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THE BALANCE OF THE ROK AND NORTH KOREAN GROUND FORCES

by

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Since the ROK and North Korea stand face to face in the Korean Peninsula, there has been constant concern about the risk of war. In this situation, prevention of war on the Korean Peninsula is much more important than anything else. It is feasible when the balance of conventional military forces is kept. The purposes of this thesis are to compare each side's ground forces as major military strength, to develop the ROK ground force structure planning for ground force balance of the ROK against North Korea, to identify the important factors for reinforcement of ground forces in wartime, and to present the Combat models considered for the Korean Peninsula. In addition to those it proposes the U.S. presence in Korea and the improvement of early-warning capabilities.

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The Balance of the ROK and North Korean Ground Forces

by

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requirements for the degree of

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ABSTRACT

Since the ROK and North Korea stand face to face in the Korean Peninsula, there has been constant concern about the risk of war. In this situation, prevention of war on the Korean Peninsula is much more important than anything else. It is feasible when the balance of conventional military forces is kept. The purposes of this thesis are to compare each side's ground forces as major military strength, to develop the ROK ground force structure planning for ground force balance of the ROK against North Korea, to identify the important factors for reinforcement of ground forces in wartime, and to present the Combat models considered for the Korean Peninsula. In addition to those it proposes the U.S. presence in Korea and the improvement of early-warning capabilities.

TABLE OF CONTENTS

LIST OF TABLES

I. INTRODUCTION

The Korean peninsula is critical to regional and global peace and security. Since the Korean War it has been an arena of military confrontation between the Republic of Korea (ROK) and North Korea. With a total of about 1.5 million North Korean and ROK's troops facing each other across the four kilometer-wide demilitarized zone (DMZ), the possibility of renewed conflict is ever present. [Ref. 1: p. 35]

This thesis[1] compares each side's military strength as measured by its ground forces, to develop the ROK ground force structure planning, to identify the important factors to ground forces in wartime, and to present the Combat models which would apply on the Korean Peninsula.

A. BACKGROUND

At the 1943 Cairo Conference, a joint statement was made by Franklin D. Roosevelt, Chiang Kai-shek, and Winston Churchill declaring that after the surrender of Japan, Korea would become free and independent--in due course. This was reconfirmed by the 1945 Potsdam Declaration, and subsequently by the Soviet Union, which declared war on Japan. At the 1945 Yalta Conference, however, the leaders of the United States, Great Britain, and the Soviet Union reached a secret agreement which included dividing the Korean peninsula at the 38th Parallel to facilitate in the disarming of Japanese forces.[Ref. 2: p. 409]

In accordance with the Yalta agreement, the Soviet Union promptly dispatched forces to the area north of the 38th parallel and established a military government which eventually helped to solidify the North Korean Communist regime. The United States forces moved into South Korea and established another military government. However, the United States still claimed that the 38th Parallel was not a political demarcation, but a temporary expedient to facilitate military operations. When the initial efforts to reunite Korea failed, a conference of foreign ministers convened to settle the matter. [Ref. 3: pp. 97-104]

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1 I learned about each side's military organizations when I attended the Korea Military Academy. However, I was not aware of the extent of each side's total military strength. As a consequence of this thesis effort my knowledge base has been sustantially enhanced. Hopefully, readers of this thesis will also benefit from it.

An agreement was reached stating that Korea would become independent after five years under the joint trusteeship of the United States, Great Britain, the Soviet Union, and China. Under the auspices of this agreement, a joint commission of the United States and the Soviet Union was convened in Seoul in March 1946 to assist in establishing a unified government for Korea. When these efforts failed, the United States decided to take the matter to the United Nations.

The United States adopted a resolution on 14 November 1947 which called for general elections under the supervision of the United Nations Commission. Elections were held on 10 May 1948 in South Korea only, because the Soviet military commander refused the U.N. Commission access to North Korea. On 15 August 1948, the Government of the Republic of Korea was inaugurated with Syngman Rhee as its first president.

North Korea countered with its own elections on 9 September 1948, establishing the Government of the Democratic People's Republic of Korea. [Ref. 4: pp. 170-71]

As said above, the division of Korea had its origins in the conclusion of World War II and the incipient Cold War between the United States and the Soviet Union. The Korean War (1950-1953) hardened the division and left the military confrontation between the Republic of Korea and North Korea.

Despite the bitterness of the division, reunification of the peninsula remains the proclaimed objective of both Korean governments.

North Korea's isolation and unpredictability add significantly to dangers on the peninsula. Kim, Il Sung, the regime's all powerful leader, has since 1945 laid exclusive claim to the mantle of Korean nationalism and made unification, through force if necessary, the dominant objective of the North Korean state. Short of war, North Korea has constantly sought to destabilize the ROK. Most dramatically, North Korean agents attempted in October 1983 to assassinate the ROK President while he was visiting Rangoon, Burma. Several ROK officials were killed, including four cabinet members. North Korea's unpredictability also reflects the fact that it is one of the most closed and controlled societies in the world. At least as long as Kim, Il Sung is in power, North Korea poses a threat to the ROK which cannot be dismissed.[Ref. 1: pp. 36-7]

One of the key defense goals for the Republic of Korea is to deter, or if necessary counter with military forces, an attack of North Korea. With a balance of forces, if the two sides mutually perceive the balance, then war should not occur in the Korean Peninsula. Although all of the military forces--ground, air, and naval--on each side affect the overall balance, this thesis focuses on ground forces. North Korea will use the ground forces as the major means of invasion. This is because ground forces are the area of greatest concern to the ROK. That is why any war on the Korean Peninsula is likely to be dominated by ground forces. This thesis examines total ground forces of each side, then it identifies and develops factors which influence conventional balance of ground forces in wartime.

B. THESIS OBJECTIVES

At present, the fact that North Korean forces are deployed offensively heightens the risk of war on the peninsula and threatens the Republic of Korea. Sixty-five percent of the North's forces, including large numbers of tanks and artillery, are dug in within about 40-miles of the border. North Korea is also believed to have twenty special forces brigades that could be quickly dropped behind ROK lines. As a result, the warning time of an attack on the ROK could be very short. The danger of this situation for the ROK lies partly in the fact that one-third of the ROK's population is within 25-30 miles of the demilitarized zone (DMZ) and that much of its industry is located in Seoul. [Ref. 1: p.37]

Standing face to face the ROK and North Korea in the Korean Peninsula, there has been constant concern about the risk of war between the ROK and North Korea. For over 30 years the Korean Peninsula has one of the few geographic areas in the world where the highest state of readiness has been sustained. Full scale hostilities could be initiated by North Korea in a matter of hours.

In these situations, prevention of war on the Korean Peninsula is more important than anything else. It is possible when the balance of conventional ground forces is kept. So, this thesis provides a quantitative assessment of the current balance of the ROK and North Korean ground forces and some force structure planning issues for ground force balance of the ROK against North Korea. Then it identifies the important factors for reinforcement of ground forces in wartime in the Korean Peninsula. In addition to those factors, Dynamic models are developed and considered for use on the Korean Peninsula.

C. SCOPE, LIMITATIONS AND ASSUMPTIONS

The comparison of the ROK and North Korea is made in terms of their military strength. The ground forces are especially focused upon. The combat aircraft in each side's air force is considered on the basis of close air support capabilities for ground forces. Naval forces are not considered. This is because each side's major forces are ground units and because this thesis is limited to the ground forces.

Comparison between each side is made according to recently declassified data from military reports. Each side's weapons are compared according to the written weapon system data. Among these weapons are those considered which William P. Mako presented in the book "*U.S. Ground Forces and the Defense of Central Europe*" published in 1983 by the Brookings Institution. [Ref. 5: pp. 114-25]

The quantity and quality comparison of each side's weapons may be a little different from the actual quantity and quality. Therefore, this thesis assumes that each side's weapons function normally when North Korea breaks out war, that North Korea does not break out chemical, biological and radiological warfare (CBR warfare), and that North Korea initiates full scale hostilities. It's also assumed that each side's forces are applied to constant marginal productivity, that is, more weapons of any kind continue to provide the same capability as the first such weapon. This assumption is in favor to North Korea because North Korea enjoys advantage in the quantities of weapons against the ROK.

D. METHODOLOGY

Any number of static indicators can be used to compare the combat potential of ground forces. These include numbers of divisions, total ground manpower, manpower in major combat (divisional or brigade-sized) units, weapons counts, and such indexes as armored division equivalents. But any single static indicator is not wholly satisfactory. Single division counts are criticized on the grounds that the divisions of different armies - even if of the same type - normally differ in size, organization, and combat potential [Ref. 6: pp. 92-3]. Lucas Fischer, of the Arms Control and Disarmament Agency, maintains that "total manpower is not a particularly useful measure because different countries count ground personnel differently and allocate them differently between combat and support roles." [Ref. 7: pp. 7, 15]

Comparative counts of tanks, artillery, missiles, and so forth have been criticized for ignoring the potential interactions among different categories of weapons. This shortcoming has inspired the development of indexing methods that reduce opposing forces to a common basis for comparison. The Static method for static comparisons used in this study is based on weapon effectiveness indices (WEI) and weighted unit values (WUV), which can alternatively be expressed in terms of armored division equivalents

(ADEs).[2] This Static method is developed in the next chapter. To identify and develop some major force structure planning issues while using the Static method, Cost-Benefit analysis is considered.

The Static method considers only the total of forces available to each side at a given time and it does not acount for the progress of fighting or combat losses on either side. After the war starts, numerous operational factors interact over time, the prospects for coventional defense cannot accurately be measured by a mere static comparison of opposing weapon inventories. Dynamic assessments are more appropriate measures since warfare is a dynamic process. Dynamic methods, which attempt to model the progress of a battle and reflect combat losses, are discussed more fully in chapter 3.

E. ORGANIZATION

The thesis consists of 4 main chapters. Chapter I states the thesis's background, objective, scope, limitations, assumptions, and methodology.

Chapter II examines the static balance of ground forces between the ROK and North Korea. In Chapter II, existing ground force structures are compared, and the likely purpose of North Korean forces is identified. Then, the Static method for static assessment of each side's ground forces is evaluated and a recently developed force capabilities of each side is evaluated. The conclusion for this chapter identifies and develops force structure planning issues for the ROK ground forces.

Chapter III examines availability of forces which affects the ground forces and presents Dynamic models. The limitations of the Lanchester model in the Korean Peninsula are discussed and the Epstein model is developed. Basic parameters for the Dynamic model are considered.

Finally, based the preceding research, this thesis is concluded by proposing the U.S. Armed Force presence in Korea for the prevention of war, the improvement of early-warning capabilities to avoid the surprise attack, and the situations for the balance of military strength on the Korean Peninsula.

