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## The sinews of power: Labor and capital in the production of national military force capability

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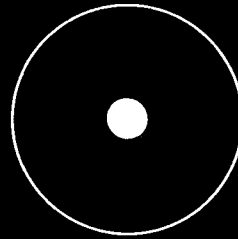
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Berlin

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THE SINEWS OF POWER:  
LABOR AND CAPITAL IN THE PRODUCTION  
OF NATIONAL MILITARY FORCE CAPABILITY

by

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## Abstract

This paper provides an overview of the arms accumulation process and explicates two central and related items within that process: the factors that go into the production of a state's military capabilities and the choices that states make between these factors. Using data on fifty major countries for the time span from 1962 to 1980, measures of capital and labor inputs are produced by employing principal components analysis in a pooled cross section/time series context. These measures are then used as the basis for assessing the level of conventional military capability available to states given a capability production function which assumes diminishing marginal returns to isolated factor inputs. The choice between inputs to capability production is discussed and a model representing the major considerations in such a decision is subject to empirical scrutiny.

## Zusammenfassung

Dieser Aufsatz beinhaltet einen Überblick über Prozesse des Ausbaus von militärischem Machtpotential. Zwei wesentliche und eng miteinander verknüpfte Komponenten, die in den Rüstungsprozeß eingehen, sowie die Wahl, die Staaten bezüglich dieser Komponenten treffen, werden erläutert. Maße für den eingebrachten Aufwand an Kapital und Arbeitskraft werden für 50 Staaten während der Jahre 1962 bis 1980 entwickelt. Dafür wird eine Hauptkomponenten-Analyse mit der aus aggregierten Querschnittsdaten zusammengestellten Zeitreihe durchgeführt. Die so erhaltenen Maße werden für die Bewertung des vorhandenen konventionellen Rüstungspotentials der Staaten herangezogen. Sie gehen in eine Produktionsfunktion ein, die von der Annahme abnehmenden Grenznutzens isolierter Input-Faktoren (Personal, Kapital) ausgeht. Die Wahl zwischen den Input-Faktoren Kapital und Personal für das Rüstungspotential der Staaten wird diskutiert. Ein Modell, in das die wichtigsten Bedingungen für diese Entscheidung eingehen, wird empirisch überprüft.

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## INTRODUCTION

This is the first in a series of papers which provides a theoretical and empirical basis for understanding the dynamics of arms accumulation. The effort is itself part of a larger project, GLOBUS, which seeks to develop a global model that illuminates the stresses and strains governments and their peoples are likely to confront through the next two decades. The GLOBUS project focuses on major dimensions of political and economic activity, as well as relations between these spheres. In attempting to do this it integrates these into a complex global model that emphasizes both the domestic and international arenas. There is, of course, a broad range of problems on the acknowledged and unacknowledged world agenda for the remainder of the twentieth century. One of the most critical items on that agenda is the arms accumulation problem. It is assumed that this problem is embedded in a series of vital domestic and international relationships and that the developments we may see in this area may have grave implications for a large number of other human activities. With this in mind, we have decided to include a representation of the processes surrounding arms dynamics within our model.

In this paper we provide an overview of the framework to be used in modeling the arms accumulation process. The major part of the paper, however, is devoted to an explication of two related elements within that process: the factors that produce a state's military capabilities and a state's choice between these factors. As we point out below, it is insufficient to use the defense budget of a state for purposes of representing the capabilities of a state. This is not to deny the importance of the defense spending question, but rather to point out the need to go beyond budgets when attempting to deal with the problem of arms accumulation. Herein, we propose a measure of the conventional force capabilities of a state that is useful for cross-temporal and cross-sectional purposes. This measure is expressed as a function of two critical elements:

military capital and military labor. Much of the report is devoted to measuring these two inputs to the force capability production function and elaborating on the way in which states choose between labor and capital in constructing their armed forces.

#### ARMS ACCUMULATION

Most work on arms accumulation has focused exclusively on the resource allocation question. While we view this as important, we do not believe it to be the only question that needs to be answered in this area. That aside, it is apparent that this traditional focus has had critical implications for the way in which analysts operationalize certain important concepts and, as a consequence, the conclusions they draw from their work. For example, when trying to represent stimulative factors in decisions to allocate more or less resources to defense, analysts have almost exclusively represented these as some measure of the defense spending efforts of a nation's opponent. This dramatically diminishes the data availability problem. However, this sort of representation necessarily entails certain weaknesses. While defense spending and changes therein provide some clue both to an opponent's strength and intentions, it is not at all clear that these are the type of stimuli which provoke another nation to adjust its defense spending. Let us leave aside the question of intentions and focus on the capability question.

