is capable of carrying 24 JASSMs (which have a range of 200 nm or more), so only a handful of bomber sorties would be needed to deliver 50–100 missiles.[43]

Even in circumstances that see China enjoying at least local air superiority in the vicinity of its fleet, other weapons and tactics could be used.[44] Naval mines of various kinds could be deployed from aircraft, surface vessels, and submarines during the warning period; if nothing else, Chinese efforts to clear them would slow the attack's tempo and allow more time both for the defender and for a political solution to be reached. Given the relative paucity of likely invasion sites in Taiwan and the limited capability that every navy has, to date, demonstrated for dealing with modern mines—especially when under

[43] We do not mean to endorse a particular weapon here but simply to point out the potential value of a capability. For information on JASSM and the proposed "maritime interdiction" version, see Jane's Online (2008).

[44] If the defender has air superiority, it seems unlikely that China would undertake an attack in the first place.

fire—timely use of naval mines could offer substantial leverage to the island's defenders.[45]

Adding It Up: The Invasion Threat to Taiwan

China's growing capabilities have meaningfully changed the calculus regarding a possible attempt to invade Taiwan. A few years ago, a large-scale PLA amphibious assault on the island was almost unthinkable; Taiwan and its U.S. ally seemed assured of maintaining a degree of air superiority that all but guaranteed that any cross-strait assault would prove a bloody failure.

Looking to the near future, improved air defense capabilities, including shipboard defenses, a growing inventory of modern fourth-generation fighters, and a powerful and flexible force of offensive ballistic missiles place in jeopardy the long-held assumption of the defense's control of the skies over the Taiwan Strait and Taiwan's coastline. As we showed in Chapter Four, the PLAAF likely has, or will soon have, a credible ability to challenge the United States and Taiwan for air supremacy, perhaps opening a window for an invasion attempt.

We nonetheless conclude that, even under these circumstances, an invasion of Taiwan would, in the face of properly prepared defenses, remain a bold and possibly foolish gamble on Beijing's part. There are three main reasons for this.

First, while neither the Chinese military nor Taiwan's has any track record in large-scale modern warfare, the burdens of conducting a large amphibious offensive—a profoundly difficult and complex

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[45] Submarines could also be used to attack the invasion fleet directly. We have heard somewhat conflicting accounts regarding the suitability of the Taiwan Strait for tactically offensive submarine operations. Should submarines—and here we mean, in essence, U.S. nuclear attack boats (SSNs)—in fact be able to fight and survive in the strait, their firepower would substantially increase the defenders' odds of success.

As for mines, it is worth noting that the decision not to use the USMC in an amphibious attack during Desert Storm was strongly influenced by the presence of sea mines, which had inflicted serious damage on two U.S. Navy ships (the amphibious assault ship *Tripoli* and the cruiser *Princeton*) during the campaign. We are once again indebted to James FitzSimonds for this insight.

undertaking even for the most competent militaries—would make the PLA's inexperience the more telling. As the defender, Taiwan has the easier job, and could also benefit from having the world's most powerful and experienced military, that of the United States, as its primary ally.

Second, absent a much-accelerated construction program, the PLAN's fleet of amphibious shipping will remain modest relative to the magnitude of the requirements for assailing Taiwan. The 100-ship amphibious force we project for China in the early twenty-teens can only transport about 31,000 troops at a time. Even without taking losses into account, the PLA would still be compelled to complete multiple lifts to put ashore a force adequately sized and supplied to defeat the ROC military on its home ground. While this problem could be somewhat ameliorated by the rapid capture of an intact port, proper defensive preparations (e.g., preplanted demolition charges that can be remotely detonated) can reduce the risks to the defender. And, the commercial ships that might be used to move troops and equipment into a port would be very vulnerable to the same tactics and weapons used against the PLAN's vessels—probably more so than their naval counterparts, since commercial ships would not have been constructed to military damage-control standards and would lack any but the most rudimentary and ad hoc defensive weaponry.

Finally, and perhaps most importantly, we have argued that Taiwan could—provided proper concepts were embraced, plans developed, hardware acquired, and personnel trained—present a reasonably robust, layered defense even without friendly air superiority. Over the horizon, engagement by long-range ASCMs launched from air, sea, and shore would weaken and disrupt the Chinese task force; mines hastily deployed offshore would slow and further disrupt the choreography of the assault; and attacks employing hundreds of shorter-range missiles from helicopters and fixed and mobile launchers ashore and focused on the amphibious ships during the last few miles of their run in to shore would wreak further havoc on the strength and organization of the attack. Finally, a variety of weapons, from air-launched PGMs and artillery, rocket, and mortar fire to direct fire from tanks and antitank missiles, could be brought to bear against PLAN transports while

they were unloading—and highly vulnerable—on the beach. Taken together, this "four-rings" approach to defending Taiwan, if properly prepared for and executed, could still turn any Chinese invasion attempt into a bloody fiasco.

It is not clear that this kind of stout defense could be mounted today were it called for. Large numbers of antiship missiles, whether longer-range ones like the Hsiung Feng or the smaller, Hellfire-class variety, are needed, employing multiple survivable (both mobile and small and well-concealed) launchers. To negate the effects of Chinese interdiction efforts on the movement of supplies to beach defenses, adequate stockpiles of these weapons as well as other materiel need to be securely prepositioned near likely invasion targets. Taiwan should more fully exploit countermeasures to Chinese targeting, including the extensive use of camouflage, concealment, and deception (e.g., decoys), and electronic warfare. Finally, the ROC military would need to systematically practice these tactics, and fine-tune its ability to respond quickly and effectively to the limited warning time—possibly denominated in hours, and certainly not likely to be more than a handful of days—that would precede a Chinese attack like the one examined here.

The United States is not necessarily well prepared to assist in such a campaign. U.S. antisurface warfare capabilities have atrophied somewhat since the end of the Cold War. USAF bombers no longer pack a standoff maritime strike punch, while the MITL guidance of the Navy's SLAM-ER makes it unsuited for use in the kinds of numbers that would be called for in a counter-invasion campaign. So, changes in planning, doctrine, and equipment will be needed on the U.S. side as well.