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[2] Since 1971, armored division equivalents (ADEs) have been used in official U.S. studies to assess the strength of ground forces. The estimates of force strengths are based on standard measures of weapon effectiveness developed by the U.S. Army. See William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*, pp. 108-25.

II. THE STATIC BALANCE OF ROK AND NK GROUND FORCES

According to recently declassified data from military reports, *i.e., The Military Balance, 1987-1988,*[3] North Korea outnumbers the ROK in active personnel, tanks, artillery pieces, and armored vehicles. It is less clear how this numerical advantage translates into a comparison of the ROK and NK military capability. That relationship, generally referred to as the conventional balance of forces, depends not only on numbers but on the quality of weapons and on other factors, such as when and how quickly each side mobilizes for war.

As pointed out in Methodology (Introduction chapter), the conventional balance in the Korean Peninsula consists of several factors. The quantitative balance between the ROK and NK is a function of so many factors--many of which are impossible for either side to determine with certainty--that predicting the outcome of a confrontation is nearly impossible. Useful insights can be obtained, however, by examining the relative military posture of the two sides [Ref. 8: p. 7].

This study of the static balance in the Korean Peninsula focuses on ground forces. This is because any war on the Korean Peninsula is likely to be dominated by ground forces and the ROK and North Korea have the world's seventh and sixth largest armies [Ref. 9: pp. 127-28], that is, the major military strength in the Korean Peninsula is the ground forces. This chapter provides existing ground force structures, identifies the likely purpose of North Korea forces, and provides a quantitative assessment of the current balance of the ROK and North Korean ground forces. Also, the conclusion for this chapter identifies and develops force structure planning issues for the ROK ground forces.

A. GROUND FORCE STRUCTURES AND DEPLOYMENT, AND NK OUTLOOK

Many types of forces affect the conventional balance in the Korean Peninsula. Most of them are ground forces operated by each side's army. These ground forces are organized into units of various sizes. According to the composition of U.S. ground forces (combat units only), a company consists of 3 platoons including 90 to 150 soldiers, a

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[3] International Institute for Strategic Studies, *The Military Balance, 1987-1988,* (London: IISS, 1987).

battalion consists of 3 companies including 550 to 800 soldiers, a brigade consists of 3 to 5 battalions including 4500 to 5000 soldiers, a division consists of 3 brigades including 10,000 to 16,500 soldiers, a Corps consists of 2 to 5 divisions including 25,000 to 140,000 soldiers.[4] The ROK Army (ROKA) division follows the U.S. division organizaton, and the difference between the ROK and the U.S. division is to be made up of 3 regiments instead of 3 brigades. Another difference is that the ROKA infantry division is heavy in the number of combat soldiers - the typical ROKA infantry division has some 15,000 soldiers of which more than 10,000 serve in its organic infantry regiments and battalions and it is light in terms of equipment, transportation and communications assets. In the area of division anti-tank capability, for example, ROKA infantry division has 6 Tows, 18 106-mm RR, and 48 90-mm RR, but a U.S. division has 54 Tows, and 243 Dragons. The ROKA infantry divisions have very limited antitank capability, in comparison to a U.S. division, and the ROK forces nearly use absolute U.S. equipment. [Ref. 10: pp. 66-7]

North Korean divisions are modeled after the USSR PRC[5] divisions, and manpower (about 10,000 men), about 65% of the strength of a ROKA division. Most of the manpower differences lie in combat support and logistics troops. [Ref. 11: p. 148]

The lightness tendency of each side's infantry divisions (in terms of equipment and anti-tank assets of U.S. and Europe forces) is because the Korean War (1950-1953) indicates that any conflict on the Korean peninsula probably would involve several battles running across a series of mountains and ridges, and it would probably break out at night.

According to the recently declassified data from military reports, North Korea has a significant advantage in numbers of troops and equipment on the ground. (See Table 1.) Much of North Korean artillery is more powerful and longer range than the ROK's. The North Korean artillery is either towed or self-propelled, but its artillery is more self-propelled and mobile than the ROK's. Also, its artillery can reinforce the front troops without movement of their positions. North Korean ground forces are highly mechanized and mobile. North Korea possesses a Special Unit, the Eighth Special Corps, of some 112,000 men, which can be dispatched to ROK for conducting guerrilla

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[4] Congressional Budget Office based on Department of the Army data and on CBO, *Army Ground Combat Modernization for the 1980s: Potential Costs and Effects for NATO.* (November 1982), p. 59.

[5] People's Republic of China.

warfare. Also, North Korea possesses some 5 million Reserve Militia who in time of war can be fully mobilized to carry out combat duties. [Ref. 12: p. 100]

Table 1. COMPARISON OF ROK AND NK GROUND FORCES

Category Weapons	ROK	Ratio	North Korea
Active Personnel*	567,000	1:1.3	750,000
Division Equivalents**	54	1:2.0	106
Equipment			
-Tanks	1,340	1:2.4	3,175
-AFVs***	1,110	1:1.5	1,690
-Antitank Weapons****	3,340	1:1.0	3,300
-Artillery, Mortars	8,600	1:2.0	17,000

Source: IISS, *The Military Balance 1987-1988,* London, pp. 162-65. * The ROK Active Personnel includes marines. ** It considers combat division only, and brigade, for example, commando airborne brigade is figured into a division. *** AFVs (armoured fighting vehicles) include reconnaissance **(recce)** , mechanised infantry combat vehicle (MICV), and armoured personnel carrier (APC). **** The ROK's is estimated, and North Korea's includes recoilless launchers (RCL), SU-76, and SU-100 sp(self-propelled).

In light of the Korean unique geography, the ROKA has developed tactics suitable to the Korean Peninsula. For example, night operations and mountain operations, etc. have been developed. The use of infiltration operations against North Korea by a special attack troops, *e.g.*, commando troops should be emphasized. It coerces North Korea into not starting a war and North Korea has also hardened its military facilities by putting them underground and protecting them with concrete shelters.

The ROK and North Korea troops facing each other across the four kilometer-wide DMZ along 155 miles front are deployed. The ROK troops are deployed concentrically along 155 miles of the DMZ. Major troop units are concentrated in or near Seoul because more than one-fifth of the ROK's population and some two-fifths of its industry are concentrated in or near Seoul. A successful defense of the ROK must be a forward defense. However, only some 25 miles south of the DMZ, Seoul is virtually within range of the North's long-range artillery and barely a few minutes flying time from North Korean airspace. Concentration of ROk troops along the front is vulnerable because it does not provide the depth of a battlefield and it requires a high premium on good surveillance and intelligence to avoid a surprise attack. It may cause the ROK forces to have a high attrition rate in the initial days of fighting. [Ref. 13: p. 14]

But, the ROK is far from the disorganized and defenseless territory which tempted Kim Il-Sung's attack in 1950. Nor is Seoul as vulnerable to capture as its proximity to the DMZ might suggest. Mountainous terrain channels the movement of mobile forces to a few invasion routes, and these are now heavily fortified. The ROK force levels and the difficult approaches mean that, even with its numerical superiority, the North could not be assured of carrying through a successful attack,although the capital still remains vulnerable to air attack and long-range bombardment. Other factors such as quality of equipment, leadership, training, morale, combat experience, communications, and surveillance, and logistics and the kinds of circumstances which could give rise to conflict would probably determine the outcome. The ROK forces are well-trained and highly-disciplined. They have demonstrated their combat ability in the past in Vietnam. Many present-day commanders have proven their skills. [Ref. 13: p. 16]

The ROK has emphasized anti-armor forces while the North emphasizes armor. The ROK has more anti-tank guns and weapons which can be fired from the ground or the air: the ROK has better close air support forces. This structure of forces offsets many of the North Korean numerical advantages usually cited. [Ref. 14: p. 73]

North Korean forces, on the other hand, are offensively deployed. More than seventy-five percent of North Korean forces are within fifty miles of the DMZ [Ref. 14: p. 72]. North Korea has undertaken on extensive military reorganization and deployment which included repositioning of ground combat forces nearer the DMZ. Substantially more than 100 new military installations are being constructed in the four forward corps and new units have arrived at numerous existing installations in the same area. This forward deployment includes corp-size elements with artillery, armor, and mechanized infantry assets. North Korea has markedly increased mobility and firepower of its military forces. The North Korean army's mechanized program, begun about 10 years ago provides, a potent direct-fire support capability with greatly enhanced mobility. [Ref. 15: p. 101]

North Korea had dug three underground tunnels for sending its forces into the ROK front's rear areas. Three tunnels have been discovered in the past - in 1974, 1975, and 1978. The last two were dug at least fifty meters below the the surface, and were approximately two meters high and two meters wide. How many tunnels have been and are being built, and how large, is open to question. Some sources claim that ten to thirteen more tunnels have already been built and have been detected by the ROK, but not precisely located and that another ten to thirty are now under construction. The possibility has been raised that each of the more than twenty North Korean divisions along the DMZ is digging at least one tunnel. The tunnels are said to be large enough to move at least two thousand and perhaps as many as thirteen hundred troops an hour through each as well as small trucks and artillery pieces [Ref. 16: pp. 95-6]. North Korea has some one hundred thousand commandos/rangers. It is expected that the commandos would be the vanguard of an invasion, using the tunnels, 250 AN-2 transport aircraft to infiltrate at night into the ROK to disrupt the ROK forces from the rear by attacking military bases, communications sites, ground control facilities, and other targets. Seventy percent of the commando force is thought to be ground /para troop soldiers [Ref. 17: p. 103]. North Korea illegally acquired 87 Hughes 500/300 model helicopters. These 87 helicopters provide North Korea with an added air lift capability for troops and material. More importantly, however, is thier potential use in inserting North Korean special purpose or guerrilla forces deep into the ROK rear areas to attack air-bases, command, control and communications facilities, and logistics centers. [Ref. 15: p. 101]

North Korea adopted the "Four Great Military Policylines" at the Fourth Korean Workers' Party (KWP) Congress in 1962. It contained the slogans "arm the entire population," "fortify the entire country," "cadetify the entire army," and "modernize the entire army." Under the first policy the working masses in North Korea were trained to bear arms in addition to the regular forces, by establishing units like the Worker-Peasant Red Guard Units. The second policy helped to strengthen defense all over North Korea, fortifying the front lines and building undergound supply structures. The third policy was intended to enable all Korean People's Army(KPA) soldiers to assume the task of leadership, if necessary, so that military units might constantly be replenished and combat ready during wartime. Under the fourth policy, the KPA was to be given the latest advanced training as well as the latest weapons and equipment to be domestically produced or purchased from abroad if necessary. [Ref. 18: pp. 21-2, 101-03]

For these and other reasons, North Korea is likely to make a surprise attack while initiating full scale hostilities as well as the guerrila warfare. North Korea is trying to reduce the ROK warning time of a possible attack and to increase the chances of a successful surprise attack. At present, the warning time of an attack on ROK could be very short, perhaps as little as 12-24 hours. Also, because of the North's general disadvantage in population and industrial capacity, North Korea does not want any war that lasts a long time.