One of the few points on which most arms accumulation analysts agree is that a certain level of defense spending in one country does not buy the same level of military capabilities elsewhere. Nations have different endowments and basic capabilities, they face different types of security problems, and they will choose to spend their defense budgets in different ways. While these differences may, in part, be reflected in the "responsiveness" one nation has for another's defense outlays, the essence of the stimulus-response relationship is likely to be poorly captured in an equation system incorporating others' defense spending as the primary international stimuli.

What is really needed is a measure of the opponent nation's military capabilities, not its costs. Costs are a central consideration in defense spending decisions. But the question of costs is one decision-makers are likely to attend to only with reference to their nation's own defense program.

The problem holds equally for some of the more elaborate models of arms races. Here analysts often introduce the notion of some ratio-goal on which arms spending decisions are presumed to depend. It is not the strength or movement in another's defense capabilities that is alone important. Rather the critical question is what this implies for the relative position of the responding state. If the relative position of the state is within an acceptable range, then one choice is entailed. If it is outside that range, another choice should be favored. Again, the comparison of defense spending levels seems inappropriate. What both sides' money buys, what has been purchased in the past and remains employed, and the consequent relative capabilities are the important considerations.

It would seem then that a shift away from the monetary measuring stick is required. Some steps in this direction have already been taken by a number of scholars. To date, however, work in this area has not advanced very far and another effort is clearly required. The following pages serve to detail a new attempt at grappling with this problem.

The process of accumulating arms and the associated process of paying for them is complex. We argue that the defense spending decisions of states which fundamentally determine the level of arms) are driven by a variety of forces (refer to Figure 1). Of particular importance is the extent to which the real military capabilities of the state conform to some desired level which itself is a function of, among other things, assessed security threat from both the international and domestic environments. We assume that these capabilities require a certain relatively fixed proportional outlay for their maintenance.