Our conclusions regarding the rather dim prospects for a Chinese invasion of Taiwan come with two caveats. First, if the PLAAF's challenge to the defender's control of the air over the strait is as serious as was portrayed in some of the cases described Chapter Three, a successful defense against an invasion will be made much more difficult. While heavily fortified defensive positions have in the past proven difficult to neutralize via air or sea bombardment, a competent air force well stocked with PGMs—as we portray the PLAAF as being in our analysis—could plausibly hold them at risk if allowed to operate freely

over the beaches. In those circumstances, large-scale movement on the ground could likewise be subject to heavy attack. Chinese air control would thus increase the value to Taiwan of small, highly mobile systems, such as self-propelled ASCM launchers and short-to-medium range surface-to-air systems that can "shoot" and then "scoot" to survive.[46] At the very least, U.S. and ROC air power and Taiwan's surface-to-air defenses need to be effective enough to prevent the Chinese from roaming freely through the battlespace.[47]

Also, our analysis has focused on a traditional amphibious attack that aims to bring sufficient and sufficiently heavy forces ashore to defeat an enemy's army. China could choose a more novel, and riskier, course of action, such as launching a massive wave of SRBMs to suppress ROCAF bases and air-defense battle management, then immediately seizing a port and an airfield into which troops and equipment would flow using military and commercial air and sealift. Such a strategy would rely heavily on surprise for survivability and shock for effectiveness, but it would be imprudent for Taiwan's defense planners to ignore it as a possibility.

In the next chapter, we will discuss these and other implications of our work and make specific suggestions as to how Taiwan and the United States can improve the security of the island in the context of China's growing military power. Here we will simply conclude that, while it remains unlikely that the PLA could in the near term successfully invade Taiwan, both the ROC and the United States need to be proactive in ensuring that the odds remain stacked in their favor.

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[46] One might think of the 1991 Gulf War as an analogy, with Taiwan playing the role of Iraq. Fixed targets and large formations of moving vehicles were at the mercy of Coalition airpower in Desert Storm, but individual truck-mounted SCUD missile launchers defied all efforts to track and destroy them.

[47] The benefits of modern firepower, like tracers, do point both ways, however. If China's dominance of the skies were sufficiently tenuous or limited that the United States could push even a few bomber sorties per day safely over a beachhead, weapons such as the CBU-105 sensor-fused weapon/wind-corrected munitions dispenser (SFW/WCMD) could be utterly devastating to PLA troops coming ashore or moving inland.

CHAPTER SIX

Implications, Conclusions, and Considerations

This assessment of the cross-strait military balance is rather more sobering than was its predecessor (Shlapak, Orletsky, and Wilson, 2000). Put simply, none of the cross-strait military trends are pointing in Taiwan's favor. China is putting in place the kinds of capabilities—large numbers of modern SRBMs and up-to-date air forces are the main ones discussed in this report, but the PLA's modernization is much broader—that pose problems for Taiwan and the United States that are not easily solved. The most likely picture that emerges of a cross-strait fight in 2013 features ROCAF and U.S. land-based fighters being grounded or destroyed in the initial minutes and Taiwan's most modern SAMs largely suppressed in that same time frame. This translates to a rapid seizure of air superiority by the Chinese. Whether Beijing wishes to exploit this situation to mount an invasion, to prosecute a protracted campaign of coercive bombardment, or in some other way, Taiwan and its U.S. ally will be in deep trouble.

This much is clear. What is less certain is what this shift portends, and what, if anything, can and should be done about it.

Whether or not China presents a military threat to U.S. interests in East Asia is a contentious issue. Traditionally, "threat" is defined as some function of a potential adversary's capabilities and its intentions. If the analysis we have presented is accurate, the "capabilities" part of that equation is clearly problematic for Taiwan and the United States. Soon, or perhaps already, the PLA will be able to hold at risk a wide range of military targets on Taiwan, plausibly challenge the United States and Taiwan for control of the air over the strait, and credibly

threaten the bases for U.S. power projection in the vicinity of Taiwan. This much seems clear.

Whether one sees a "China threat," then, boils down essentially to one's perception of Beijing's intentions. It is not unreasonable to believe that China will seek its foreign policy goals, including unification with Taiwan, peacefully, and will choose not to challenge the U.S. position in the Western Pacific; this is probably the most likely course of events. However, should China's leadership choose, or feel compelled by circumstance, to employ more forceful means to advance their interests, they will have the necessary tools increasingly at their disposal.

The Political Backdrop

Ultimately, the import of all three sides' military capabilities hinges on the evolution of the political relationship between Beijing and Taipei. The cross-strait dilemma is a political dispute with a military dimension, not vice versa, and the ebb and flow of the political relationship will drive the intensity and trajectory of the military confrontation.

As this is written, Ma Ying-jeou's term as Taiwan's president has so far engendered a welcome thaw in relations between China and the island. In April 2008, then vice president elect Vincent Siew met with Hu Jintao—the highest-level contact between Chinese and Taiwanese leaders in many years—and regularly scheduled charter flights from the mainland to Taiwan began in July of that year. In the wake of the Beijing Olympic Games, the situation along the Taiwan Strait appears less "dire" than it has since at least the mid-1990s.

There is, however, no guarantee that this honeymoon will grow into an enduring relaxation of tensions. As discussed in Chapter Two, there are very real limits to how far any democratically accountable leader can steer Taiwan toward China's orbit, and that utmost boundary lies well short of the degree of sovereignty over Taiwan on which Beijing continues to insist as the only and nonnegotiable acceptable resolution of cross-strait affairs. China has not renounced its "right" to use force to prevent Taiwan's "independence," nor discussed amending its antisecession law, nor withdrawn any missiles from the arsenal

of hundreds it has pointed at Taiwan. Just as Ma is constrained by the limits of the possible within the Taiwanese polity, so too are Hu and his colleagues atop the Communist hierarchy. The goal of "reunification" has become a core tenet of China's own politics, and movement away from it could spell trouble for any leadership in Beijing, just as growing too accommodating toward China would be dangerous for Ma or any other leader on Taiwan.

So long as the most Taiwan is willing to give falls well short of the minimum with which China would be satisfied, the cross-strait relationship will remain precarious, uneasy, and uncertain. This means that military factors—deterrence and defense—will remain prominent elements of the East Asian scene, and the United States will find itself remaining entangled in the strategic and operational calculi of the China-Taiwan standoff.

In this final chapter, we recap our findings regarding the three dimensions of the cross-strait military balance addressed in this study and suggest courses of action to help Taiwan and the United States counter the mostly pessimistic trends we identified. Then, we both elevate our point of view and extend our time horizon to discuss some of the longer-term geostrategic implications of our work.

The Fall of Shot: Of Warheads, Wreckage, and Will

As detailed in Chapter Three, China's capabilities have developed to the point that it is capable of mounting very destructive attacks against Taiwan's military infrastructure. As part of a large-scale offensive, the PLA could employ its SRBMs and LACMs to suppress Taiwan's air defenses, permitting attacks by manned aircraft armed with PGMs. The increasing accuracy, warhead variety, and numbers of Chinese missiles would also permit smaller, coercive attacks aimed at specific political, military, or economic targets.