B. THE METHOD OF ESTIMATING GROUND COMBAT POTENTIAL

As stated earlier, any number of static indicators can be used to compare the combat potential of ground forces. This includes numbers of divisions, total ground manpower, weapons counts, and such indexes as armored division equivalents.

To keep the analysis relatively simple and easily understood, the estimation of ground combat forces between the ROK and North Korea relies primarily on "static" comparisons. Static methods consider only the total of forces available to each side at a given time; they do not attempt to account for the progress of fighting or combat losses on either side. Such methods can, however, be used to examine how many forces became available to each side. In some cases--for instance, after the war starts--dynamic assessments are more appropriate measures. Dynamic methods, which attempt to model the progress of a battle and reflect combat losses, are discussed more fully in the next chapter.

1. Static Method

As discussed already, the Static method used in this thesis is based on weapon effectiveness indices (WEI) and weighted unit values (WUV) deloped by the U.S. Army [Ref. 5: p. 108]. The WEI WUV method avoids, as much as possible, subjective assumptions concerning the conduct of war. This technique first evaluates and ranks each type of ground weapons--such as a tank, personnel carrier, or howitzer--relative to other weapons of the same type, to arrive at an effectiveness index for each weapon. Weapons are typically evaluated on the basis of their firepower, mobility, and ability to survive an enemy attack. [Ref. 5: p. 14]

The estimates of force strengths are based on standard measures of weapon effectiveness . Each weapon is rated against the standard for its category, which produces a weapon effectiveness index (WEI). Thus various types of tanks receive WEI scores and are then ranked against a norm, which for tanks is the U.S. M60A1. For example, the M60A1, as the norm, receives a WEI of 1.00; the M60A3, an upgraded version of the M60A1, an index of 1.11 based on its improved fire control system and power train; and the Soviet T62 tank when measured against that category's standard - a U.S. M60A1 tank(1.00) - has a WEI of 1.03 [Ref. 5: p. 28]. Tanks of other nations are scored relative to the M60A1 in the same way. Each category of weapons, such as tanks, artillery or armored personnel carriers, then receives a relative weighting, or WUV score, based on its contribution to the unit's overall performance of its mission in either an offensive or defensive posture. As one would imagine, tanks receive a relatively high WUV factor (55 for defensive operations in Europe), and weapons such as individual rifles receive a lesser weight(1.2 for desensive operations). (See Table 2, 3.)

Table 2. RELATIVE VALUE OF EQUIPMENT IN A U.S. ARMORED DIVISION

Weapon Category	Number of Weapons	Weapon Effectiveness Index	Category Weight (defense)	Weighted Value
Small Arms	2,880	1.00	1.2	3,456
APCs				
-M113A1	376	1.00	6.0	2,256
-M114A1	179	0.93	6.0	999
Tanks				
-M60A1	324	1.00	55.0	17,820
ARV				
-M551	27	1.00	36.0	972
Antitank Weapons				
-TOW M113A1	90	1.00	46.0	4,140
-Dragon	254	0.64	46.0	7,478
Artillery				
-M109A1	54	1.00	85.0	4,590
-M110A1	12	1.15	85.0	1,173
Mortars				
-M106A1	53	1.00	47.0	2,491
-M125A1	45	1.00	47.0	2,115
WUV	---	---	---	47,490
ADE	---	---	---	1.00

Source: William P. Mako, *U.S. Ground Forces and the Defense of Central Europe* (Brookings Institution, 1983), p. 114.

Table 3. **RELATIVE VALUE OF EQUIPMENT IN A SOVIET DIVISION**

Weapon Category	Number of Weapons	Weapon Effectiveness Index	Category Weight (offensive)	Weighted Value
Small Arms	1,116	1.00	1	1,116
APCs				
-BRDM-2	124	0.89	13	1,435
Tanks	325	1.02	64	21,216
ARV				
-PT76	22	0.75	36	594
-BRDM Sagger	9	0.70	36	227
Antitank Weapons				
-BMP	132	0.89	27	3,172
-Sagger	12	0.50	27	162
-SPG9	9	0.21	27	51
Artillery				
-M1975	18	0.44	72	570
-M1974	6	0.44	72	190
-D30	36	0.40	72	1,037
-BM21	18	0.54	72	700
Mortars				
-M1943	18	1.01	37	673
WUV	---	---	---	31,143
ADE	---	---	---	0.66

Source: William P. Mako, *U.S. Ground Forces and the Defense of Central Europe* (Brookings Institution, 1983), p. 121.

The total WEI/WUV score for an entire unit, such as a division, can be calculated using these factors. To arrive at the unit's total score, each weapon's index is multiplied by the appropriate weighting fator and all the products are totaled. The score for each combat unit, such as an U.S. light infantry division or a Soviet motorized rifle division, is then normalized against a U.S. armored division. The resulting value is called an armored division equivalent (ADE) [Ref. 8: p. 14]. Sample WEI/WUV calculation of an U.S. armored division and its Soviet counterpart is shown at Table 2, 3. This method is suitable and easy to calculate the total scores when each combat unit organization is normalized.

In the case of the ROK and North Korean ground forces, since the ROK and North Korean combat units are various and the data are limited, it is difficult to calculate the total WEI/WUV scores of each side's total ground forces according to each combat unit. So, when the ROK and North Korean ground forces are calculated according to the Static method, each combat unit is ignored.

2. Applying The Static Method

To apply the Static method to estimating ground forces of the ROK and North Korea, all weapons are classified into category weapons, such as Small Arms, Mechanized Infantry Combat Vehicles(MICVs), Armored Personnel Carriers(APCs), Mortors, Artillery, Anti-tank Weapons, and Tanks. Then, each category weapon receives a average WEI and a relative weighting, or WUV score, based on its contribution to the units overall performance of its mission in either an offensive or defensive posture.

As dicussed earlier, it is assumed that North Korea will attack the ROK. The total WEI/WUV score for entire units, or the ROK and North Korean ground forces, can be calculated using this factor. To arrive at the each side's total score, each category weapon's index is multiplied by the approriate weighting factor and all the products are totaled.[6] The total score for each side is then normalized against an U.S. armored divi-

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[6] There is an implied premise in this static measures for total score of each side. If we define W = war fighting capacity (output), and

$$W = f(x_{1j}, x_{2j}, \ldots, x_{kj})$$

x_{ij} means the number j of units of the i th weapon system.
$i = 1, 2, \ldots, k$
$j = 1, 2, \ldots, M_i$,

then the static measures of force capability can be obtained by assuming a linear homogereous production function:

$$W = \frac{\partial W}{\partial x_{1j}} x_{1j} + \frac{\partial W}{\partial x_{2j}} x_{2j} + \cdots + \frac{\partial W}{\partial x_{kj}} x_{kj}$$

in the condition of that $\frac{\partial W}{\partial x_{ij}} = \frac{\partial W}{\partial x_{ij-1}}$ = Weighted Value (canstant marginal product for additional units).

sion (ADE). Therefore, all ROK and North Korea ground forces can, theoretically, be related on a common basis using their ADE scores.

As a result, each side's ground forces are established by specific values of the WEIs for various ROK and North Korea weapons by assessing each weapon's capability. By the way, because data about WEI are classified, this thesis just relies on Mako's *U.S. Ground Force and the Defense of Central Europe* published by the Brookings Institution, 1983. [Ref. 5: pp. 114-25]. The Weighting Values or WUVs, were also determined by the book pointed out above

3. Limitations Of The Static Method

Like any analysis that attempts to quantify the many aspects that contribute to military capability, the WEI WUV approach suffers from several important drawbacks. One obvious drawback is the lack of more recent and detailed WEIs for the individual weapons and WUVs able to be applied in the ROK and North Korean forces. This analysis, however, does not purport to be a precise evaluation of either the ROK's or North Korea's military capability. Rather, it is an attempt to assess the relative position of the two sides under a wide range of assumptions. Thus, if the underlying values used to make the assessments err by a small percentage for each side, the relative error should cancel out.

This analytic method also ignores many attributes of a military unit--such as quality and training of personnel, support equipment, logistic capability, and the interplay of various weapons--that can determine the outcome of a particular battle. Despite their importance, however, these factors often do not lend themselves to easy translation into numerical values. Such comparisons are obviously subjective and not as amenable to quantification as tank range, accuracy, or speed. This is the case, too, with resupply and maintenance capability. Every one knows that efficient ammunition and fuel resupply is necessary for the effective operation of a combat unit, but very few analysts have sugested ways to quatify such a capability. this shortcoming may be especially important because the ROK devotes more of its resources to providing logical support than does North Korea. The ROK ground forces do not receive credit for this effort in the WEI WUV analysis.

Static comparisons like these using the WEI WUV method also ignore other decisive variables, such as strategy, maneuver, terrain, and combat attrition which determine the conduct of war. Indeed, the WEI WUV method is useful primarily for evaluating the forces that each side could have at its disposal at the onset of hostilities, or the total forces that each side had measured at a point after mobilization. Such comparisons, therefore, are more valuable for assessing the relative standing of opposing forces before a war starts, and are more useful for evaluating deterrence capability rather than war-fighting ability.

Finally the WEI/WUV method assumes that the added benefit of additional weapons is linear--that is, more weapons of any kind continue to provide the same additional capability as the first such weapon. This assumption is called "constant marginal utility" in economic jargon and ignores the fact that, beyond a certain point, additional weapons of one kind might be redundant and therefore of no added utility. Such a way will be unfavourable to the ROK because North Korea has more weapons than the ROK. [Ref. 8: pp. 16-8]

Together these varous limitations suggest that assessments of the conventional balance using WEI WUV scores can not usefully predict the outcome of a confrontation between the ROK and North Korea. WEI/WUV scores are, however, useful tools in investigating the effect of various assumptions on today's conventional balance and show the relative benefits obtainable from increasing the number of each weapon system, and what substitution of weapon systems could compare total capabilities without increasing total expenditures.[7]

4. Static Assessment Of Each Side's Ground Forces

The forces summarized in Table 1 include those available throughout each side's ground forces. North Korea enjoys the advantage of the physical military balance on the Korean peninsula. North Korea has roughly thirty percent more army manpower (750,000 vs. 567,000, including marines for the ROK), a 2.4 to 1 advantage in main battle tanks (3,175 vs. 1,340), 50 percent more armored fighting vehicles (1,690 vs. 1,110, including APCs), and 2 to 1 advantage in artillery pieces (17,000 vs. 8,600, including mortars). [Ref. 19: pp. 162-65]

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[7] As an example of the above, let us compare a 155mm Howitzer and a Tank M60A1. The 155mm Howitzer unit cost is $311,220 and its annual cost is $49,166, and Tank M60A1 unit cost is $2,063,073 and its annual cost is $35,587. By the way, 155mm Howitzer's WUV is 102 (for defense) and Tank M60A1's WUV is 55 (for defense). In a point of Cost-Benefit analysis, the 155mm Howitzer is much better (102 vs. 55). For a life-cycle cost of each weapon without discount rate, it takes over one hundred years Tank M60A1 to reach a breakeven point against the 155mm Howitzer. So, according to the Static method, the 155mm Howitzer is far better than a Tank M60A1 when each unit is compared for capability in a point of Cost-Benefit analysis. See Directorate of Cost Analysis Office of the Comptroller of the Army, *Army Force Planning Cost Handbook (AFPCH)*, (November 1982), pp. III-479, -480.