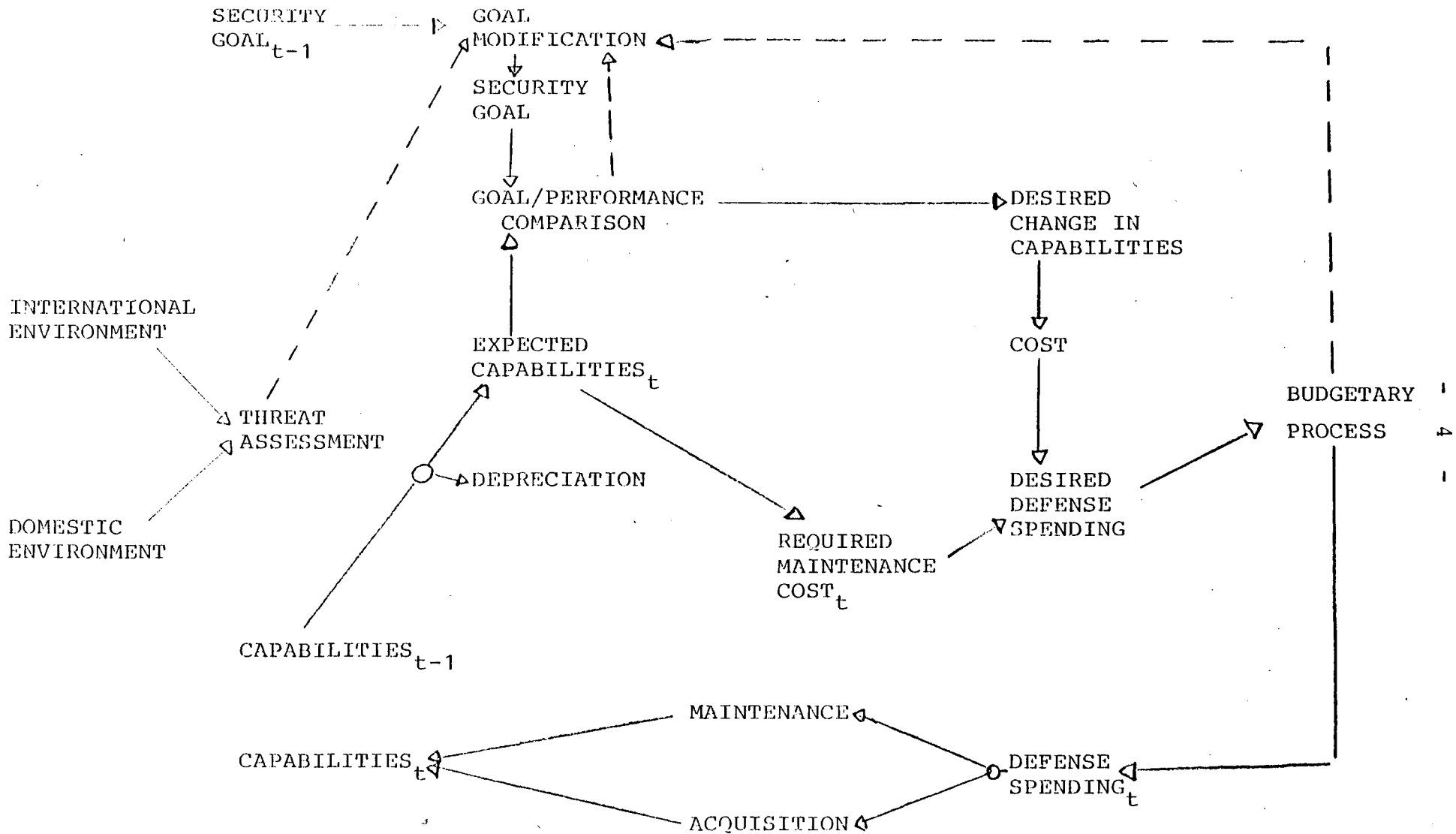


Figure 1: Defense Capabilities and Defense Spending--A Process View



Defense spending levels do not necessarily conform to the arithmetic of desired defense capabilities. Budgeting pressures may require a level of spending below that deemed required. On the other hand, the budgetary process may also allow for a defense spending level in excess of that required in light of present security goals. In an indirect way as well, the budgetary process will affect the defense capabilities of a nation by helping to shape the security goal itself.

Improvement in our understanding of the dynamics of arms accumulation hinges critically on the development of a measure of military capabilities. This measure should provide at least an approximate assessment of the military strength of a nation in both absolute and relative terms. The character of the measure should allow for comparison of military capabilities both across countries and over time. In addition, the measure should be associated, under specified conditions, with the financial outlays used to support the defense sector.

An index which provides for at least an approximate assessment of the absolute and relative military capability of a nation will go far in achieving the goal of representing what decision-makers perceive when they attempt to assess the national security positions of their states. The stock of military power has greater significance in the evaluation of this situation because of the cross-national cost differentials in the acquisition and maintenance of military power. Cross-temporal cost differentials need to be reflected as well, since the military strength of a state may alter dramatically through time and in a way not necessarily revealed by defense spending levels because of such factors as obsolescence, deterioration, war-connected losses, and changing acquisition and maintenance costs.

The military strength that a nation accrues must be financed. However, what is paid for out of the defense budget depends at any one time not so much on any slight shift in the defense spending of another state as it does on the existing stock of capital and associated personnel costs as well as

any alterations in these factors. Defense establishments usually are not created overnight nor are they quickly disassembled. The existence of the establishment entails costs that are normally carried in the budget. These represent relatively fixed costs and they should vary both across countries and over time in light of certain political and economic considerations, e.g., conscription, labor force size, wealth, etc. These costs, too, will vary in response to decisions to alter the military strength of the state. A measure of national military capabilities should reflect these considerations.

#### MEASURING MILITARY CAPABILITIES

Mihalka (1980) has undertaken a preliminary effort to deal with this problem. Since the solution we propose follows from his work, it would be useful to summarize the findings of his research. Mihalka examined two cross-sectional slices of data (for 1972 and 1979) on the weapons inventories and military personnel of 57 countries. Employing principal components analysis on five variables (number of tanks, combat vessels, combat aircraft, strategic launchers and size of armed forces) he was successful in isolating a single robust factor in each cross-section. The factor scores generated on the basis of these results produced a reasonable picture of the rankings in the international hierarchy in those two years. Although the analysis did not allow for a comparison of the absolute levels of military strength held by any state at the two times of observation, the relative standings in both years appear not too unreasonable. Mihalka then went on to briefly describe a possible relationship between defense outlays and capabilities as measured by his index and also to give brief consideration to some of the possible political, strategic, and economic determinants of a nation's military capability.

Mihalka's findings represent a clear step forward. However, the results can be fairly criticized on a number of grounds. First, as Mihalka freely admits, the capability scores generated on a cross-sectional basis cannot be used sensibly in a dynamic analysis of the absolute level of military capabilities. Second, the assumption implicit in his

model that the marginal return associated with the addition of each unit of weapons stock is constant may be challenged. Equally plausible, given organizational complexities, may be the assumption that there are diminishing returns to the inputs to military capabilities. By way of example, the return in military power to Turkey by its increase in tank holdings from 1500 in 1975 to 3500 in 1980 may represent a greater marginal increase in capabilities than the Soviet tank increase from 45200 in 1975 to 48200 in 1977. An alternative conception of the marginal return might also give a more reasonable portrayal of the distances between states in the international military hierarchy than that suggested by Mihalka's results. Third, and critical from the theoretical perspective we take, is the problem of justifying the inclusion of a measure of personnel in an index representing a stock that depreciates. There is no denying that personnel variables are important in assessing the military power of a state. It does, however, seem inappropriate to assume that they are subject to the depreciative tendencies weapon systems normally manifest. A fourth problem with Mihalka's scale is its inclusion of a strategic weapons index. We believe that such weapons represent a very different class of capabilities and that they should be considered separately.