Existing and near-term BMD capabilities are expensive and of uncertain effectiveness against modern ballistic missiles such as the CSS-6 and CSS-7. And, given the large volleys of missiles China will be able to fire, it must be anticipated that these relatively limited

defenses will be overwhelmed, and probably destroyed, in the early minutes of any major PLA attack.[1]

Passive defense measures, such as hardening, camouflage, decoys, jamming, and, for air bases, capabilities for rapid recovery after attack remain valuable, especially in the face of smaller attacks. A China able to launch large missile attacks followed up by sizable air raids will, however, likely be able to inflict significant damage on a number and variety of targets of Beijing's choosing, almost regardless of Taiwan's defensive preparations.

As China's ability to deliver accurate fire across the strait grows, *it is becoming increasingly difficult and soon may be impossible for the United States and Taiwan to protect the island's military and civilian infrastructures from serious damage.* This is hardly surprising, and is rooted in the basic physical and operational reality that, given foreseeable technologies, it is and will remain cheaper and easier to build rockets able to deliver payloads accurately onto a relatively large and stationary target like a runway than it will be to build rockets able to reliably intercept fast-moving miniscule targets, like other rockets.[2]

So what can the United States and Taiwan do? We have two observations.

First, although even the most robust combinations of available active and passive defenses cannot keep China from inflicting heavy damage on Taiwan if Beijing is committed to doing so, they can raise the price of entry. That is, by improving air and missile defenses and moving aggressively to harden and implement other passive measures, Taiwan can substantially reduce its vulnerability to small, selective missile strikes, forcing China to employ fairly large numbers of missiles in even "limited" attacks.

The goal of these investments would not primarily be to save infrastructure or run the PLA out of missiles but to compel Beijing to

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[1] As noted earlier, China has procured a number of Israeli Harpy drones, many of which are likely to be targeted against Taiwan's air defense radars.

[2] The same logic has, to date, held true for nonkinetic defensive technologies, such as directed energy. Should some breakthrough occur in one of these arenas, this forecast would of course merit reexamination.

initiate any hostilities at a fairly high and unambiguous level of violence. By ruling out "onesie" and "twosie" kinds of attacks—which could arguably fall in the grey region between "war" and "non-war," clouding the political situation and perhaps limiting the support forthcoming to Taiwan from its friends, including the United States—a more "robust" Taiwan would confront China with the choice of starting either a fairly big war or no war at all.[3] Removing a number of rungs from the bottom of China's perceived escalation ladder should at least modestly enhance deterrence of *any* attack, and is worth close scrutiny as a strategic option for a Taiwan whose range of choices for protecting itself from Chinese strikes is shrinking.[4]

Second, the absolute magnitude of the missile threat in and of itself to Taiwan should not be exaggerated. Although China appears to be quite proficient in producing capable, modern SRBMs, missiles are an expensive way to deliver high explosives; you can, after all, only use each one once. What differentiates the emerging danger to Taiwan is not just that there are more missiles opposite it; the total "throw weight" of the SRBM force we project in Chapter Three is about 495 tons, or about 21 B-1B loads.[5] While that is a potent capability, it alone may not suffice to degrade Taiwan's defenses sufficiently to either induce capitulation or enable invasion.

What is important about the PLA's SRBMs is their potential to "kick in the door" for follow-on attacks by aircraft, which—assuming that attrition can be kept low—are a fairly efficient way to haul high explosives from point "A" to point "B." As discussed earlier, if China's missiles can suppress Taiwan's air defenses long enough for PLAAF attack aircraft to deliver large numbers of PGMs on shelters, command facilities, and other targets, that period of temporary suppression can

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[3] Or, if China, despite the low probability of success, chose nonetheless to employ small numbers of missiles, the opportunity to choose between a big war and an ineffectual one.

[4] China could employ other "low-end" use-of-force options against Taiwan, such as seizing one or more offshore islands, harassing Taiwan's maritime trade, or making cyberattacks; this report does not address any of these alternatives. Nonetheless, removing small missile attacks from the set of options available at China's disposal would leave Beijing without one of its high cards in a cross-strait crisis.

[5] A B-1B can carry up to 24 one-ton GBU-31 JDAMs.

be converted into permanent destruction and Taiwan left open to bombardment essentially at Beijing's will.

One approach to countering this heightened threat has two components. The first is for Taiwan to follow through on what appears to be a survival strategy for its air force. Elements of this—notably the large, underground hangars for hundreds of fighters that have been constructed at two ROCAF bases—are already in place. Other pieces would include highly redundant or reconstitutable command and control systems, underground storage of and buried distribution systems for fuel, well-protected war reserve stockpiles of SAM radars, launchers and missiles, and so forth. Under this strategy, the arrival of Chinese missiles would find the ROCAF largely hunkered down, shielding itself from the blows as best it can but not sacrificing the bulk of its assets in futile efforts to defend.[6] When the PLA has largely exhausted its SRBM inventory, the ROCAF would emerge at least somewhat intact and prepared to defend the skies over Taiwan in a fairer fight than would have eventuated had it attempted to operate under intense fire.

One obvious Chinese counter to such a strategy would be to make visible preparations for launching a missile barrage, forcing the ROCAF into hiding, then lead with the air attack instead of the missiles. To offset this possibility, Taiwan would need to leave at risk enough defensive capabilities—fighters flying from dispersed strips, mobile "shoot-and-scoot" SAMs—to increase the risks of such a gambit to an unacceptable level.[7]

If such a force-preservation strategy is at least moderately successful, Taiwan's airspace will not be wide open to PLAAF aircraft, which should at least somewhat meter the punishment that China can inflict.[8] In this case, then, the problem is to deal with the 500 or so tons

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6 As our analysis of the air war in Chapter Four showed, China's ability to reduce ROCAF sortie generation to a trickle largely negates its value anyway.

7 As was noted when we examined the effects of varying levels of defense suppression in Chapter Four, highly mobile medium-range air defense systems that could threaten Chinese aircraft at higher altitudes could prove very valuable.

8 In the next part of this chapter, we will discuss an additional option to further reduce China's ability to follow up even successful missile attacks with high-tempo, sustained air operations.

of warheads—the 21 heavy bomber loads—that the PLA's SRBMs can deliver.[9]

Make no mistake, 1,000 half-ton detonations on Taiwan will inflict a meaningful amount of pain, death, and damage. But, it is a relatively small number of weapons compared with the kinds of bombardments experienced by other countries in recent years. U.S. forces expended about 17,000 PGMs in the 43 days of the 1991 Gulf War, an average of nearly 400 per day; against Serbia in 1999, the USAF delivered about 8,500 PGMs, and would have used more had they not been in short supply.[10] Compared against poundings such as these, the weight of fire to which Taiwan would be subjected in the near to mid-term appears substantially less intense, but only if the PLAAF's ability to employ manned attack aircraft against the island can be held down. If China can follow up missile strikes with air attacks, not only will its prospects for invasion be improved, but so will its ability to coerce Taiwan into surrender without an invasion. The force-preservation strategy discussed above is one way to move toward reducing the likelihood of China succeeding in such a campaign.