But, the ROK ground forces do enjoy a qualitative edge, even though the qualitative advantage of the ground forces is not so pronounced as with air and naval forces. Most of their ground equipment is superior, in terms of late model tanks and APCs, and advanced ground missiles (surface-to-surface, surface-to-air, anti-tank). For example, the ROKA was refitting M-48 tanks with 105mm guns that were larger, more accurate, and faster than the 100mm guns on North Korea's T-54, T-55, and T-59 tanks. It was also designing a new tank especially adapted to conditions in Korea. However, much of North Korea's artillery is more powerful and self-propelled, and of longer range than the ROK's. [Ref. 12: p. 100]

When all ground forces are converted to armored division equivalants (ADEs) using the WEI WUV method, the North Korean total 750,000 in active personnel available to the North Korean theater would be equal to 28 ADEs, and the ROK's 567,000 in active personnel would be reduced to about 20 ADEs. Converting the two side's combat divisions to ADEs therefore reduces the ratio from roughly 2 to 1 (106 to 54 division equivalants) to just 1.4 to 1.0. This is, as stated earlier, because North Korean divisions number about 65% of the strength of a ROK division.

5. The ROK Ground Force Structure Planning Issues

As figured out in the previous section, North Korean ground forces enjoy forty percent more static military strength. This is because North Korea has a 183,000-man advantage in active personnel (750,000 vs. 567,000) and enjoys a quantitative lead in some critical areas, such as number of armor and artillery. For the static ground force balance in the Korean peninsula , the ROK should reinforce troops and or equipment.

There are many methods in reinforcing the army, for which ROK increases force numbers or modernizes the equipment, etc.. By the way, the ROK has a limitation to increasing the soldiers. Equipment modernization includes increasing equipment quantity. The ROK won't throw away existing less quality equipment for force modernization. As a result, the ROK must increase equipment quantities. It can make the ROK forces modernized as well as reinforecd.

In a speech in January 1983, the President set out the aims of the ROK defense policy. He emphasized the ability to strike deep into enemy territory as well as to engage the forces in close contact. The concept is similar to the Follow On Forces Attack (FOFA) ideas being developed by NATO, in which attacking troops and those moving forward to reinforce them are engaged by deep strikes by missiles and aircraft [Ref. 20:

p. 103]. In the point of view of the Army long-range artillery pieces are needed for the above defense policy.

More than seventy-five percent of North Korean ground forces are within fifty miles. Correspondingly, the ROK ground forces are also concentrated along the front, especially in or near Seoul because of the priority of the defense of Seoul. It does not allow for, as pointed out earlier, a defense in depth to the ROK. On the other hand, the ROK can not deploy troops rear away from front because of North Korean surprise attack.

For this situation, what is best for the ROK? The ROK needs static military strength and more depth of the battlefield. The ROK needs mobile power in the light of the ROK strategy which involves an early counter-offensive across the DMZ. Therefore, this answer is tank. Tanks provide firepower and mobility on both offensive and defensive operations. In the WEI WUV method, its WUV score is highest except artillery WUV score. (See Table 2, 3.)

However, more important equipment is the Artillery Piece. The terrain on the Korean Peninsula comprises 75 percent of mountains with elevations greater than 500 meters. These provide limited road networks and impede the movement of Tanks, and limit the field of vision. Operation of a tank is limited in the Korean Peninsula. Artillery is suitable to this terrain. Artillery also provides the ROK with the depth of battlefield. While being deployed near the front, it can support the forward combat troops and attack North Korean troops moving forward to reinforce by deep strikes. Besides these, the ROK must reinforce artillery because the ROK is inferior in quantity and quality in artillery and a forward defense demands heavy artillery and mortar bombardment.

Also, the ROK needs more commando troops. As discussed earlier, the North has hardened its military facilities by putting them underground and protecting them with concrete shelters. Apparently, the artillery is buried in caves and concrete; aircraft hangars and repair facilities are inside mountains big enough to handle fifty or more fighters; air defense missiles are in buried bunkers; air defense radars are stored underground and brought up by elevators; submarines and patrol boats are in drive through granite and concrete harbors [Ref. 14: p. 75]. When North Korea starts war, attack to these North Korea's is suitable as the commando troops. So, the ROK needs to reinforce these forces in correspondence with North Korea.

III. DYNAMIC MODELS IN THE KOREAN PENINSULA

Although figured out the static ground force balance according to the Static methods in the previous chapter, these methods, as noted earlier, consider only the total of ground forces available to each side at peace-time but they do not account for the progress of fighting or attrition rate on each side. A close accounting of each side's static ground forces is obviously necessary to any such static force assessment, but such static accounting alone is not sufficient enough for the wartime situation.

When the war starts, the factors which have influence upon the ground forces are not only static ground forces but also factors to reinforce its forces, such as reserve forces, domestic military production capabilities, close air support (CAS) capabilities, the allied forces, and so forth. Because warfare proceeds dynamically, the prospects for conventional balance cannot accurately be measured by a mere static comparison of opposing weapon inventories. A dynamic analysis is essential.

Therefore this chapter examines the factors, or availabilities of forces, which critically have influence upon war except static ground forces, such as reserve forces, domestic military production capabilities, CAS capabilities, and the allied influences Then the Dynamic models which are usually used at present, such as Lanchester model and Epstein model, are presented and developed.

A. AVAILABILITIES OF FORCES

As figured out earlier, each side's static ground forces are 20 ADEs for the ROK and 28 ADEs for North Korea. Neither all of the ROK ground forces nor all of North Korean ground forces are currently in place in the front. However, because each side's ground forces are deployed concentrically near the front and it does not take a long time for troops in the rear to arrive at the front, each side's ground forces may be available in a day after mobilization.

This section discusses factors to reinforce the ground forces except static ground forces, even though factors which are discussed are limited. These are Ground Reserve Forces, Domestic Military Production Capabilities, CAS Capabilities, and the Allied Influences.

1. Ground Reserve Forces

North Korean regular ground forces now number 750,000, compared to 567,000 for the ROK - an advantage of 183,000 men, or thirty percent. However, the ROK has a very large advantage in all services in well-trained, first-line reserve forces. the ROK ground force reserves number 1.1 to 1.4 million, the North's 230,000 to 500,000.[8]

Besides well-trained reserves, both nations have enormous numbers of para-military[9] forces - people who have received some military training, but are not integrated into the regular military establishment. The ROK has about 7.4 million para-military forces: a 3.5 million Civilian Defense Corps.[10] Estimates of North Korean para-military forces vary widely. Analysis agrees that there is a 38,000-man security force and border guards, but numbers on the Workers, Peasants and Youth Red Guard vary from 1.76 million to 3.7 million.[11] However, it might take a long time each side's para-military forces to be mobilized in wartime.

In a long war, the ROK larger population (42.2 million vs. 21.2 million) would prove an advantage. the ROK presently has 8.1 million males fit for military service compared to 2.9 million for the North. More over, the ROK has a total of 464,000 males reaching age for military service each year, compared to 260,000 for the North.[12] However, as one of the "Four Great Military Policylines", or "arm the entire population.", is adopted at the Fourth KWP Congress in 1962, it is expected that North Korean reserve force readiness is higher than that of the ROK. That is, North Korea can quickly mobilize reserve forces. North Korea claims mobilization in 12 hours, and up to 5 million have some reserve militia commitment.[13] As a result, since North Korea does not try to make any war that will last a long time, the larger population of the ROK won't influence the reinforcement for force strengths.

Unfortunately, unclassified literature contains little information on how long it might take each side's reserve forces to prepare these less ready forces for combat. Furthermore, most of these forces have to travel some long distances to reach each side's

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8 Lower estimates are *CIA Factbook 1985*, pp. 127-29; higher estimates are International Institute for Strategic Studies *The Military Balance 1987-1988*, pp. 162-65.

9 this section treats para-military as potential reserve forces.

10 See footnote 1.

11 Ibid.

12 Ibid.

13 Ibid.

front. The estimates of the time needed by the ROK and North Korea to ready their reserve forces is difficult. As a result, availability of reserve forces is dominated by speediness of mobilization as well as numerical and qualitative forces.

2. Domestic Military Production Capabilities

The ROK and North Korea have two of the most advanced indigenous military production capabilities in the Third World. Each side can produce nearly the full range of ground and air equipment, with the major exceptions for modern jet military aircraft, sophisticated missiles, and high technology items, especially electronic equipment. Therefore the ROK and North Korea are moving toward self-sufficiency in building weapons and both are close to that goal. Each side has worked from the ability to maintain and repair weapons provided by other nations, to producing entire weapons under license (co-production), in some instances, to the final step of researching, designing, and developing new weapons systems domestically. [Ref. 14: p. 64]

Because Nixon's decision to withdraw the 7th Division in 1971 came as a shock to the ROK, its military industry began in earnest after the event. The ROK can now produce roughly seventy percent of its military needs domestically.[14] Most of its weapons are copies or modifications of U.S. equipment, many of which are locally assembled or produced under license.

The ROK military industry is very adept at producing ground equipment. It makes almost everything from barbed wire to tanks, including rifles, mortars, machine guns, 105mm and 155mm howitzers, recoilless rifles, armored personnel carriers, anti-tank missiles, mines and more. It co-produces M-48A3 and -A5 tanks, M109A2 self-propelled 155mm howitzers, M-79 grenade launchers, and Vulcan air dedense systems.[15] Co-product of an indigenously designed tank, known as the XK-1 or the Republic of Korea Indigenous Tank (ROKIT), began in 1986. It weighs forty-five to fifty-two tons, is armed with a 105mm gun, and has a digital fire-control computer.[16]

The ROK capability to build military aircraft lags behind that of ground equipment, but it has advanced from repair and overhaul, to assembly, to licensed pro-

14 *Armada International,* (August 1985), pp. 18-20.

15 Numerous sources, *Armada International,* (August 1985), pp. 18-20; *Jane's Defense Weekly,* (October 5, 1985), p. 737; *Jane's Armor and Artillery 1984-1985,* pp. 49-50; IISS, *The Military Balance 1984-1985,* pp. 102-103.