Our proposed measure extends from Mihalka's work but goes well beyond it by (a) allowing for cross-temporal comparability, (b) introducing the notion of diminishing returns, (c) distinguishing between labor and capital, and (d) excluding strategic weapons. In so doing, then, we produce an index which (a) can be employed in dynamic analysis, (b) provides a more realistic representation of the distances between states in terms of capabilities, (c) permits the introduction of the depreciation notion, and (d) does not confuse the distinction between strategic and conventional military capabilities.

#### A Capability Generation Index

As economists have long recognized, two critical elements in the production of any good are the capital and labor inputs

that are used in the production process. A similar situation may be assumed to hold with respect to the military capabilities that a state produces in order to achieve foreign and domestic policy aims. We postulate the following general relationship in the production of military capabilities:

$$C_{i,t} = K_{i,t}^b * L_{i,t}^{1-b}$$

where:  $C_{i,t}$  represents the military force capabilities available to state  $i$  at time  $t$ ,

$K_{i,t}$  represents the principal weapon stocks (i.e., military capital) of  $i$  at  $t$ ,

$L_{i,t}$  represents the labor inputs (i.e., military personnel) of  $i$  at  $t$ , and

$b$  represents the capability productivity of military capital.

The capability productivity of military capital is assumed to be twice that for labor, and the sum of the productivity of labor and capital is assumed to be equal to one. By implication the marginal returns to an increase in one of the two inputs, labor or capital, is less than one.

In order to measure these capital and labor inputs we have employed variables which represent the three principal elements of each. On the capital side, as with Mihalka, we include variables representing the number of major surface combat vessels (destroyers or greater), the number of tanks, and the number of non-strategic combat aircraft. Thus, the principal capital item in each of the naval, land and air forces that might be used in conventional warfare is included. On the labor side, we include the size of personnel in land (i.e., army and marines), naval and air forces.

Information on the variables detailed above provide a basis for assessing the conventional military capabilities of a nation. They must, however, be combined in some way to provide a single dimension representing capital and one representing labor. An obvious data reduction technique to be used in this instance is the one employed by Mihalka, viz., principal components analysis. Given that we wish to develop temporally consistent indicators, it is necessary that we employ a different type of data base than that used by Mihalka. We have chosen to perform our analyses on a pooled cross-section/time-series data structure. This will allow for the same type of cross-sectional comparisons possible with Mihalka's results but in addition will permit the indices to be employed in dynamic analysis.

With the capability generation formula, the proposed representations of capital and labor, and the data structure upon which these representatives are to be built, the type of measure described above can be created. Before turning to the results of this effort, it would be useful at this point to turn attention to the sample of countries examined as well as the data sources that have been used in this study.

#### Spatial-Temporal Domain and Data Base

We chose to limit our study to 50 countries (see Table 1). The sample size decision was dictated in the main by the availability of data. Mihalka's study included 57 countries. Given that his analysis centered on two cross-sectional slices, his slightly larger sample was more feasible. As to the countries included within our sample, three relatively complementary criteria were employed in their selection. These criteria were: (a) the country is a member of the GLOBUS sample of 25; (b) the country is a salient international competitor of one or more of the GLOBUS countries; (c) the country spent more than one billion dollars (US) on its military establishment in 1980. The first two criteria are self-explanatory. The third was dictated by a desire to insure that countries with significant military power were included in the analysis.

TABLE 1

Countries Included  
in the Study

- |                             |                              |
|-----------------------------|------------------------------|
| 1. United States (USA)      | 26. Sweden (SWE)             |
| 2. Canada (CAN)             | 27. Norway (NOR)             |
| 3. Cuba (CUB)               | 28. Denmark (DEN)            |
| 4. Mexico (MEX)             | 29. Nigeria (NIG)            |
| 5. Venezuela (VEN)          | 30. South Africa (SAF)       |
| 6. Brazil (BRA)             | 31. Libya (LIB)              |
| 7. Chile (CHL)              | 32. Iran (IRN)               |
| 8. Argentina (ARG)          | 33. Turkey (TUR)             |
| 9. United Kingdom (UKG)     | 34. Iraq (IRO)               |
| 10. Netherlands (NTH)       | 35. Egypt (EGY)              |
| 11. Belgium (BEL)           | 36. Syria (SYR)              |
| 12. France (FRN)            | 37. Israel (ISR)             |
| 13. Switzerland (SWZ)       | 38. Saudi Arabia (SAU)       |
| 14. Spain (SPN)             | 39. Peoples'Rep. China (PRC) |
| 15. Fed. Rep. Germany (FRG) | 40. Taiwan (TAI)             |
| 16. German Dem. Rep. (GDR)  | 41. Dem. Rep. Korea (DRK)    |
| 17. Poland (POL)            | 42. Rep. of Korea (ROK)      |
| 18. Hungary (HUN)           | 43. Japan (JPN)              |
| 19. Czechoslovakia (CZE)    | 44. India (IND)              |
| 20. Italy (ITA)             | 45. Pakistan (PAK)           |
| 21. Yugoslavia (YUG)        | 46. Thailand (THA)           |
| 22. Greece (GRC)            | 47. Malaysia (MAL)           |
| 23. Bulgaria (BUL)          | 48. Philippines (PHL)        |
| 24. Romania (ROM)           | 49. Indonesia (INS)          |
| 25. Soviet Union (USR)      | 50. Australia (AUL)          |