Unfriendly Skies: New Concepts Needed for New Challenges

Because the ROCAF does not appear operationally survivable in the first few days of a cross-strait war, the battle for control of the air over Taiwan must be considered in a new light.

Basing constraints mean that the United States alone cannot bring enough fighters to the battle to offset both China's quantitative superiority and its narrowing of the qualitative gap. Geography dictates that if the USAF and USMC are pushed back from Kadena, they

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[9] As China's SRBM force grows, this number will of course also increase.

[10] PGM numbers from Cohen (1993, Table 191, pp. 553–554) and Lamb (2002, p. 28). Note that we are not claiming that bombardment with China's SRBMs alone could not possibly compel Taiwan's acquiescence, nor that a campaign the size of Operation Allied Force necessarily would. We are just comparing the relative payload deliverable or delivered in the three cases.

will be hard-pressed to find basing that both lies outside the range of China's SRBMs and is reasonably close to the battlespace. For example, Misawa Air Base in northern Japan is almost 1,450 nm from the centerline of the Taiwan Strait, but only about 550 nm from Chinese territory; the distance to the strait is roughly tripled compared with Kadena, but the added distance between Misawa and China—on the order of 100 nm—is hardly significant.

Nor is it likely that carrier-based aviation could make up for the loss of ROCAF capability, let alone the suppression of Okinawa or a withdrawal to a relatively safe but distant outpost such as Guam. In rough numbers, we would expect a fully operational ROCAF to produce on the order of 650 first-day sorties from its fleet of 317 fighters, not making any allowances for attrition. We assess each carrier deck as putting roughly 50 fighters a day over the strait, again without attrition. Simple arithmetic suggests that to replace lost ROCAF sorties on a one-for-one basis in our base case, where Taiwan manages to generate only 100 sorties on the first day, would require 11 carriers to make up for the 550 "missing" ROCAF sorties.[11] Even if this calculation is pessimistic by a factor of two, meaning only five carriers would be needed to replace the combat power lost due to the ROCAF's suppression, it is still highly unlikely that the U.S. Navy could hope, let alone promise, to have so many on the battle line in the first days of a war.

Superior training, aircraft, avionics, and weaponry can, likewise, only do so much to offset Red's advantage. As a limiting case, look again at the first-day base case sortie totals from Table 4.4. The PLAAF flies 387 sweep and escort sorties, along with another 250 multirole fighters dedicated to attack missions but carrying modern BVR weapons for self-defense. The USAF, meanwhile, flies a total of 20 F-22 missions from Kadena. If *every* F-22 launches *every* one of the eight missiles it carries, and *every* one of those missiles shoots down an enemy fighter, the PLAAF will suffer 160 losses.[12] Sixty percent of the Chinese

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[11] Sortie potential of an undamaged base, less the 20 that each generates in our base case, times the number of bases.

[12] This is about 25 percent per-sortie attrition, which is extremely high, but actually *less* than the 30 percent total loss rate that the PLAAF suffered in our simulation of the first day

fighter sorties and *all* of the roughly 400 ground-attack sorties would survive their encounters with the deadly U.S. fighters and their infallible missiles.

What this means is that *the United States and Taiwan can no longer be confident of winning the battle for the air in the air*. This represents a dramatic change from the first five-plus decades of the China-Taiwan confrontation. Limiting the amount of air-delivered punishment inflicted on Taiwan demands new concepts and capabilities to hold the PLAAF at bay.

One option might be to seek to disperse USAF fighters among a larger number of bases. This may offer the dual advantages of forcing China to use more missiles to suppress land-based combat operations and possibly forcing Beijing to attack bases in countries other than Japan, such as the Philippines and South Korea. On the down side, dispersed basing can substantially complicate logistics and so reduce overall sortie rates. Also, the geography of the region dictates that few, if any, possible bases are as close to the strait as is Kadena, while many are no further from China—leaving them, too, vulnerable to attack.

Another alternative would be to seek to pose the same kind of threat to the PLAAF's bases as the Chinese are presenting to those on Taiwan and Okinawa. Like the Chinese, the United States and Taiwan could seek to use survivable and accurate ballistic missiles to strike Chinese air bases, cutting runways, destroying aircraft parked in the open, and possibly attacking hardened shelters.[13]

What kinds and numbers of forces would be needed to mount such a campaign? Reading from the charts used in Chapter Four to show the necessary size of Chinese attacks on ROCAF bases, we will

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of combat. In that case, of course, the F-22s killed far fewer than 160 Chinese jets, while Marine and USN F/A-18s chipped in, as did those Taiwan fighters that managed to get into the air and those of Taiwan's SAMs that survived the initial onslaught. Those latter systems would likewise claim their share of the hundreds of survivors of the one-sided fight described here, but the majority of the Chinese jets would still reach their targets.

The authors owe the idea behind this example to former RAND colleague John Stillion.

[13] LACMs could be also be employed, especially against shelters. They would likely be more vulnerable to interception than would ballistic missiles, however, so the calculations in this chapter are based on ballistic missiles only.

assume that on average three accurate missiles with runway-penetrating submunition warheads would be needed to cut each runway, and four to six more with appropriate submunitions to blanket parking ramps and open revetments. So, for a typical base with two runways, on the order of 10–12 arriving weapons at each could be enough to severely impede or possibly stop high-tempo combat operations for a period of hours to days. Allowing for missile reliability, we will notionally target 15 at each base.

We used multiple open sources to identify possible fighter bases in China's Guangzhou and Nanjing military regions, the two opposite Taiwan.[14] Using these assessments and Google Earth imagery of each base, we identified approximately 40 installations where Chinese fighter or attack aircraft appear to be based, or that appear capable of accommodating fighters (e.g., have revetments or shelters). Firing 15 weapons at each base would require at total, then, of 600.

As we have seen, ballistic missiles offer substantial advantages as anti-air-base weapons; they fly quickly, are very hard to intercept, and the high terminal speed of the warhead imparts a helpful dose of kinetic energy to penetrating submunitions such as the ones used to crater runways.

Currently neither the United States nor Taiwan fields a missile with the appropriate characteristics. The U.S. Army Tactical Missile System (ATACMS) has too short a range, and the Tomahawk Land Attack Missile (TLAM) may not be survivable enough against the air defenses that China would likely deploy in the regions from which it would be fighting a cross-strait war. While Taiwan is reported to be developing its own LACM, the numbers usually ascribed to the program—around 300 missiles—are probably not enough to undertake a serious campaign aimed at suppressing China's fighter force ("Taiwan to Produce 300 Hsiung Feng IIE Cruise Missiles," 2008).