16 *Asian Defense Journal,*(November 1984), p. 110.

duction. The ROK started co-producing F-5E fighter aircraft (the most modern version of the F-5) in 1982 and licensed assembly of Hughes 500 Defender helicopters with TOW anti-tank missiles in 1978.[17] In 1985 the first repair facility for F-100 jet engines (used in F-15s and F-16s) was established in the ROK.[18]

North Korean domestic military industry is equal or superior to the ROK's in ground equipment, but inferior in air weapons system. Like the ROK, the North can and does produce the entire range of ground systems. Significutly, it produces substantially more ground weapons than the ROK and probably benefits from economies of scale. By the late 1970s, it was producing light tanks, multiple rocket launchers, radar and other advanced conventional equipment. North Korea had also developed a "war-sustaining" infrastructure of fuel stocks, ammunition, spare parts, etc., which could support high-intensity combat operations for 'many weeks' without outside aid (from the Soviet Union or China).[19] Apparently all new armor being added to North Korean forces is domestically produced. Tanks now include a version of the Soviet T-62 model.[20] Some estimates put North Korean production of tracked vehicles at three hundred per year (one hundred tanks, one hundred APCs, one hundred self-propelled guns).[21]

3. Close Air Support Capabilities

Although numerically smaller, the ROK air force would appear to be superior to that of North Korea in combat capability, and advantage may be growing. North Korea has some 840 combat aircraft plus 110 armed helicopters compared to about some 476 combat aircraft and 189 Hughes 500MD Defender for the ROK, a significant margin of nearly seven-five percent in combat aircraft [Ref. 19: pp. 162-65]. But the ROK aircraft are more modern and in corporate higher technology. They have better range, great speed, a higher ceiling, more firepower, superior maneuverability, better avionics and weapons delivery capabilities. Another words, they can fly faster, farther,

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17 *SIPRI Yearbook 1984,* p. 276.

18 *Armada International,* (August 1985), p. 22.

19 Former US Defense Security Harold Brown, *Thinking about National Security: Defense and Foreign Policy in a Dangerous World,* (Boulder, CO: Westview Press, 1983), p. 123.

20 Statement by Gen. Robert Sennewald to House Armed Services Committee, (March 8, 1983), p. 4.

21 *Forces Journal International,* (september 1984), p. 84.

and higher; they handle better: they can deliver more powerful weapons more accurately. The ROK pilots are far superior to North Korean. North Korean pilots are believed to be relatively unskilled, largely because of very limited flying time.

North Korea does have large numbers of combat aircraft (840 vs. 476), but they are very old and of low quality.[22] About three-quarters of their combat aircraft are 1950s vintage. Until the delivery of the MiG-23s during the past two years the latest fighter, in their arsenal were 1960s-vintage MiG-21s.

Of the approximately 840 North Korea combat aircraft, 540 are ground attack aircraft and three hundred are intercepters. The ground attack planes are particularly antiquated. Nearly one-third (280 aircraft) of the North's combat aircraft are MiG-15s and MiG-17s. MiG-15s were the first modern Soviet jet fighter, appearing 1949 and used during the Korean War (1950-1953). MiG-17s came on the scene four years later. Both are subsonic, cannot be used at night or in bad weather, have very poor radar (essentially eyeball contact), high vulnerability (strong infrared signature) and low ammunition capability. The North also has eighty Il-28 light bombers and thirty Su-7B Filler A bombers, both of which were first introduced in the late 1950s.

Another one hundred and sixty of the North's combat aircraft are MiG-19s. One hundred are configured as fighters, sixty as intercepters. MiG-19s were introduced in 1955, and the Soviets stopped production later in the decade. Like the MiG-15s and -17s, they are very primitive aircraft by today's standards.

The MiG-21 Fishbeds, of which they have 150, are extremly limited. They have short range, crude avionics, poor navigation, very light armament, and serious engine problems.

Some MiG-23s are much more advanced aircraft than anything else in the North Korean arsenal. First deployed with Soviet forces in the early 1970s, the MiG-23 is the aircraft of choice for most close Soviet allies. Its sophisticated radar, superior avionics, more powerful engine, and better armaments are a big leap forward for the North air force. It is, however, far from the "top-of-the-line" for Soviet aircraft and not nearly as modern as the F-16. Anyway, the delivery of forty to fifty MiG-23s to North Korea will affect the ROK. [Ref. 14: p. 69]

In early February 1985 the U.S. Commerce Department revealed that a West German company had illegally shipped eighty-seven U.S.-made Hughes Model 300C, 500D, and 500E helicopters to North Korea using a circuitous route through Japan, the

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22 CIA *World Factbook 1985*, pp. 127-29.

Netherlands, and other nations. The North will probably convert most of them to carry air-to-surface missiles, rockets, and machine guns. They could improve the North's ability to infiltrate into the ROK and launch a surprise attack; at the least, they will make detection in wartime difficult.[23]

The ROK have some F-16 fighter/ground attack aircraft. The F-16 is widely regarded as the best airplane of its type in the world. Currently, the F-5 aircraft is the mainstay of the ROK air force. They have both the original F-5A/Bs and the upgraded F-5E/Fs. It is far superior in all aspects to any plane in North Korea's inventory, except the MiG-23. F-5s can be used either as fighters or intercepters.

The ROK also has some F-4D/Es. The F-4 Phantoms still considered one of the world's best ground attack aircraft, better than the F-5s. It is fast, powerful, and versatile. The ROK is phasing out its F-86F Korean War-vintage fighter-bombers. The ROK air armaments are far superior to the North's. [Ref. 14: pp. 67-70]

In sum, the ROK air force, though outnumbered, is much more capable for CAS than North Korea's.

4. The Allied Influences

The final consideration that affects forces available to the ROK and North Korea is the role that the allied (U.S.A., Soviet, China, and Japan) might play. The major powers surrounding the Korean Peninsula generally maintain an active interest in the overall situation and specific developments in each side. Security ties that both the ROK and North Korea maintain with their respective allies are an indication of the strategic values and importance that the major powers attach to the Korean Peninsula.

North Korea, for instance, is the only communist country that is allied with both the Soviet Union and China, by virtue of a Treaty of Friendship, Cooperation, and Mutual Assistance signed with each country in 1961.

The ROK likewise signed the Security Treaty in 1954. The ROK-U.S. Joint Combined Forces (which replaced the United Nations Command) as well as annual ROK-U.S. security consultative meetings are stitational manifestations of the close security ties established between the two countries.[24] There are apparently more U.S. troops in the ROK now than at any time since the Nixon withdrawal. At the end of

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23 Good details in *Washington Post* (July 14, 1985).

24 Chae-Jin Lee and Hideo Sato, *U.S. Policy Toward Japan and Korea*, (New York: Praeger, 1982).

March 1986 the number was some 40,000, including some 30,000 Army. The U.S. presence provides assurance of a U.S. response in the event of attack.[25] As a result, four major powers will affect the Korean Peninsula. If war breaks out on the assumption of the withdrawal of U.S. troops stationed in the ROK, the odds are against the ROK. These are because the Soviet Union and China lie adjacent to North Korea, while the United States would have to come across the Pacific to support the ROK.

B. DYNAMIC MODELS

One of the pioneers in the development of such dynamic methods was Frederick William Lanchester (1868-1946). He is best remembered for his equations of war, dubbed the Lanchester's equations. First set forth in his 1916 work, *Aircraft in Warfare,* these have a variety of forms, the most renowned of which is the so-called Lanchester square law. This section refers to the many presentations of Lanchester's equations in detail and discusses their limitation in applying to the Korean Peninsula.

Another dynamic model is recently developed by Joshua M. Epstein of the Brookings Institution.[26] The Epstein model, which attempts to simulate the conduct of a conventional war of attrition, is based on the premise that both the attacker and defender can control their levels of attrition to their forces in an effort to attain some objective.

For this method are needed the basic parameters and constants for which values must first be assigned. So, availabilities of forces which influence its basic parameters and constants, such as ground reserve forces, domestic military production capabilities, CAS capabilities, and the allied influences, were examined in the preceding section. Finally, the Epstein model considered for the Korean Peninsula is developed.

1. Lanchester Model

As stated above, the equations developed by Frederick William Lanchester have for decades dominated the dynamic assessment of conventional balances. Exploration and critique of Lanchester's theory are most derived from Joshua M. Epstein's *'The*

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25 Department of Defense Fact Sheet, "U.S. Military Strengths Worldwide as of March 31, 1986," (June 3, 1986).

26 Joshua M. Epstein, *The Calculus of Conventional War: Dynamic Analysis Without Lanchester Theory,* (Washington, D.C.: Brookings Institution, 1985).

Calculus of Conventional War: Dynamic Analysis Without Lanchester Theory.'[27] Only a few points are again emphasized corresponding to the Korean peninsula.

a. Lanchester's Equations

Because the literature on Lanchester's equations has, unfortunately, been very technical and mathmatical, this study provides a nonmathematical introduction to Lanchester's equations based on the exploration of John W.R. Lepingwell published in *International Security*, summer 1987.[28]

Lanchester's equations which have become well known are the square law and the linear law.[29] These two are laws from the basis for most applications of the Lanchester's equations. Shortly said, the square law states that the measure of combat power is a force's effectiveness times the square of its numerical size. If two forces are equal by this measure, then neither side will win. Thus, the square law makes the outcome of combat more sensitive to force size, the squared term, than effectiveness. It is for this reason that the law has become so popular in the quantity-quality debate.

Lanchester's linear law is less well known, for Lanchester hypothesized that it primarily applied to ancient combat and to the case of indirect fire. Unlike the square law, the linear law gives equal weight to force size and effectiveness.

(1) The Square Law (N^2 Law) Lanchester was led to derive the square law by observing that modern weapons allow the concentration of fire - many men with rifles can fire at a single target without interference. This observation provides the basic assumptions underlying the square law: fire is directed, both sides are able to aim and concentrate their fire upon selected targets, and fire is distributed evenly over targets. Targets must be visible and targetable, and the consequences of fire must be determinable so that after a target is disabled, fire will be immediately shifted to a new target. Its forces are lined up along a wide front, concentration of fire is limited by the range of

27 Ibid.

28 John W.R. Lepingwell, *International Security: The Law of Combat Lanchester Reexamined* (summer 1987), pp. 89-103.

29 There are other "Lanchester's equatoins" (although Lanchester did not present them in his book), such as the logarithmic law:

$$b \ln [B(0)/B(t)] = r \ln [R(0)/R(t)]$$

and equation for ambushes:

$$b/2[B(0)^2 - B(t)^2] = r[R(0) - R(t)].$$

See Tayor, *Lanchester Models of Warfare*, Vol. I, pp. 167-181.

weapons, but the square law still holds in this case if both forces are deployed with uniform density along the sector of the front being modeled. This square law can be easily derived from the above assumptions. Assume two forces (Red and Blue) facing each other in the open, armed with rifles, able to aim their fire at each other, and able to shift their fire to a new target when a target is disabled. In a given interval of time, each member of Red's force chooses a target, fires at it, and has a certain probability of hitting and disabling the target. During the time interval, it is assumed that each Red rifleman fires several rounds, and if he disables his designated target, he shifts his fire to a new one. The rate of fire times the probability of kill[30] of each shot is the *effectiveness* of the force.[31] Effectiveness is not probability, but rather the expected value of the number of targets disabled in a given unit of time. Multiplying the number of Red riflemen firing by their effectiveness gives the expected number of Blue riflemen disabled in the time interval. Thus the rate of loss of Blue is the product of the number of Red riflemen and their effectiveness.

