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NATIONAL POWER BASE AS A COMPONENT OF A LONG-RANGE FORECASTING MODEL

CONSOLIDATED ANALYSIS CENTERS, INC.

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13. ABSTRACT

National power base is viewed as the material and human resources that are available to a nation. These resources are divided into a military dimension and an economic dimension. The military dimension is the nation's realized military power, that is, those resources, skills, and political will available at a given time to engage in military conflict. A nation's military power base index is constructed from the nation's population, its energy consumption, its GNP, and its GNP per capita. Future values of national power base are determined by two broad categories of variables. The first category includes variables external to the forecasting model, such as increases in population and growth in GNP, that have an impact on a nation's power base. The second category includes relationships with other central environmental descriptors that are expected to have an impact on the index. In the paper, international conflict, international alignment, and internal instability are the three descriptors that affect the rates at which military and economic power base change.

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I. INTRODUCTION: CONCEPTUALIZATION

> Power is an explanatory concept that is applied with equal facility to physical phenomena and human affairs....In public affairs, both domestic and international, the notion is virtually unchallengeable that the success of a man or an organization depends on the possession of accumulated power greater than the amount of power held by opponents....References to power simply make sense; it is meaningful to speak about a powerful man, a powerful group, or a powerful nation.[1]

Power has long been recognized by scholars and practitioners as an important element in the analysis of international politics. The need for national power springs from the lack of alternatives to self-help in order to secure the conditions for national welfare and survival. In the absence of systemic changes that would eliminate the contest over values in international politics, power will continue to be an important environmental descriptor. Conflict, then, is at least as important a reality of the international system as is cooperation, thus propelling states to "make the preservation or improvement of their power position a principle objective of their foreign policy."[2]

A. THE MEANING OF POWER

But what is power? The theoretical literature that deals with the concept

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1 Charles A. McClelland, Theory and The International System (New York: The Macmillan Co., 1966), p. 61.

2 Nicholas J. Spykman, America's Strategy in World Politics: The United States and the Balance of Power (New York: Harcourt, Brace and World Co., 1970), p. 7.

can be divided into two categories; one which conceptualizes power in terms of a relationship between actors, and a second that links power to the holder, that is, something possessed.

The first category, power characterized as a relationship, suggests that power "exists only as influence is achieved" and is therefore measurable only after power is exercised.[3] L. S. Shapley and Martin Shubik, James G. March, Robert Dahl, Dorwin Cartwright, and Georg Karlsson have offered formal definitions that treat power as a relationship.[4] In all cases their measurement attempts hinge on the outcome of the relationship and thus measurement occurs only after power is exercised. Power in this sense, then, is not a useful descriptor for the Long-Range Environmental Forecasting (LREF) model.

The second category, however, represents an important concept for long-range forecasting in the international system in at least three ways. First, power, which we will now call "power base," can be used as a variable to predict some of the other central environmental descriptors. Second, power base can define the importance of a

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[3] Klaus Knorr, Military Power and Potential (Lexington, Massachusetts: D. C. Heath and Company, 1970), p. 3.

[4] L. S. Shapley and Martin Shubik, "A Method for Evaluating the Distribution of Power in a Committee System," American Political Science Review, Vol. 48 (1954), pp. 787-92; James G. March, "Measurement Concepts in the Theory of Influence," Journal of Politics, Vol. 19 (1957), pp. 202-226; Robert A. Dahl, "The Concept of Power," Behavioral Science, Vol. 2 (1957), pp. 201-215; Dorwin Cartwright, "A Field Theoretical Conception of Power," in Studies in Social Power, ed. by Dorwin Cartwright (Ann Arbor, 1959), p. 183-220; Georg Karlsson, "Some Aspects of Power in Small Groups," in Mathematical Methods in Small Group Processes, ed. by Joan H. Criswell, Herbert Solomon, and Patrick Suppes (Stanford, 1962), pp. 193-202.

situation. For example, when a nation ranked high on the power base descriptor is involved in conflict, the disruption caused in the international system is usually more dangerous than the disruption caused by conflict involving a nation ranked low on this descriptor. Finally, power defined as a relationship is to a large extent a function of power base. This aspect will be further discussed below.

We define power base as the material and human resources a nation can bring to bear in order to influence the behavior of other nations. Therefore, we think of power base as an attribute of a nation, which may or may not be used to influence other nations. While we make a sharp distinction between power (the relationship) and power base (the means possessed) the former depends heavily on the latter. Indeed, it is because power base contributes to a nation's ability to succeed in influencing the behavior of other nations that it is a vital descriptor of the international system.