The United States has in the past, however, deployed missiles with characteristics similar to those called for by these kinds of attacks. Nearly 300 U.S. Army Pershing 2s, for example, were deployed in Europe in the 1980s. These missiles had a range of around 1,000 nm

[14] The two most complete sources appear to be Wikipedia (2009e) and Kopp (2007).

and featured a very accurate MaRV warhead. Given the technological advances since the Pershing was developed more than 30 years ago, it certainly seems that a new MRBM-class weapon could be developed that would be able to reach most of the fighter bases in the Nanjing and Guangzhou military regions from U.S. bases on Guam or other islands in the Marianas.

The programmatic and political implications of this concept cannot be ignored. If the United States wanted the capability to launch multiple waves of missiles against Chinese bases, or wanted the option to employ the weapon against other targets in China (for example, SRBM bases), many more than 600 missiles would be required. To protect them against preemptive attack, a survivable basing mode, such as hardened silos, would be needed, adding to the costs. Submarines might also be a deployment option.[15]

Politically, the Intermediate-Range Nuclear Forces (INF) Treaty of 1988 prohibits the United States from deploying missiles with ranges between 500 and 5,500 km, which would include this hypothetical missile. While Russia has recently threatened to unilaterally withdraw from the INF agreement, a decision by Washington to do so would be problematic, to say the least (de Nesnera, 2007). And, of course, the decision to attack Chinese territory on the scale contemplated here would be fraught with escalatory risks. However, if Beijing executes an attack of the kind we have depicted—plastering air bases on Taiwan and Okinawa (and in the future, perhaps Guam)—the United States might have little choice but to try to slow China's sortie production to a similar extent to restore some balance between the two sides' air forces.

An important datum in this regard is how the Chinese would perceive any attacks they might launch at U.S. bases in Japan or

[15] If the history of the submarine-launched and intercontinental ballistic missile forces is any guide, land basing may prove to be less expensive than deploying the missiles aboard submarines (assuming that new subs would need to be procured to accommodate both the weapon and the mission). The United States would also want to be quite confident that Beijing would, in the stress of an ongoing war, be able to reliably discriminate between the launch of a nuclear-armed submarine-launched ballistic missile and that of a conventional one.

Guam. Does Beijing see these as crossing an escalatory line that could legitimize large-scale U.S. attacks on parallel targets (e.g., air bases) in China? Making clear to the Chinese, through declaratory policy and force development, our belief that any such attacks would represent crossing a very bright red line in terms of permitting counterforce attacks on the Chinese homeland, may be important in shaping the escalatory dynamics of any crisis and to enhancing the overall deterrence situation on the strait.

And, finally, it is hard to predict how China would respond to such a U.S. move. Would it seek to proliferate fighter bases, deploy missile defenses, or move away from a dependence on fighter-bombers to emphasize other means of threatening Taiwan? We can offer no insights except to say that China *will* react, and thinking through how follow-on moves might play out would be important before proceeding with any counter to China's growing power.

Other concepts that exploit existing or programmed systems to suppress PLAAF sortie generation may be possible; for example, extended-range JASSM missiles could be fired from USAF bombers against at least some Chinese bases. While less survivable than ballistic missiles, the stealthy JASSM should be more able to penetrate Chinese air defenses than TLAMs.[16] The weapon is already planned, and no treaty limits its numbers or use.

What should be taken away from this discussion is not that the United States (or Taiwan) should embark immediately on a program to deploy many hundreds of missiles, whether land-based or air-launched, with which to threaten the Chinese air bases that in turn threaten Taiwan. We have not done detailed operational analysis to precisely estimate the necessary characteristics of such weapons, nor the needed numbers, and the political and budgetary consequences of fielding such

[16] The range of the JASSM-ER is reported to be "more than 500 nm," meaning that it could not reach a number of PLAAF fighter bases if launched sufficiently far from the Chinese coasts to afford protection to the launching platform. A variant that could be launched from U.S. Navy guided-missile submarines (SSGNs) could both increase the "reach" of a JASSM-based force and augment the numbers that could be fired in an initial wave. No such version is planned, to the best of the authors' knowledge. On the range of JASSM-ER, see "$21.1M for 12 JASSM-ER Test Missiles" (2007).

a force, let alone employing it, would be severe. Nor can we predict what strategic, operational, and tactical countermoves Beijing might undertake in response any U.S. initiative like this. The main point here is that, *absent new concepts and capabilities that may or may not be fiscally or politically feasible, the United States and Taiwan can no longer count on controlling the air over Taiwan or the strait*. This state of affairs is very different from that which has prevailed in the past, and creates a new need to explore how a Chinese invasion attempt might be countered in circumstances where the skies are not open to unconstrained Blue operations.

On the Beach: Defeating a Chinese Invasion

The first and probably most important effects of the loss of air superiority would be felt by U.S. and Taiwanese ISR assets. Manned and unmanned platforms—AWACS, JSTARS, P-3, E-2, Global Hawk and similar aircraft—are needed to locate, identify, track, and target any Chinese warships or amphibious forces in the strait. These invaluable aircraft are extremely vulnerable to enemy fighters and SAMs, and can safely operate only in areas where friendly control of the air is virtually assured. Because of the new shape of the air war over the strait, these secure operating locations will likely be pushed sufficiently far eastward to make uninterrupted coverage of the strait difficult or even impossible by these classes of platforms.

Further, large U.S. and Taiwanese surface vessels operating in the strait will be at great risk from both Chinese submarines and air attack, making them unreliable as both intelligence and antisurface warfare assets. Large, fixed radars ashore will be among the high-priority targets for China's initial missile attacks, and will likely be disabled or destroyed in the opening minutes of any large-scale war.

If the United States and Taiwan cannot rely on having continuous, high-quality ISR coverage of the strait, counter-invasion strategies that rely on precise and timely information about the invasion fleet will not be robust. Nor, probably, will plans that envision the rapid movement of large ground-force units from one place to another on Taiwan,

given the extent of damage that could be inflicted on Taiwan's military and transportation infrastructures by Chinese missile and air strikes.

Maintaining a viable counter-invasion defense in the face of these obstacles will not be easy, but—unlike the situation with the fight for air superiority—we believe it can be done via concepts that employ existing systems, though perhaps in new ways.

We argued in Chapter Five that small, mobile, short-range surface-to-surface missiles of the RBS-17/Hellfire class and longer-range ASCMs launched from survivable platforms could, if deployed in adequate numbers, take a substantial toll of China's amphibious fleet. Those ships that do make it to shore to unload could be engaged by any weapon capable of attacking a stationary target that could reach the landing zones within the time frame—tens of minutes to perhaps two hours—that each large assault vessel spends unloading.

Besides the Hellfire-type missiles already described, these include standoff weapons, such as JASSMs or SLAM-ERs launched by bombers and other platforms kept on station outside the most threatening envelope of Chinese fights and SAM defenses. Even if, say, 75 percent of each wave of 20 Chinese amphibious vessels made it ashore, only 30 or so JASSM-class weapons—roughly two full B-1 loads—would be needed to fire two at each ship. A single hit with the 1,000lb JASSM warhead would likely seriously damage any amphibious vessel.