If we double the number of Red riflemen while holding the number of Blue riflemen constant, Red will be able to fire twice as many bullets as Blue as before; they can concentrate their fire on the Blue riflemen. Since Red's volume of fire has doubled, Blue's rate of loss will double. If each side is composed of homogeneous forces with the same type of weapon and vulnerability, and both sides are using directed fire, we can obtain the square law by expressing the logic in mathmatical form.Using the notation:

R : number of men on Red's side
r : the effectiveness of Red's fire on Blue
B : number of men on Blue's side
b : the effectiveness of Blue's fire on Red.

We may the represent the rate of loss of the forces:

$$\frac{dB}{dt} = -rR$$

[30] The probabilities of hitting and disabling the target are conceptually different, but in Lanchester's derivation, they are combined into one probability. This probability is referred to as the probability of kill in keeping with the common usage of the term.

[31] Effectiveness is called the attrition-rate coefficient by Taylor. Although the latter term is more accurate, this subsection uses the term "effectiveness" for consistency with Lanchester. See Taylor, *Lanchester Models of Warfare*, Vol. I, p. 64.

$$\frac{dR}{dt} = -bB$$

where dB/dt is the rate of change of the Blue force over time, and dR/dt is the rate of change of the Red force over time. The parameters R and B are referred to as force levels,[32] since they can represent numbers of riflemen, tanks, or other forces. The above equations state that in a very short period of time, the rate of loss of one force is proportional to the number and effectiveness of the opposing. Solving these two equations for the case of equally matched forces gives the square law equality condition:

$$rR^2(0) = bB^2(0).$$

This equation states that two forces are equal when the products of the square of their force lebels and their effectiveness are equal.[33] Equal in this sense means that both forces will be completely destroyed if the battle is allowed to continue untill completion.[34] The square law indicates that the appropriate measure of a force's military capability is the force level squared times its effectiveness, which Lanchester termed the *fighting strength* of the force. If a force's size is doubled, its fighting strength would be increased by a factor of four, while if its effectiveness were doubled, its fighting strength would only double. The square law therefore indicates that the outcome of combat is more sensitive to changes in numbers than to changes in weapons effectiveness. This is often taken to mean that weapons quantity counts more than quality, hense the invocation of the square law in the quantity-quality debate. This interpretation of the square law is more favorable to North Korea than the ROK because North Korea enjoys a majority in numbers of weapons but has a little less qualitative weapons than the ROK.

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32 Kaufmann calls these variables the combat power of Red and Blue.

33 The above form of the equation is obtained by setting the rate of loss equations equal and integrating with respect to the two force levels, giving the general solution,

$$r[R^2(t) - R^2(0)] = b[B^2(t) - B^2(0)].$$

with $R(t)$ and $B(t)$ set to zero.

34 In theory, the combat between equal forces continues for an infinite length of time sincee the equatoins and variables are continuous, but in practice, targets are discrete and the battle will end at some point. The forms of the Lanchester equations presented here assume that combat will be continued untill the end. Breakpoints can be incorporated into the equations, allowing one to model forces that do not fight to the finish and that might "break" at different force levels. The choice of these breakpoints may be critical to the outcome of a model. See Taylor, *Lanchester Models of Warfare*, Vol. I, pp. 123-40, 236-368.

The square law captures an important characteristic of modern warcfare in that it incorporates the advantages concentration of fire gives. The differential casualty ratio, this is defined as the ratio of the loss rate of Blue and Red forces (dB dR = rR bB) and varies inversely with the force ratio. Because the larger force can concentrate its fire on the smaller forces, if the larger force adds more numbers, its losses will decline because it can destroy the enemy even more rapidly. the more the winning force outnumbers the losing force, the greater will be the loss rate of the losing force, while the winner's loss rate will stay the same. The battle will therefore last a shorter period of time, and the winner will suffer fewer casualties

The behavior of the differential casualty ratio points out the importance of concentration and supports the military dictum of never dividing one's force. As Lanchester recognized, it is always preferable to outnumber an opponent by as much as possible and to engage the enemy with the force simultaneously rather than sequentially:

As an example of the above, let us assume an army of 150,000 giving battle in turn to two armies of 120,000 and 90,000 respectively, equally well armed (same effectiveness): then the strengths are equal since $(150{,}000)^2 = (120{,}000)^2 + (90{,}000)^2$. If, on the other hand, the two smaller armies are given time to effect a junction, then the army of 150,000 will be overwhelmed, for the fighting strength of the opposing force, 210,000, is no longer equal, but is in fact nearly twice as great-namely, in the relation of 49 to 25.

Thus, there is a distinct advantage in concentrating forces because square of the sum will be greater than the sum of the square of the component forces [Ref. 21: pp. 89-100].

(2) The Linear Law. Lanchester's linear law drops the assumption of concentration of fire. Lanchester originally derived the linear law by considering ancient short-range weapons: soldiers equipped with weapons such as swords could find little advantage in concentration because several soldiers could not simultaneously attack an opponent. Ten men with swords fighting one man would have to fight him sequentially, as they could not all get close enough to engage him simultaneously. Under more modern conditions, the linear law may hold in artillery duels using indirect fire.

In the case of indirect fire, both sides are engaging in fire that is not directed against any one target but is evenly distributed throughout a given area. Firers do not have information on the effects of fire and do not shift fire to a new target when a target is disabled. Targets are overkilled, and indirect fire is therefore less efficient than direct fire. This lack of retargeting means that fire is not concentrated as is direct fire.

Artillery duels provide a good example of indirect fire. the rate of loss of Blue forces under fire will depend not only on the number of Red guns firing and Red's effectiveness, but also on the size of Blue's forces in the area under fire. This can be seen by imagining a group of Blue artillery units distributed uniformly over an area and then subjecting the area to bombardment. If we assume a constant amount of bombardment, then the more artillery units in the area, the more losses they will sub- stain per unit time. Thus, the rate of loss is similar to that of the square law, with the addition of a term for the size of the force under attack. If we assume homogeneous forces with the same weapons and vulnerabilities on each side, we can write the equations for the linear law:

$$\frac{dB}{dt} = -BrR$$

$$\frac{dR}{dt} = -RbB.$$

Integrating the above equations gives the linear law equality condition:

$$rR(0) = bB(0).$$

The linear law differs from the square law in several important re- spects. First, it does not give any special advantage to force level. The force level is not squared and counts for as much as effectiveness. Second, concentration of forces has no effect on reducing the winner's total casualties. Since both side's force level appears in the loss rate, adding more forces increases the number of targets in the area for the enemy to kill, as well as increasing the enemy's own loss rate. The battle may end sooner, but the winner will still lose the same number of troops. This is reflected in the fact that the differential casualty ratio for the linear law $(dB/dR = r/b)$ does not depend on the force levels of the two forces.

So, the use of the linear law has been limited to specific weapons and situations.[35] Massing forces to create local superiority in fighting strength is still feasible under the linear law and is necessary to success. The difference is that concentrating past

[35] For example, one aircraft is said to be worth four of an enemy's aircraft, then an exchange rate of 4 to 1 will be formed. If nothing else is given, this suggests a linear law.

the point where one wins is to no avail, whereas in the case of the square law, it helps to reduce the winner's casualties [Ref. 21: pp. 100-103].

b. *Critique of Lanchester's Theory*

Lanchester's theory suffers at least three serious problems.[36] This discussion is, of course, concerned specifically with problems beyond those encountered by all models (for example, the need to aggregate; to estimate effectiveness coefficients and other numbers; to idealize and simplify).

(1) Problem 1 : No Considering Withdrawal. A plausible model of ground war should capture the basic connection between attrition and the movement of the battle front. Historically, the basic rationale for withdrawal has been to reduce one's attrition: if a defender's attrition exceeds a certain threshold, he may withdraw, which action reduces his attrition. Not one of the Lanchester models (for example, the so-called square law or linear law) reflects this essential feedback, nor is it mathematically possible for them to. Not one of these equations can capture the effect of withdrawal - a response to attrition - on the rate of attrition itself.

This is evident from Lanchester's attrition equations themselves. When solved for the opposing Red and Blue forces surviving at any time, t, the Lanchester square differential equations yield the following formulas (See the previous section.):

$$R(t) = \frac{1}{2}[\{R(0) - \sqrt{\frac{b}{r}}B(0)\}e^{\sqrt{br}\,t} + \{R(0) + \sqrt{\frac{b}{r}}B(0)\}e^{-\sqrt{br}\,t}]$$

and symmetrically,

$$B(t) = \frac{1}{2}[\{B(0) - \sqrt{\frac{r}{b}}R(0)\}e^{\sqrt{br}\,t} + \{B(0) + \sqrt{\frac{r}{b}}R(0)\}e^{-\sqrt{br}\,t}].$$

$R(t)$ and $B(t)$ are the Red and Blue forces at time t, which r and b (real numbers between zero and one) are their respective Lanchester effectiveness coefficients. Clearly, $R(t)$ and $B(t)$ depend only on r, b, t (time), and the initial Red and Blue forces. The rate

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[36] Joshua M. Epstein explained in the book of "*The Calculus of Conventional War: Dynamic Analysis without Lanchester Theory*, (Brookings Institutions, 1985), and *Strategy Force Planning*, (Brookings Institutions, 1987)."

of withdrawal does not appear; thus withdrawal does not affect the rate of attrition. The same is true for all other forms of the Lanchester's equations.

Formulas have been tendered to represent the velocity of the battle front as a function of the changing force ratios produced by the Lanchester attrition equations. Assuming Red to be a superior attacker, one procedure is to calculate the force ratio $x = R(t)/B(t)$ from the attrition formulas above and then to calculate the velocity of the front, $V(t)$, as a function of that ratio using the formula:

$$V(t) = \frac{V_{\max}}{\sqrt{e^{(4/x)2}}},$$

where $V_{\max}$ is the maximum feasible rate (in kilometers) There are many alternative formulas posting velocity as a function of the force ratio.[37] But these are implausible algorithms in that they are "one-way" calculations; movement is influenced by attrition, but not conversely. The movement of the front is not fed back into the ongoing attrition process, when the entire point of withdrawal was to affect that process - to reduce one's atrition rate.[38] Surely it is contradictory to assume some benefit in withdrawal (otherwise, why would anyone withdraw?) and then to reflect no benefit whatsoever in the ongoing attrition calculations. Yet all the original forms and contemporary extensions of the Lanchester's equation suffer this glaring inconsistency.[39]

By the way, North Korea will attack with heavy artillery and motar bombardment in the initial war. These will cause the ROK high attrition. Therefore, the

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37 Alternative formulae are given in Tayor, *Lanchester Models*, Vol. II, p. 533.