B. THE IMPORTANCE OF THE POWER BASE

Most theoretical discussions of the power concept stress dependence on power base as the attribute that allows a state to exercise power. Hans Morgenthau speaks of power as a "psychological relationship between those who exercise it and those over whom it is exercised." But the psychological relationship is based in large measure on the elements of power that the nation possesses.[5] Raymond Aron defines power as "the capacity of a political unit to impose its will upon other units." He goes on to suggest that a unit's power base (Aron uses the term

[5] Hans J. Morgenthau, Politics Among Nations (4th ed.; New York: Alfred A. Knopf, 1967), p. 27.

force) is subject to approximate evaluation and power can be estimated by reference to the power base available to a state.[6]

A. F. K. Organski's notion of power is "the ability of the nation's representatives to influence the behavior of other nations." However, in order to influence, a nation must possess the instruments of power, that is, "the qualities we think of as conferring power -- wealth, resources, manpower, arms, . . ."[7]

We do not suggest that power is totally dependent on power base, that is, that a single measure of power base will predict the outcome of all power relationships. Situational determinants, credibility, and relationship to goals are among the factors that condition and modify the weight of a nation's power base and thus its effect on the power relationship. Nevertheless, power base is the foundation from which power or influence is derived. And in its interaction with the other environmental descriptors -- conflict, domestic instability, international alignment, and economic interdependence -- power base takes on some of its situational determinants.

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[6] Raymond Aron, Peace and War (New York: Frederick A. Praeger, 1966), pp. 47-48.

[7] A. F. K. Organski, World Politics (New York: Alfred A. Knopf, 1961), pp. 96 and 98.

MEASUREMENT

For purposes of the Long-Range Environmental Forecasting model, we view the power base descriptor as the material and human resources available to a nation. Recognizing that material and human resources are the essential elements of a nation's power base, we still must determine which resources most accurately reflect this concept.

We proceeded in this task on the basis of four interrelated steps. Initially we reviewed the literature dealing with national power in search of the elements that scholars have considered important determinants of a nation's strength. Second, we sought indicators that would represent these elements while at the same time performing correlation analyses[8] to ascertain which of the indicators could be used to represent several elements. Third, we made a preliminary data search to be certain that data were available for the indicators chosen. Finally, we ranked nations on the basis of several different indicator composites and compared them to rankings developed by others.

A. LITERATURE REVIEW

The literature that attempts to evaluate a nation's power base is vast. Here we will discuss only a few representative studies. One such study by Organski[9] examines nations that are known to be powerful by their performance in order to determine which of their characteristics contribute

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[8] Correlation analysis is a statistical procedure that indicates how closely two or more variables are related.

[9] Organski, World Politics, pp. 116-210.

to a nation's power base. He includes six elements in his list: geography, resources, population, economic development, political structure and national morale. Organski then descriptively weights the six elements and suggests interrelationships among them. From there he constructs an empirical index for power base that is based on only two of the six characteristics originally suggested--population size measured directly, and economic development indicated by GNP per capita. These two elements, multiplied together, give a nation's GNP which becomes his final indicator of a nation's power base.

Morgenthau identifies nine elements of national power base: geography, natural resources, industrial capacity, military preparedness, population, national character, national morale, the quality of diplomacy, and the quality of government. Beyond a discussion of the component parts of these nine elements, Morgenthau considers the importance of the interrelatedness of the elements. He stresses that merely calculating the amount of an element does not necessarily indicate a nation's relative power. He notes, for example, that India has a very large population and would be ranked number two on the basis of that element alone. But in the case of India, population can in some ways be considered a source of weakness or a drain on power base because so much of the nation's limited wealth must be allocated to feeding the population.[10]

Knorr focuses his attention on the components of military potential. He divides the elements into three broad categories: economic and technological capacity, administrative skill, and political foundations.

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[10] Morgenthau, Politics Among Nations, pp. 106-144.

Economic and technological capacity includes population, resources, productivity, capital equipment, and the stage of economic and technological development. Administrative skill determines the efficiency with which these resources are used, and political foundations refer to the success the regime experiences in allocating resources to producing military capabilities.[11]

Knorr's three categories include most of the determinants of power base suggested by other authors. Operationalization of the power base descriptor for the Long-Range Environmental Forecasting project includes these three major categories, although, as we will see below, we distinguish between a military and an economic dimension of the national power base. As the various indicators are discussed, reference will be made to the factor that is assessed by that indicator. It should be stated at the outset that skill and, to a greater degree, political will are measured only indirectly.

B. INDICATORS

1. Military Power Base

As noted, national power base is divided into a military dimension and an economic dimension. Each will be discussed in turn. The military dimension represents the nation's realized military power, that is, its resources, skills, and political will available at a given time to engage in military conflict. It is indicated by the size of armed forces, amount of military expenditures, and military expenditures per person in the armed forces.

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[11] Knorr, Military Power and Potential, pp. 24-30.

The size of the military establishment (number of people in the armed forces) and the money devoted to its maintenance are both related to a nation's size (population and wealth) in general. Usually, the greater the population the greater the number of people under arms. Similarly, the greater the total wealth available the more that is spent on the military in absolute terms. The correlation between population and armed forces for Europe in 1967 was .98, while the correlation between GNP and military expenditures for the same year was .96.