Finally, those Chinese troops that did make it safely ashore could be attacked with a wide array of direct and indirect fire weapons. The key for the defender in this phase of the operation would be have in place at the start of hostilities the troops, weapons, and stockpiles needed to fight this battle, since movements of large formations of troops and major resupply efforts will be greatly complicated if China can seize air control. Ideally, these stockpiles and weapon positions would be concealed and hardened to increase their survivability in the face of Chinese attacks.

Broadening the Scope: Implications for Other Scenario Variants

As we noted earlier, the analysis presented here focused on just one particular scenario, the "quick victory invasion." We believe this scenario fits well with what is known of contemporary Chinese strategic thinking and military doctrine; however, there are several other ways for conflict to erupt across the Taiwan Strait. Can our findings speak at all to any of these contingencies?

Beijing has several coercive options that involve the exertion of minimum military force, such as cyberattacks on Taiwanese infrastructure or a quarantine of shipping flowing to and from the island. Except to the extent that the effectiveness of these options ultimately rests on China's ability to back them up militarily, our work has little relevance to these cases.

As we move up the continuum of violence, things change some. Consider a prolonged coercive bombardment of Taiwan. We noted earlier that improved active and passive missile defenses could limit China's ability to seek leverage from very limited attacks with a handful of SRBMs. If nothing else, the mainland would exhaust its inventory of missiles more rapidly were it forced to launch four or five SRBMs to reliably get one or two through to their targets. Assuming that Taiwan's supply of interceptors is adequate and that Taiwan remains resolute, this approach may prove unsuccessful.[17]

Move, then, further up the continuum of violence, to a strategy that resembles that used by the United States in multiple conflicts dating back to World War II. This approach would involve heavy, sustained bombardment of Taiwan's military and economic infrastructure, intended to compel capitulation. If and only if these attacks fail to achieve their ends would China undertake a well-prepared invasion against opposition that the PLA would expect to be weakened past

[17] Given that theater missile defense systems such as Patriot are expensive, they are being produced in fairly limited quantities, as are the interceptor missiles themselves. It is highly unlikely, therefore, that Taiwan could be resupplied with any useful numbers of radars, launchers, or even missiles in the time frame relevant to any reasonable cross-strait scenario (days to a few months).

the point of credibility by the weeks or months of pounding it had absorbed.

A campaign like this would likely begin in a manner very similar to the "QVI" scenario we present: with heavy missile and air attacks aimed at gutting Taiwan's air force and air defenses. In this situation, however, the payoffs to China from also preemptively attacking U.S. bases appear less clear.

In the QVI case, immediate and effective U.S. intervention could jeopardize China's ability to rapidly defeat Taiwan's defenses and open the way for PLA troops to quickly occupy the island. This slower-moving scenario, on the other hand, offers Beijing an opportunity to wait and see how the United States responds before committing itself to fighting the superpower. If the United States displays "hostile intent"—as defined by the Chinese leadership—its bases on Okinawa would be as vulnerable some hours or days into the conflict as they were at H-hour.[18] And, if China's initial attacks on Taiwan truly cripple the island's defenses, Beijing could hope that the United States would ultimately choose not to engage a powerful adversary in what might appear to be already a lost cause—provided it had not already been attacked.

A more prolonged "softening up" campaign could also help China by wearing down the mobile or hardened anti-invasion capabilities that we discussed in the previous chapter. It is one thing to hide for a matter of hours or days while retaining the ability to respond rapidly to an attack; over weeks or months, China could expect to inflict some attrition and further diminish Taiwan's ability to defend itself.[19]

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[18] In the future, U.S. bases further afield, such as Guam, could be *more* vulnerable days into the conflict than at the outset if China used the time before U.S. intervention to deploy, e.g., submarines with LACMs to their vicinity.

[19] This would be especially true if China has managed to cut off resupply to Taiwan, either by blockading the island or attacking its seaports and civilian airports.

The Tyranny of Distance and the Longer Term

In the near to mid-term, then, we conclude that:

- China's ability to suppress Taiwan and local U.S. air bases with ballistic and cruise missiles seriously threatens the defense's ability to maintain control of the air over the strait.
- Restructuring Taiwan's air defenses to "ride out" heavy strikes on its bases and other installations can complicate Chinese planning and reduce the leverage Beijing can derive from its SRBM force and growing fleet of modern fighter-bombers.
- Regaining the initiative in the air may require that the United States and/or Taiwan field a new, expensive, and politically problematic suite of strike capabilities aimed at China's own air base infrastructure.
- Making clear to Beijing the consequences of attacking U.S. bases and forces in East Asia in terms of counterstrikes on the Chinese mainland could enhance deterrence.
- A reasonably robust "four rings" defense against a large-scale Chinese invasion should be possible even with a degree of PLA control of the air, but it will require new capabilities and concepts to be put in place.

This is clearly a much less optimistic picture than was painted by our 2000 assessment, and it poses hard strategic, operational, and programmatic decisions to both Washington and Taipei. It obviously does not bode well for the future stability of the situation along the Taiwan Strait.

In the longer term, the United States and Taiwan may confront an even more fundamental strategic dilemma, one inherent in the basic geography of the situation. Taiwan lies only a few hundred miles from the military might of the PLA; Taipei, meanwhile, is about 1,500 nm from the nearest U.S. territory, Guam; it is nearly 4,400 nm from Honolulu, and about 5,600 nm from the West Coast of the United States. *This geographic asymmetry, combined with the limited array of forward basing options for U.S. forces—and China's growing ability to*

mount sustained and effective attacks on those forward bases—calls into question Washington's ability to credibly serve as guarantor of Taiwan's security in the long run.

The parallels to a Western Hemisphere example may be instructive. Havana is about 205 nm from Miami; it is roughly 5,200 nm from Moscow. Cuba during the Cold War was thus in a situation broadly analogous to Taiwan's today: It was a long way from its patron and uncomfortably close to its adversary. That disparity played out most dramatically in 1962, when U.S. dominance of the Caribbean posed a conventional threat to Cuba that the Soviet Union could offset only with nuclear threats. Throughout the years of East-West confrontation, West Berlin was in similarly precarious straits, particularly up to and through the construction of the Berlin Wall in 1961. Crises revolving around actual or feared Soviet threats to the city were a periodic feature of the Cold War in the late 1940s, 1950s, and early 1960s.

In the cases of both Cuba and West Berlin, the defending superpower's ability to mount a credible conventional defense was very limited. Under those circumstances, the security of each side's outpost came to be seen as dependent on it being folded into the broader set of extended deterrent commitments made by Washington and Moscow, which in turn ultimately rested on each side's asserted willingness to risk nuclear conflagration in defense of its interests.