38 It should be noted that withdrawal may be intended to lure the enemy into entrapment or ambush, through these tactical withdrawals would also have an effect on attrition that Lanchester attrition equations cannot reflect. In the case of the traditional forced withdrawal, one may dispute whether it is the attrition rate specifically that the defender is seeking to reduce; it might be a complicated function of cumulative attrition, attrition rate, of change of attrition rates, and so forth. Withdrawal seeks to alter (or to prevent from worsening) the pattern of defense death. No such effect will be evident from the Lanchester's equations because withdrawal has no effect on attrition rates: there is no feedback from withdrawal to the course of attrition. Indeed, Lanchester's own exposition made no attempt whatsoever to estimate either the effect of attrition on movement or the effect of movement on attrition.

39 The only other interpretation is that the Lanchesterian framework is consistent, but is systematically biased in favor of the offense: the defense never gets any attrition-relief by withdrawing, though he vainly tries, because the offense always manages to stay in "full concentration" contact. That is, the offense perfectly anticipates the defender's tactical withdrawls, and always has the mobility, reconnaissance, and other capabilities necessary to keep attrition going as though no withdrawal were underway. This point applies to all - not just Lanchester - models that lack feedback from withdrawal to attrition.

ROK might be willing to withdraw to a new position to avoid further losses, at least for the moment, in the situation of the less static military forces.

(2) *Problem 2 : No Trading of Space for Time.* Because there is no feedback from withdrawal rates to attrition rates, the Lanchester expression for the duration of the war (that is, the time elapsed) gives exactly the same answer whether the defender withdraws at ten miles or does not withdraw at all. The Lanchester duration (time) is totally independent of the amount or rate of withdrawal (space) and of the functional form chosen to calculate the velocity of the front. This, too, is easily demonstrated.

Letting t_{end} stand for the time (in days) required by Red to annihilate Blue, the square law duration will illustrate the general point. There are various ways to write the duration: one is[40]

$$t_{end} = \frac{1}{\sqrt{br}} \ln\left(\frac{\sqrt{R_0^2 r} + \sqrt{B_0^2 b}}{\sqrt{R_0^2 r} - \sqrt{B_0^2 b}}\right)\frac{1}{2}.$$

Here again t_{end} obviously depends only on r, b, and the initial Red and Blue forces. The duration of the war, t_{end}, is totally independent of the amount or rate of withdrawal. The same is true of the duration formulas derived from other forms of the Lanchester differential equations. In short, the Lanchester's equations are incapable of representing perhaps the most fundamental tactic in military history: trading space for time. *Given Blue and Red forces and effectiveness ratings,* how much longer does the war last if, rather than holding his ground, Blue (the defender) trades away 10 kilometers? Or 50? Or 100? According to the Lanchester's equations, not one second longer. All else fixed, how much longer does the war last if one adopts this movement function as against that movement function? The Lanchester's equations are incapable of answering the question.

In the situation of the Korean peninsula, the ROK and North Korean static force ratio is 1 to 1.4 (20 ADEs vs. 28 ADEs). Therefore, when North Korea strikes first, the ROK will trade space for time. Although the ROK does not have enough space to fight while trading space for time, there is more or less 40 kilometer space just in the direction from the front to Seoul.

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40 See Kaufmann, *Arithmetic of Force Planning,* p. 210.

(3) *Problem 3 : No Diminishing Marginal Returns.* This point concerns the most famous and widely used result of Lanchester's theory, the square, or N^2, "law." Given Red and Blue forces, Lanchester states his famous N^2 stalemate condition as follows: "the fighting strengths of the two forces are equal when the *square of the numerical strength multiplied by the fighting value of the individual units are equal.*"[41] What he called *fighting values* are simply the Lanchester coefficients, *b* and *r*. Thus in modern notation the square law says that a Blue force, $B(0)$, will stalemate a Red force, $R(0)$, only if

$$bB(0)^2 = rR(0)^2.$$

Equivalently, the effectiveness ratio, b/r, must equal the square of the numerical ratio, $R(0)/B(0)$, for Blue to stalemate Red. So, for example, to stalemate an adversary three times one's size (in lethality units), it does not suffice to be three times as effective (per unit), or even six, seven, or eight times. Rather, one must be fully nine - or N^2 - times as effective. There simply is no convincing evidence of this; indeed, there is impressive evidence to the contrary.

As noted explicitly below, one of the necessary (though not sufficient) conditions for any of the Lanchester's equations to hold is that no movement (that is, defensive withdrawal) of the front be possible (since movement would have some effect on attrition rates, a feedback precluded in the Lanchester's equations). What sorts of military engagements would qualify? Assaults on small, defended islands, for example.

The case of Iwo Jima - an island roughly five miles long, where the defender was basically surrounded, and where movement of the front was all but impossible - is among the special cases to which Lanchester's equations may apply. It is a case in which there is any statistical correspondence between events as they unfolded and as hypothesized by the Lanchester,s equations. Even if the statistical fit were good, there would be no basis for extrapolation to cases where movement is possible (for example, Europe). And, in fact, the fit is not good; J. H. Engel's famous "fit" of the Lanchester square equations to Iwo Jima is marred by insufficient data. Specifically, Lanchester's equations yield theoretical attrition curves for each side, defender and attacker. "Engel assumed that the attrition history of the defending [Japanese] forces was in accord with the Lanchester square-law predictions, since no data on observed attrition history for

[41] Lanchester, *Aircraft in Warfare*, p. 48. Lanchester's emphasis. A stalemate is, of course, a fight to the finish in which both sides are drawn to zero.

that force were available."[42] This is why, despite his tantalizing "fit" of the square equations to the U.S. data, Engel himself wrote, "The question might be raised: are there other forms of Lanchester's equations that might apply to the battle of Iwo Jima.... The answer to this question is 'yes'."[43] Commenting on the Engel study, James Busse notes that "there must be enough data from both sides (enemy and friendly) of the battle to allow a quantitative comparison between theory and experiment.... Engel's theoretical fit to the American data is remarkably good, but nothing can be said about the fit of the missing Japanese data to the predictions of Lanchester's equations. In this repect, more data is needed before an adequate verification of Lanchester's theory will exist." Busse then attempted to fit the finite difference analogue of the Lanchester square equations to the Inchon-Seoul campaign. He found that they "are not satisfied by the data pertaining to this engagement."[44]

History's refusal to conform is not surprising when one notices that, at bottom, the Lanchester square equations deny a phenomenon to which virtually all social processes - including war - are subject: the phenomenon is diminishing marginal returns. To see this, a brief derivation is necessary.

The Lanchester square law is derived from the Lanchester square differential equations:

$$\frac{dR}{dt} = -bB \quad ; \quad \frac{dB}{dt} = -rR.$$

These equations say that the instantaneous rate of decrease in Red's force (the time derivative, dR/dt) equals a constant (the Lanchester effectiveness coefficient, b) times Blue's strength (B), and analogously for Blue (the negative signs indicate that forces are decreasing). They imply the more revealing equation

$$\frac{dR}{dB} = \frac{bB}{rR},$$

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[42] Helmbold, "Some Observations on the Use of Lanchester's Theory for Prediction," p. 778. Emphasis added.

[43] J.H. Engel, "A Verification of Lanchester's Law," pp. 170-71.

[44] James J. Busse, "An Attempt to Verify Lanchester's Equations," pp. 587-97. Quotations are from pp. 587-88 and p. 596.

from which the famous N^2 law is obtained directly by integration.[45] Let us take a closer look at equation ($dR/dB = bB/rR$), which implies the square law.[46] It asserts that the instantaneous casualty-exchange ratio, dR/dB - the limiting ratio of Reds killed per Blue killed - is a linear function of the force ratio, B/R. [47]

Thus the casualty-exchange rate, dR/dB, grows at a constant - never marginally diminishing - rate, b/r, as the force ratio, B/R, grows. No crowding, no force-to-space constraint, ever sets in to moderate the "concentratability" of Blue's force. This is highly implausible; it is the essence of the Lanchester square law.

Some forms of the Lanchester differential equations do not imply a square relation (for example, the linear law), while others allow for asymmetrical solutions in which one side enjoys a square effect and the other does not (the so-called ambush variant).[48] Where (a) no diminishing marginal returns set in (for example, no force-to-space constraints apply) and (b) where movement of the front is precluded, certain forms may be more or less appealing. But as noted above, no form of the Lanchester's equations registers, or can register, the effect of withdrawal (a response to attrition) on the rate of attrition itself. For that reason, they suffer the serious problems set forth at the outset.

According to the Lanchester's theory based on 'no diminishing marginal returns', the ROK would never win war. However, the ROK has many advantage able to win war despite of inferiority in the static strengths.[49]

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[45] See the square law subsection above. As noted in the text above, the effectiveness ratio, b/r, must equal the square of the numerical ratio, R/B, to stalemate.

[46] In fect, the above equation both implies and is entailed by the Lanchester square state equation given in the above note.

[47] If we define $dR/dB = y$, $B/R = x$, $b/r = a$ (positive constant), then $y = ax$ (linear function).

[48] This may well be the most plausible of all Lanchester variants, when applied to guerrilla engagement. See Taylor, *Lanchester Models*, Vol. I, pp. 169-81.

[49] See 'the ROK Ground Force Structure Planning Issues' subsection in Chapter II and the preceding section.

2. Epstein Model

As noted earlier, the Dynamic model in this subsection was based on one developed by Joshua M. Epstein.[50]

The equations presented in this section are those which the Congressional Budget Office modified the model, as described in Epstein's 1985 publication. In particular, modifications were incorporated to allow the addition of reinforcements and the use of weapons for follow-on-force attack. The model was also expanded to accept attrition rates that vary over the course of the war.

Epstein attempts to capture these phenomena through mathematical equations describing each side's starting position and losses for each day of a theoretical war. When hostilities begin, each side's total forces can be assigned a numeric value, such as the weapon effectiveness index weighted unit value (WEI/WUV) score described in chapter 2. In addition, each side might start out with a specific number of ground-attack aircraft with which it can inflict losses on the other side's ground forces. As the war progresses, each side loses ground cambat capability and aircraft as determined by the equations Epstein has developed. The defense; in order to maintain its losses at an acceptable level, gives up ground. The mathematical process of removing ground and air assets can continue for a specified number of days or until one side is decimated [Ref. 8: pp. 77-83].