It should be noted that we attempted to include as long a period of time as possible within the scope of the study. Given the availability of data, the maximum length of time in the end turned out to be the 19 year period from 1962 to 1980.

Any attempt at developing measures of the stock of national military power quickly confronts the problem that there is a dearth of relevant and useful data available. While relatively extensive information on this question is constantly being accumulated and assessed by most national governments, there is a real reluctance on their part to make these publicly available. In the end, we, as a number of others before us, have had to turn to the Military Balance produced by the International Institute for Strategic Studies in London. This has been published annually since 1958 and represents the most exhaustive and continuous international survey of the distribution of military power. Despite this place of prominence, the publication suffers from a number of deficiencies.

The scope of country coverage has not been consistently broad through the period examined. Early volumes of the publication focused exclusively on NATO and the Warsaw Alliance plus a number of other states joined in bilateral and multilateral security pacts with the two alliance leaders. As time passed the scope of coverage expanded with principal Third World countries being surveyed and finally nearly universal coverage being provided. A second problem with the Military Balance has been its somewhat haphazard reporting on the stocks of weapons systems possessed by many nations. The further back in time one goes, though this depends to a great extent on the particular country, the less certain it is that one will actually find such information. Related to this last point is the peculiar tendency manifested in many of the earlier publications to be very forthcoming and detailed on the character and quantity of weapons systems maintained by East European and certain Third World countries, and, surprisingly, to be much less informative about countries in the Western Alliance.

By the early to mid-seventies the publication became much more "balanced" in the provision of such details.

In an effort to minimize the amount of missing data we surveyed a variety of relevant journals, annual publications, and monographs. With the exception of the recent publication by Collins on the US-Soviet Balance, none of these sources proved particularly helpful in filling the holes left from the coding of information contained in the Military Balance.

Given that there are fifty countries in the sample and nineteen years within the time frame of the study, a complete data set would require 950 observations for each of the six variables. Table 2 describes the success achieved in reaching this objective. Information on military personnel was most easily acquired. For each of three variables, observations were available for approximately 88% of the cases. Simultaneous observations on all three were available for nearly 88% of the cases. Obtaining information on the three conventional weapon stocks posed greater difficulties. In particular, acquiring data on the number of tanks held in a state's military inventory of active weapons proved to be quite problematic with the result that approximately 35% of the cases have missing values on this variable. In all, 592 cases, or about 62% have complete data on all of the weapon inventories.

### Results

The results from the two principal components analyses are presented in Table 3. In both instances a single robust dimension has been uncovered. 83% of the variance within the capital items and 84% within the labor items are accounted for by their respective dimensions. The range of loadings on each component is relatively narrow, and thus the contribution of any standard unit of a particular variable to the score a country receives on one of these dimensions is relatively equal. Given the observed movements of the variables this is quite attractive. An illustration from the capital



Table 2

Availability of Data on the  
Stocks of Principal Weapon  
Systems and Military Personnel,  
1962-1980

<u>Capital Items:</u>	Percentage of cases with non-missing observations
Major Combat Surface Vessels (SURF)	83.3% (791)
Tanks (TNKS)	64.8% (616)
Combat Aircraft (AIR)	75.2% (714)
Joint Occurrence	62.4% (593)
 <u>Labor Items:</u>	
Personnel in Army and Marines (LAND)	88.2% (838)
Personnel in Navy (SEA)	88.5% (841)
Personnel in Air Force (AIRP)	88.1% (837)
Joint Occurrence	87.7% (833)

Table 3

Principal Components  
Analyses of Capital  
and Labor

Capital:

Variable	Loading	Factor Score Coefficient	Obs. Mean	Obs. s.d.
SURF	.873	.350	10.7	29.4
TNKS	.929	.372	2211.0	6148.8
AIR	.932	.374	635.4	1546.9