Is this the future of the U.S.-Taiwan security relationship? If China's military power continues to grow and a permanent solution to the China-Taiwan imbroglio remains elusive, this question could take on increasing salience. Is the security of Taiwan of sufficiently great importance that the United States would be willing to rely not on a decreasingly credible conventional deterrent, but instead on the threat that any attack on Taiwan would risk a broader, more dangerous conflict between China and the United States? If not, then where will Washington be willing to draw the line should China seek to expand its sphere of influence in East Asia? The Philippines? Korea? Japan? With another decade of improvements in the PLA like what has been seen in the past ten years, these issues may become troubling indeed for the U.S. leadership.

In raising these questions, we do not mean to endorse one answer or another, nor to imply that Beijing has or will develop any sort of hegemonic appetite regarding East Asia. We do want to suggest, however, that a China that is conventionally predominant along the East Asian littoral could pose a direct, difficult, broad, and enduring challenge to the U.S. position as guarantor of regional stability and security, a challenge that could extend well beyond Taiwan.

A Question of Balance: Maintaining Equilibrium on the Strait

It is at least a little paradoxical that, at a time when the cross-strait political dynamic is more placid than anytime in 15 or so years, the military balance should be assessed as increasingly problematic for Taiwan's defense. Beijing appears to be building the PLA needed to support a range of military options against Taiwan at the same time that it seeks, through diplomacy and economic interaction, to render such a conflict unnecessary. The two efforts are not unrelated.

It is probably worth noting that relations between China and Taiwan seem subject to rapid and dramatic changes in tone and trajectory. A DPP comeback in the next election cycle—motivated by increased fears of China, perceptions of corruption or ineffectiveness in the Ma administration, or other factors—could upset the apple cart. A political or economic crisis in China could impair the legitimacy of the Communist leadership, which might then seek to burnish it nationalist credentials by adopting a more forceful attitude toward Taiwan. The improvements in China's military capabilities, meanwhile, show no signs of slowing and, in any event, will not reverse themselves in the policy-relevant future. So, the problem of defending Taiwan will remain an important one for U.S. defense planners and security strategists.

What this study suggests is that those plans and those strategies may, in the coming years, need to be less about decisively defeating Chinese attacks on Taiwan than increasing the perceived costs to China of waging such attacks. By hardening and protecting key military, government, and perhaps even economic sites, Taiwan can render

small-scale missile and air attacks unlikely to succeed, forcing China to commit early on to waging a major conflict versus pursuing a carefully calibrated coercive strategy. By deploying its air and air-defense forces so as to mount a minimal but credible early defense while preserving the bulk of combat power for use when China's SRBM force has been exhausted, Taiwan can make rockier the PLAAF's road to lasting air superiority.

For its part, the United States could invest in hardening its air bases in the area—primarily Kadena and Iwakuni—to make them more robust in the face of Chinese bombardment. This would include building sufficient shelters to protect all the fighters at the two bases (thus preventing China from destroying dozens of U.S. aircraft parked in the open), hardening other mission-critical capabilities (e.g., fuel stocks), and ensuring that adequate personnel and resources are available to repair damaged operating surfaces. And by developing a credible capability to threaten a range of targets on the Chinese mainland, especially air bases, the United States can hold at risk critical PLA power-projection assets. This would add a powerful weight to U.S. side of the deterrence equation, not only in a cross-strait confrontation but also in future scenarios wherein Tokyo, Seoul, or other critical U.S. friends and allies might be threatened by the emergence of not just a more powerful China, but a more ambitious one, as well.[20]

The situation in the Taiwan Strait, then, can be seen as a possible prelude to a broader challenge to the United States in East Asia that might emerge in the next 10–20 years. As with almost every question impinging on Sino-U.S. relations, these are questions of balance. The United States and its allies must continue to pursue a strategy that simultaneously hedges against Chinese military might while engaging and enmeshing Beijing in networks of political, economic, and human ties that, it may be hoped, will eventually render that strength anachronistic. As China's military power grows, the price tag associated

[20] We are not predicting that a more "expansionist" China is certain to arise, or even that this is particularly likely. However, a successful hedging strategy will endeavor to cover down against even unlikely future developments, provided the consequences for being unprepared are large and the cost of insurance is proportionate to the risk.

with this hedging policy will likewise go up. But the present Taiwan dilemma also raises an important question of long-term geopolitical interest: What roles should and can the United States seek to play in an East Asian landscape that includes an economically vibrant, militarily powerful, politically unified, and self-confident China? Looking at Taiwan and beyond, what is the new equilibrium in East Asia, and how can the forces at work there be managed to make that equilibrium tolerable to the United States? That, indeed, is the ultimate "question of balance" posed by any examination of the growing imbalance of military power across the Taiwan Strait.

APPENDIX

Missile Attacks on Economic Targets on Taiwan

China's missiles could be used to coerce or punish Taiwan by attacking a broad range of military and civilian targets on the island. Targeting Taiwan's economy is one potentially attractive option for the PLA.

A thorough assessment of the possible effects of the full range of possible missile attacks against Taiwan's economy is a far broader undertaking than this study can attempt, as is any attempt to formulate "optimal" economic attack options for the Chinese. But, we wish to illustrate, at least to first order, the kind of damage that China could inflict. To do so, we examined how ballistic missiles might be used to strike at a core component of Taiwan's economy, the semiconductor industry.

Attacking the "Silicon Island"

The semiconductor industry is a major engine of Taiwan's economy. In the second quarter of 2007, the revenue of Taiwan's varied integrated circuit industries was $11.3 billion, roughly one-fifth of total global revenues for the IC industry (Taiwan Semiconductor Industry Association, 2006).[1] It is estimated that, in 2006, revenues for Taiwan's IC fabrication sector alone amounted to over $22 billion, or about 6 percent of Taiwan's GDP. In 2007, Taiwan ranked second in the world in semiconductor manufacturing, accounting for 18 percent of all pro-

[1] All figures are in then-year dollars.

duction (Taiwan Council for Economic and Planning Development, 2008).

The capital assets of the IC fabrication industry are concentrated in a relative handful of fabrication plants, or "fabs." Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest chip "foundry," has eight fabs in Taiwan.[2] Its recent plants have cost up to $3 billion to build, and next-generation "giga-fabs" being constructed may have price tags triple that (Manners, 2007).[3]

TSMC's Fab 12, which is also the corporation's headquarters, is shown in Figure A.1. Fab 12 is located in Hsinchu Science Industrial Park, which contains five other TMSC fabs as well as numerous plants and facilities belonging to other high-tech companies. Taiwan has established eight such "science parks," focusing on various modern economic sectors, including the semiconductor, optoelectronic, and biomedical industries. Each represents a large concentration of economic and technological value and enormous public and private capital investment. As such, they could be enticing targets for a Chinese coercive campaign.