In this subsection, the model's ground and close air support variables are defined. Then the equations are presented and their developments are explained.

a. Variables

Ground Forces

A(t) Attacker's ground force value surviving at the start of day t[51]

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[50] Joshua M. Epstein, *The Calculus of Conventional War: Dynamic Analysis Without Lanchester Theory*, (Washington, D.C.: Brookings Institution, 1985).

[51] The term *force value* refers to the aggregate combat power of the force (based primarily on its weaponry) expressed in common numerical units. In the U.S. Army's so-called WEI/WUV system, described in chapter 2, the force value may be gauged by weighted aggregation of the strength of its component units. The components are assigned weapon effectiveness indices (WUVs). These are then weighted and summed to obtain the force's weighted unit value (WUV). The WUV score of a standard U.S. armored division is 47,490. (This, by definition, is the WUV score of one amored division equivalent, or ADE. It can be used to convert ADEs to WUVs and vice versa.) For WUV scores, see William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*.

AREINF(t)	Attacker's reinforcements available on day t
ATOT(t)	Attacker's total ground forces available on day t
APROS(t)	Attacker's prosecution rate on day t
AGL(t)	Attacker's losses to ground combat (measured in attrition rate) on day t
ATL(t)	Attacker's total ground force loss rate on day t, to both air and ground forces
AMAX	Attacker's threshold attrition rate
D(t)	Defender's ground force value surviving at the start of day t
DREINF(t)	Defender's reinforcements available on day t
DTOT(t)	Defender's total ground forces available on day t
XCHNG(t)	Exchange rate for ground combat on day t (that is, attackers lost per defenders lost)
DMAX	Defender's threshold attrition rate
DTL(t)	Defender's total ground force loss rate on day t, to both air and ground forces
W(t)	Defender's rate of withdrawal in kilometers per day
WMAX	Defender's maximum rate of withdrawal in kilometers per day
t	Time in days, t = 1, 2, 3, ...

Close Air Support Forces

AAC(t)	Attacker's close air support (CAS) aircraft on day t
AACL	Attacker's CAS aircraft attrition rate per sortie
ASRTY	Attacker's daily sortie rate per CAS aircraft
ASRTYPK	Defender's armored fighting vehicles killed per attacker CAS sortie
ACASL(t)	Attacker's ground forces lost to defender's CAS on day t
DAC(t)	Defender's CAS aircraft on day t
DACL	Defender's CAS aircraft attrition rate per sortie
DSRTY	Defender's daily sortie rate per CAS aircraft
DSRTYPK	Attacker's armored fighting vehicles killed per defender CAS sortie
DCASL(t)	Defender's ground forces lost to attacker's CAS on day t
NUMAFV	Number of armored fighting vehicles per armored division equivalent
L	Lethality points (or WEI/WUV score) per ADE

b. *Equations*

$$A(t+1) = A(t)[1 - AGL(t)] - ACASL(t)$$

and

$$ATOT(t) = A(t) + AREINF(t).$$

Similarly,

$$D(t+1) = D(t) - \frac{AGL(t)A(t)}{XCHNG(t)} - DCASL(t)$$

and

$$DTOT(t) = D(t) + DREINF(t)$$

where

$$AGL(t) = APROS(t)(1 - \frac{W(t)}{WMAX})$$

and

$$W(t) = 0$$

if $DTL(t\text{-}1) \leq DMAX$, or

$$W(t) = W(t-1) + [WMAX - W(t-1)](\frac{DTL(t-1) - DMAX}{1 - DMAX})$$

if $DTL(t\text{-}1) > DMAX$.

Furthermore,

$$DTL(t-1) = \frac{DTOT(t-1) - D(t)}{DTOT(t-1)}$$

and

$$XCHNG(t) = 3 - 0.5[ATOT(t)/DTOT(t)]$$

if $ATOT(t)/DTOT(t) < 5.5$, otherwise

$$XCHNG(t) = 0.5.$$

The attacker's daily prosecution rate--denoted by APROS(t)--according to Epstein "represents the rate of attrition to ground combat that the attacker is prepared to suffer in order to press the attack at his chosen pace." By setting W(1) = 0 and the first day's prosecution rate, APROS(1) < AMAX, then

$$APROS(t) = APROS(t-1) - \left(\frac{AMAX - APROS(t-1)}{AMAX}\right)[ATL(t-1) - AMAX]$$

and

$$ATL(t-1) = \frac{ATOT(t-1) - A(t)}{ATOT(t-1)}.$$

For the treatment of each side's aircraft and ground losses to the enemy's air support (CAS) aircraft,

$$DAC(t) = DAC(t-1)(1 - DACL)^{DSRTY}$$

and

$$AAC(t) = AAC(t-1)(1 - AACL)^{ASRTY}.$$

To determine the daily losses to each side's CAS aricraft,

$$DCASL(t) = \frac{L}{NUMAFV} ASRTYPK \bullet AAC(t) \sum_{i=1}^{DSRTY} (1 - AACL)^{i-1}$$

and

$$ACASL(t) = \frac{L}{NUMAFV} DSRTYPK \bullet DAC(t) \sum_{i=1}^{ASRTY} (1 - DACL)^{i-1}.$$

(The model accommodates nonintegral sortie rates by appending an additional term to represent the fractional sortie, for both attacking and defending aircraft.)

c. Considerations about Estein Model on the Korean Peninsula

Dynamic Comparisons take into account each side's ability to destroy the other and the effect of attrition over time. Dynamic comparisons can be viewed as starting where static comparisons end. In addition to counting each side's weapons, the outcome depends on the ability of each side's systems to cause casualities in the other side. Thus the rates at which this can be done determine the outcome of a force comparison. In this way, Dynamic models can, based on numerous assumptions and inputs, simulate the interaction of many different types of weapons, the impact of different strategies, and the contribution of logistic support.

When considered on the Korean Peninsula, first, North Korea is willing to endure high attrition rate in order to press his attack vigorously, while the ROK is expected to withdraw whenever his daily attrition rate exceed any limit level. Second, the ROK's maximum rate of withdrawal in kilometers per day might not exceed some 20 kilometers.[52] Third, the ROK air force would appear to be superior to that of North Korea in combat capability, although numerically small. The question is how qualities of the ROK are matched to quantities of North Korea. Finally, the ROK and North Korean reinforcements available on each day are key points and open to questions. As noted in Ground Reserve Forces subsection, the ROK has a very large advantage in the number of reserve forces. How fast the ROK could, however, mobilize those after war is to open to questions.

Because variables and values used in the Dynamic model are highly dependent on the general conduct of war, many assumptions may be changed during war. Some of these conditions cannot be predicted, thus placing the credibility of such model's outcomes in question. So, the Epstein model, like any quantitative method for evaluating the relationship between two military forces, cannot be used to predict the outcome of an actual conflict. Indeed, some factors that have a large impact on the outcome of a conflict--such as leadership, morale, tactical competence--cannot be quantified. Others, and such as location of the attack, weather and other conditions at the time of attack, and the element of surprise cannot be predicted. Especially, the element of surprise will absolutely influence the outcome of war on the Korean Peninsula.

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52 During the Korean War (1950-1953), North Korea's advance rate (KM/day) was 13 and its advance rate in break-through operations was 17. That is, Seoul was captured in 3 days after war. At its time the ROK was not prepared for war. At present North Korea has more firepower and mobility, but the ROK's front is fortified. See T. N. Dupuy, *Understanding War*, (New York: Paragon House Publishers, 1987), pp. 151-55.

IV. CONCLUSIONS

In addition to the fact that North Korea has roughly forty percent more ground forces, the ROK vulnerability is to be deployed forward along the front and to not yield a great deal of territory. Though the forward defense is to avoid a surprise attack, it, ironically, causes the ROK to be vulnerable in the situation inferior in strengths. However, the balance of the ground forces on the Korean Peninsula is nearly kept by the U.S. Armed Forces stationed in Korea. This is one of the reasons why U.S. Armed Forces should exist in Korea for prevention from war.

An attack will be successful if the attacker has a three-to-one superiority over the defender. This rule of thumb is so widely accepted that it has become virtually a military principle, and, indeed, a rudimentary theory of combat. North Korea does not have a three-to-one superioty over the ROK. What North Korea can overcome the three-to-one rule of thumb might be controlled by the degree of any surprise attack [Ref. 22: pp. 31-37]. North Korea has the initiative and is able to choose the place and time of attack. The element of surprise that has a large impact on the output of a war cannot exactly be predicted, but that factor must be a critical factor. Surprise attack means that the warning time of an attack on the ROK could be very short, perhaps as little as 12-24 hours. It is important for the ROK to increase the warning time of an attack by North Korea. Its importance can be expected in a viewpoint of that improvement of early-warning capabilities is emphasized in the Meeting of the ROK-U.S. Security Council (SCM).[53] The danger of this situation for the ROK lies partly in the fact that one-third of the ROK population is within 25-30 miles of the DMZ and that much of its industry is located in Seoul [Ref. 1: p. 37].

However, the trend in the military balance is moving in favor of the ROK. The main reason for this trend in the military balance is the ROK's more dynamic economy. North Korea has for many years spent a much larger proportion of its GNP on defense than the ROK: 20-25 percent for North Korea vs. 5-6 percent for the ROK. But the ROK spending is based on increasingly larger GNP. $90.5 billion for the ROK vs. an estimated $18.5 billion for the North in 1986. Thus, in 1986 the absolute amount of the ROK dedense expenditure-$5.4 billion-exceed at $4.6 billion. This gap in defense spending will

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53 Research Institute for Peace and Security, Tokyo, *Asian Security 1985*, pp. 103-04, *Asian Security 1986*, pp. 103-04.

almost certainly widen in the years ahead given likely GNP growth rates in the ROK of at least 7-8 percent per year and, in the North, both a stagnant economy and the difficulty of raising further the percentage of GNP directed to the military.

In Chapter II, this study discussed the ROK ground force structure planning. In a viewpoint of the follow-on forces attack concept and forward defense, this study emphasized the artillery and commando troops. When the ROK reinforces troops and equipment with large defense expenditures, it is estimated that the ROK capabilities will reach the 80 percent level in the mid-1990s or toward the end of this century [Ref. 1: p. 38].

Finally, a great task with which the ROK is now entrusted is the creation of a deterrent to an all-out war. This is feasible when the balance of each side's military strength is kept. To keep the balance of military strengths are needed continuous economic growth and continuously long-termed planning for military strength reinforcement in the situation of stability. Another task is that the U.S. Armed Forces remain stationed in Korea. If this is not possible, a U.S. force withdrawal would have to be done slowly and gradually under the proper conditions. It should be part of a bargaining process with North Korea, taking advantage of the opportunity to lessen military tensions and force levels on both sides.

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