% Total Variance = 83.1

Labor:

Variable	Loading	Factor Score Coefficient	Obs. Mean (000's)	Obs. s.d. (000's)
LAND	.850	.336	302.8	515.9
SEA	.905	.377	45.0	114.4
AIRP	.896	.375	73.7	184.4

% Total Variance = 84.1

dimension will demonstrate this point. Given the factor score coefficients and standardized scores, the capital dimension entails the following: the same increase in capital can be achieved by adding to a nation's inventory either 1 major combat surface vessel, 38 combat aircraft, or 164 tanks. Given the relative costs of the average weapon in each of these categories, such a set of returns makes a good deal of sense. Given that we wish to employ the results of these analyses within the capability generation formula, some further steps are required. First, a country's value on each of the variables must be given a z score, i.e., standardized in light of the variable's observed mean and standard deviation. Second, the country's standardized score on each variable must be multiplied by the factor score coefficient associated with each variable. Third, these products are then summed to produce the factor score of the country on both dimensions. Across the range of countries in the sample, these scores take on both negative and positive values. In addition, a country's factor score does not explicitly provide one with information on how far that country stands from the real base, i.e., the true zero value where a country possesses nothing with respect to any of the variables that go into making either component. A fourth step was taken to remedy this, and thus, provide more intuitively meaningful as well as useful scores. The factor score for the hypothetical case of a country with none of a component's variables was calculated. This score was then subtracted from the factor score for each country and the result was in turn multiplied by 100. The multiplication operation is for purely cosmetic reasons. The subtraction operation provides one with the distance from zero which the country has on the capability input dimension.

Capital and labor scores for the fifty countries are presented in Table 4. These are the values for the year 1980. Both the ordinal positions of states as well as the distances between states on these dimensions seem quite plausible. With these values and the capability generation formula provided previously, one can calculate the capabilities of these states. The standings of countries on this dimension are provided in

Table 4

Capital and Labor Inputs to  
Military Capabilities, 1980

<u>Rank</u>	<u>Capital</u>	<u>Labor</u>
1.	USR (655.8)	USR (544.2)
2.	USA (366.6)	PRC (442.2)
3.	PRC (226.0)	USA (348.1)
4.	FRN ( 56.7)	IND (100.0)
5.	JPN ( 56.4)	FRN ( 64.9)
6.	FRG ( 53.4)	DRK ( 58.9)
7.	TUR ( 52.5)	TUR ( 56.0)
8.	UKG ( 41.5)	FRG ( 55.4)
9.	POL ( 41.2)	UKG ( 50.8)
10.	TAI ( 40.6)	ROK ( 50.2)
11.	CZE ( 33.2)	TAI ( 45.8)
12.	IND ( 32.6)	ITA ( 44.4)
13.	DRK ( 30.9)	POL ( 38.4)
14.	ISR ( 30.5)	SPN ( 37.1)
15.	GRC ( 29.9)	PAK ( 34.5)
16.	ROK ( 28.9)	EGY ( 32.9)
17.	ITA ( 27.9)	BRA ( 32.8)
18.	SYR ( 27.3)	JPN ( 32.8)
19.	IRN ( 26.4)	IRN ( 30.6)
20.	IRQ ( 25.3)	YUG ( 27.2)
21.	GDR ( 24.5)	THA ( 25.8)
22.	EGY ( 24.4)	INS ( 25.5)
23.	SPN ( 24.3)	CZE ( 22.8)
24.	BRA ( 23.1)	SYR ( 22.8)
25.	YUG ( 22.6)	IRQ ( 22.2)
26.	SWE ( 22.4)	GDR ( 20.0)
27.	LIB ( 21.5)	GRC ( 19.7)
28.	PAK ( 21.0)	ROM ( 19.5)
29.	ARG ( 20.1)	ARG ( 18.3)
30.	ROM ( 18.2)	CUB ( 18.3)
31.	NTH ( 17.9)	BUL ( 17.0)
32.	AUL ( 17.0)	ISR ( 16.7)
33.	BUL ( 16.6)	PHL ( 14.7)
34.	CHL ( 14.2)	CAN ( 14.0)
35.	SWZ ( 14.0)	NTH ( 13.4)
36.	HUN ( 12.7)	NIG ( 12.7)
37.	CAN ( 11.4)	CHL ( 12.2)
38.	VEN ( 8.3)	MEX ( 12.2)
39.	CUB ( 7.7)	AUL ( 12.1)
40.	SAF ( 6.8)	BEL ( 9.7)
41.	SAU ( 6.8)	HUN ( 9.0)
42.	BEL ( 6.7)	SWE ( 8.8)
43.	THA ( 5.7)	SAF ( 8.3)
44.	DEN ( 4.9)	MAL ( 6.7)
45.	INS ( 4.7)	NOR ( 6.2)
46.	MEX ( 4.1)	SAU ( 5.5)
47.	MOR ( 4.1)	LIB ( 5.1)
48.	PHL ( 2.4)	DEN ( 5.0)
49.	NIG ( 1.2)	VEN ( 4.6)
50.	MAL ( .8)	SWZ ( 4.3)

Table 5.