As the figure shows, semiconductor fabrication plants are very large buildings. The heart of each is the "clean room" in which the actual manufacture of the chip "wafers" occurs. These "rooms" are actually huge spaces, covering up to 200,000 ft^2 (18,590 m^2), often spread across several floors.[4] A warhead that penetrated a fab's clean room could render useless billions of dollars of precise fabrication tools and essentially destroy the facility.

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[2] A "foundry" manufactures chips designed by other firms, which are themselves often referred to as "fabless" enterprises. TSMC helpfully provides the GPS coordinates for each of its facilities on its public Web site.

[3] In 2005, it was reported that TSMC was considering building a new "giga-fab," whose cost was estimated at $7.5 billion (Fabtech, 2005). Intel, Samsung, and TSMC recently announced that they intend to begin migrating to a new, larger wafer size in 2012; sources have speculated that these "450mm" fabs could cost up to $10 billion each (Intel, 2008; LePedus, 2006).

[4] As a point of comparison, an American football field (including the two end zones) covers 57,600 ft^2 (5,358 m^2).

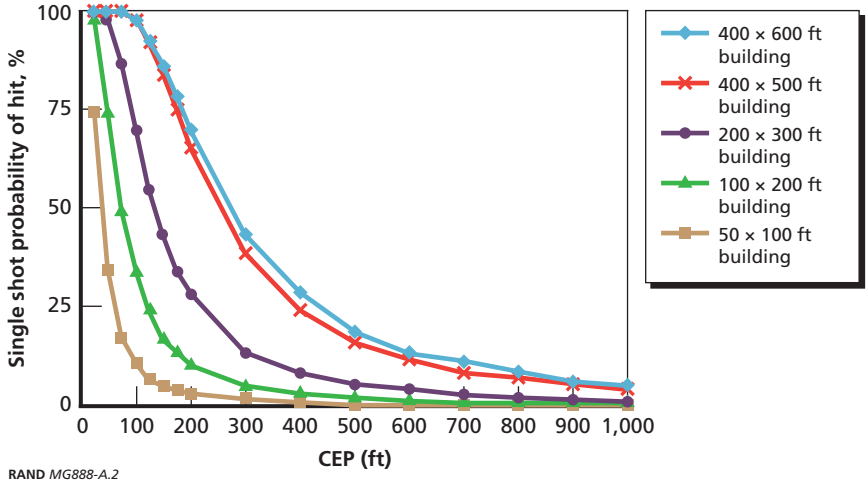
Figure A.1
TSMC Fab 12, Hsinchu Science Industrial Park, Taiwan

SOURCE: Taiwan Semiconductor Manufacturing Co., Ltd.
RAND *MG888-A.1*

We used a simple stochastic model to determine the destructive potential of ballistic missiles against buildings of various sizes; we considered the same representative missiles used in the air base attack analysis, but assumed a 500kg (1,100lb) unitary warhead instead of submunitions. As with our analysis of the attacks of air base hangars, a weapon must actually hit the building in order to be effective; that is, we assumed that near misses had no effect on the fab, a conservative assumption from the attacker's point of view.

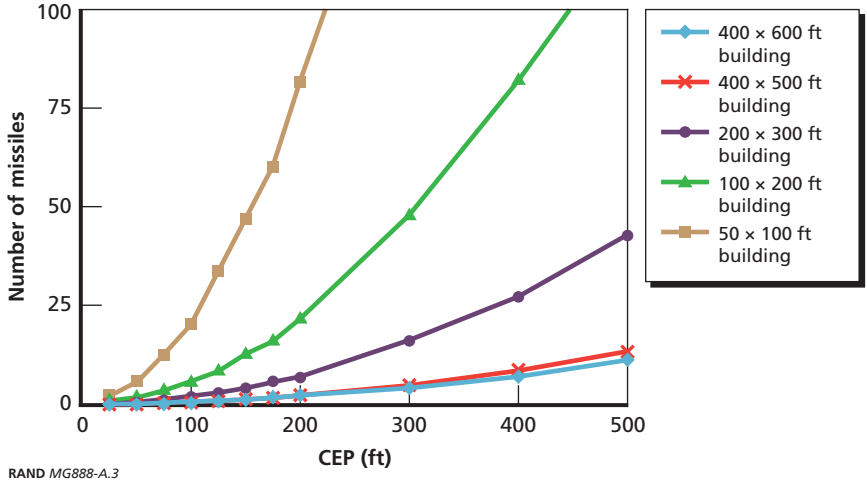
Figure A.2 shows the probability that a single missile with a given CEP will hit a building of various sizes, while Figure A.3 shows the number of missiles required to achieve a 90 percent probability of hit against these buildings. To provide some context, TSMC Fab 12 is roughly 155 x 120 m (510 x 390 ft), over 6.5 times the size of the largest hangar we considered in Chapter Three.

Figure A.2
Single-Shot Hit Probability Against Rectangular Buildings



RAND *MG888-A.2*

Figure A.3
Number of Missiles Required to Achieve a 90 Percent Probability of Hit Against Rectangular Buildings



RAND *MG888-A.3*

Given that China's SRBMs have shown steady improvements in accuracy, it is probably useful to focus primarily on the effectiveness of weapons with CEPs of 60 m (200 ft) or less. Only two or three 12m (40ft) CEP missiles are needed to have a very high probability of hitting a fab-sized target. The number required increases rapidly as accuracy falls, but for the very largest building, such as the "giga-fabs" that dot Taiwan's "science parks," the number needed remains reasonable even for CEPs on the order of 60 m (200 ft). An enormous amount of capital investment and economic activity can be held at risk with a relative handful of ballistic missiles.

There would, of course, be risks associated with attacking fabs, or most other economic targets. Even normally accurate missiles can "go stupid" and miss their targets by large distances. Taiwan's science parks include or border on residential areas, commercial districts, schools, and the other appurtenances of modern communities. A missile aimed at a fab that instead struck, say, a kindergarten or hospital could produce effects on Taiwan and world opinion quite contrary to those desired by the Chinese leadership. Even a strike that was successfully limited to its intended targets could cause unintended casualties and environmental damage due to the release of the toxic gases and caustic liquids that are used in semiconductor manufacturing.[5] These are factors that the Chinese leadership would need to take into account when deciding whether or not to pursue the kinds of attacks described here. What seems to be unquestionable is that they possess the destructive means to successfully carry out such strikes should they choose to.

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[5] These issues can be ameliorated, if not avoided, by employing weapons that are more accurate and reliable than ballistic missiles. Once Taiwan's air defense was sufficiently degraded, PLAAF attack aircraft armed with PGMs could be used to selectively attack economic targets. That these weapons could also be employed against facilities both smaller and more damage-resistant than unreinforced industrial buildings would open up a wide variety of economic targets to Chinese planners.

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