Let us examine these for a moment. The overall impression they provide is of an international military hierarchy with exceedingly large amounts of capabilities separating those at the top from all other states. The three top states, the Soviet Union, the United States and China, account for nearly 55% of the capabilities in this sample of 50 countries. Once one gets beyond these three states the distances separating all others pale by comparison. In the main, large and/or developed countries tend to cluster toward the higher reaches while small and/or developing states fall toward the bottom. The ability of a country to supply the inputs to military power will clearly have a great impact on a state's absolute amount and relative standing. As we saw in Table 4, countries choose to provide differently in terms of the amount of either capital or labor they introduce into their military sector. We turn next to a consideration of that choice.

#### THE CHOICE BETWEEN CAPITAL AND LABOR

The way in which states choose between labor and capital in constructing their armed forces is itself an important and interesting question. However, the amount of military power possessed by a state cannot explain the choice to emphasize one factor over another. In other words, there is not a one-to-one correspondence between capital and labor inputs to military power. Some states heavily emphasize capital over labor as, for example, Libya, Switzerland, and Sweden. Others place heavier relative emphasis on labor as in the instances of the Philippines, Malaysia and Nigeria. And still others accord approximately equal emphasis with examples being Hungary, Poland and the United States. While there is indeed a strong relationship between the amount of labor and capital going into a nation's military strength, neither of these components is very strongly related to the mix of factors that are maintained.

Table 5

Military Capability  
Index, 1980

1.	USR	(612.8)
2.	USA	(358.8)
3.	PRC	(281.3)
4.	FRN	( 59.2)
5.	FRG	( 53.9)
6.	IND	( 47.2)
7.	JPN	( 47.0)
8.	TUR	( 46.5)
9.	UKG	( 44.3)
10.	TAI	( 42.1)
11.	POL	( 40.1)
12.	DRK	( 38.2)
13.	ROK	( 34.7)
14.	ITA	( 32.5)
15.	CZE	( 28.1)
16.	SPN	( 27.9)
17.	IRN	( 27.6)
18.	EGY	( 26.9)
19.	BRA	( 25.9)
20.	GRC	( 25.9)
21.	SYR	( 25.7)
22.	ISR	( 24.9)
23.	PAK	( 24.7)
24.	IRQ	( 24.1)
25.	YUG	( 24.0)
26.	GDR	( 22.9)
27.	ARG	( 19.5)
28.	ROM	( 18.6)
29.	BUL	( 16.7)
30.	SWE	( 16.4)
31.	NTH	( 16.3)
32.	AUL	( 15.1)
33.	CHL	( 13.5)
34.	LIB	( 13.2)
35.	CAN	( 12.2)
36.	HUN	( 11.3)
37.	CUB	( 10.3)
38.	SWZ	( 9.4)
39.	THA	( 9.4)
40.	INS	( 8.2)
41.	BEL	( 7.5)
42.	SAF	( 7.3)
43.	VEN	( 6.8)
44.	SAU	( 6.3)
45.	MEX	( 5.9)
46.	DEN	( 4.9)
47.	NOR	( 4.7)
48.	PHL	( 4.4)
49.	NIG	( 2.7)
50.	MAL	( 1.6)

The choice countries make in providing inputs to the production of military power is one that has received little more than passing scholarly attention. One could best summarize the conventional wisdom by saying that, demands being held constant, the factor proportions allocated to the production of military power hinge on the amount of those resources generally available within a society. Now it is also recognized that certain other conditions also have some relevance. These are structural and policy factors that help favor the provision of resources for military purposes. Examples of such are conscription, which lowers the cost of labor and thus expands the supply, and the ability to determine prices for capital goods, which will tend to expand the supply of weapons stocks.

But the supply of one factor also promotes the demand for another. Thus, the ability to provide for a large capital base for the military requires some matching on the labor side. To some degree, as well, the presence of labor imposes demands for the provision of capital.

We will not elaborate a complex model of capital and labor decisions here. Rather, our intention is to provide a simple basis for understanding the differences that exist between military establishments in terms of the factors of power productivity. In light of the points made above, we put forward the following functional relations.

$$K = f(L, Y, P_k)$$

$$L = f(K, D, P_l)$$

where:  $K$  = capital;  $L$  = Labor;  $Y$  = income or wealth;  
 $P_k$  = price of capital;  $P_l$  = price of labor;  
and  $D$  = demographic base for labor.

Thus, the level of capital inputs to the military production is viewed as a function of the amount of labor allocated, the in-

come or wealth of the nation, and the price of the capital input. Labor input, in turn, is a function of capital input, the demographic base of the nation, and the price of the labor input.

The wealth and demographic bases of a nation should make a positive contribution to, respectively, the level of capital and the level of labor put into the production of military capability. Price effects should be negative. That is, the greater the relative cost of the item, the lower the level of that item a particular country would choose to add to the production process. Finally, of course, the introduction of one unit of an input should foster the tendency to allocate a greater level of the other input. In sum, we expect the K and L equations to have the following form:

$$K = b_{11} L + b_{12} Y + b_{13} P_k$$

$$L = b_{21} K + b_{22} D + b_{23} P_l$$

$$\text{where: } b_{11}, b_{12}, b_{21}, \text{ and } b_{22} \geq 0$$

$$\text{and } b_{13} \text{ and } b_{23} < 0$$

It is difficult to acquire data that would directly measure all of these concepts. Therefore, some surrogate measures were employed in order to assess the validity of the formulation. Of course, we did use the two sets of scores reported above for capital and labor. GNP was used to represent the level of income of wealth. To represent the capital price measure we used the following formula:  $-1 * \text{GNP}$  if the nation has a centrally planned economy; otherwise a zero (0). Given that political decision makers in the former countries have a significant amount of discretion in the determination of prices, we would assume that the politically valued object of national security would lead countries with centrally planned economies to have lower prices for the capital inputs to the military production function, and thus the supply would tend to be greater than that



available in market economies, *ceteris paribus*.

The demographic base, in this preliminary test of the formulation, is represented by total population. A better indicator here would reflect the size of the labor force in the normal military service age category and the competing requirements for labor in other sectors. To represent the labor cost factor we used the following formula:  $-1 \times$  population if the country had conscription of one form or another in effect; otherwise 0. Cross-nationally, conscription is likely to be one of the most significant factors in the determination of the relative price of labor.

All of the data employed in testing this formulation represent conditions existing in 1978. The GNP and population data from the World Bank's World Development Report, 1980.

The results of an analysis of the formulation are presented in Table 6. Since the equations derived from this formulation are simultaneous, two stage least squares was used to estimate the parameters. As can be seen in the table, there is a great deal of support for the formulation. The overall fit for both equations is quite high with more than 98% of the variance in both capital and labor being accounted for by this formulation. Thus, we see that income or wealth increases the quantity of capital stock inputs. Socialist states, with far greater ability to control prices within their economies, are at an advantage in that they can more easily supply capital inputs to their military arsenal. The labor coefficient in the capital equation suggests that, all else being equal, one unit of capital is provided for about every two units of labor. On the other side, a larger population enhances the ability of the state to increase the amount of labor, and this can be further increased by the introduction of a conscription system which lowers the cost of the labor input. In turn, as well, the introduction of a unit of capital, other things held constant, expands the level of labor added to the production of military force capability.

Table 6

Estimates for the Capital and Labor  
Input Equations, 50 Countries, 1978

$$K = .452 L + .08Y - .3 P_k$$

(14.48)\*            (11.28)   (-17.41)

$$R^2 = 98.5\%$$

$$L = .788 K + .136D - .113P_1$$

(40.56)            (7.56)   (-5.27)

$$R^2 = 98.6\%$$

\* Numbers in parantheses are the t- statistics  
associated with the parameters.

### SUMMARY AND CONCLUSION

This paper has provided an overview of the arms accumulation process and explicated two central and related items within that process: the factors that go into the production of a state's military capabilities and the choices that states make between these factors. Using data on fifty major countries for the time span from 1962 to 1980, measures of capital and labor inputs were produced by employing principal components analysis in a pooled cross section/time series context. These measures were then used as the basis for assessing the level of conventional military capability available to states given a capability production function which assumes diminishing marginal returns to isolated factor inputs. The choice between inputs to capability production was discussed and a model representing the major considerations in such a decision was subject to empirical scrutiny and found to be a powerful explanation.

This brief report represents another step in our project's efforts to deal with the arms accumulation problem. Earlier efforts focused on explaining defense spending decisions with traditional arms race and political economy models or else within the framework of the overall budgetary process (see Cusack and Ward, 1980, 1981; Bremer and Cusack, 1981). Our intention is to expand upon that work in conjunction with what has been reported here. The next step in our program is to focus upon the relationship between the defense budget and its components on the one hand, and the factor inputs to the military capability production function on the other. Following that we intend to expand upon the empirical basis for specifying a state's security goals. Concurrent with these efforts will be attempts to introduce the notion of human capital within the capability production function and the elaboration of a strategic capability index.

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