Less obvious, but nevertheless implicit in the size of armed forces and amount of military expenditures (expressed as relative percentages of population and GNP), is the political will to allocate resources to the military dimension.[12] Japan is a case in point. Both men and money are available to establish a considerable military force in Japan; but the political will to allocate the necessary resources is not now available. This is evident from the average of less than .9 percent of Japan's GNP that has been allocated to military expenditures in the period 1961-1970, as compared to the 4.6 percent average for NATO members during the same period.[13] In this sense, then, political will is assessed, though not directly measured, by the relative manpower and expenditures allocated to the military establishment.

The third item contributing to our measure of a nation's military power base is the expenditures per man in the armed forces. Number of men

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[12] David Easton distinguishes political interactions from other social interactions in that they "are predominantly oriented toward the authoritative allocations of values for a society." David Easton, A Framework for Political Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 50.

[13] These figures are taken from World Military Expenditures, 1971, published by the United States Arms Control and Disarmament Agency, Washington, D.C.

and amount of expenditures are best associated with the quantitative aspects of the military dimension, while expenditures per man tap the qualitative aspect. Higher expenditures per man are the result of higher living standards, greater allocation to military research and development, more money spent on acquiring weapons and equipment, and greater amounts allocated to training. These qualitative aspects contribute to greater fire power and skill in the use of men and materials and in turn increase the military dimension of power.

A measure of a nation's military power base is constructed from these three elements. The index is based on the nation's average percentage share of armed forces and military expenditures, weighted by the qualitative factor of expenditures per man. Armed forces and military expenditures are converted to percentages to insure computational standardization without sacrificing comparability across countries and over time. The calculation is as follows. For each of the first two elements we first ascertain how much was present throughout the European interstate system[14] as a whole, and then compute the percentage share held by each member nation at the time of the observation. For example, if the total number of men under arms in the European system were 50 million and a given nation had 2 million men in the military, the nation's share would be 4 percent. Military expenditure share is derived from a similar calculation. The two percentage shares indicating the quantitative elements of military power base are averaged and then multiplied by the qualitative factor, military expenditures per man, yielding the index for military power base.

$$\text{MPB} = \frac{\%\text{MIL EXP} + \%\text{ARM FOR}}{2} \times \frac{\text{MIL EXP}}{\text{ARM FOR}}$$

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[14] The European interstate system is defined as the 28 nations considered in the LREF project.

Table 1 indicates the rankings of European nations in 1967 on the military power base dimension derived from the calculation described above.

2. Economic Power Base

The economic dimension contributes to a nation's overall power base in two ways. First, it is an indication of the potential for military power in a somewhat longer term than is the military power base discussed above. Second, the economic dimension is a basis for exerting influence or exercising power in itself. This discussion will emphasize the second aspect; however, it should be kept in mind that the economic dimension, as measured below, is a major determinant of the military dimension in the future.

The economic dimension of the power base descriptor is composed of four elements: population, GNP, energy consumption, and GNP per capita. Population is an obvious element in a nation's power base. Just as a nation's military strength is increased by greater numbers of men able to fight, so too is a nation's economic strength enhanced by greater numbers of men able to work. This is not to imply that population alone establishes a nation's economic strength. Indeed, as we noted in the case of India, excessive population in relation to other elements may well represent a drain on national strength. Nevertheless, no nation can remain or become a first rate power without the large population necessary to establish and maintain a great industrial plant, to field large combat units, and to feed and supply the soldiers and citizenry.

GNP is the second element contributing to our measure of economic power base. While it varies to a high degree with population, there remains a residual element not accounted for by population. This is the labor productivity that reflects economically advanced nations.

TABLE 1

MILITARY POWER BASE RANKINGS

1967

Quintile*	Country	Index Score	Log Index
I	USSR	7368.91	8.91
II	Great Britain	957.28	6.87
	France	749.26	6.62
	West Germany	673.51	6.51
III	Italy	191.22	5.26
	Sweden	131.78	4.89
	Poland	131.72	4.89
	Czechoslovakia	123.72	4.83
	East Germany	98.38	4.60
	Netherlands	88.74	4.50
	Spain	75.52	4.34
	Rumania	66.10	4.21
	Belgium	52.82	3.99
	Switzerland	49.71	3.93
IV	Denmark	33.31	3.54
	Turkey	33.21	3.53
	Norway	32.42	3.51
	Yugoslavia	26.86	3.33
	Portugal	24.04	3.22
	Hungary	23.30	3.19
	Greece	22.11	3.14
	Bulgaria	16.10	2.84
	Finland	11.66	2.54
	Austria	11.14	2.50
V	Albania	3.94	1.60
	Ireland	3.22	1.44
	Luxembourg	0.88	0.63
	Iceland	0.00	0.00

*Quintiles have been created by determining the five equal-interval groups, where the interval is calculated based on the logarithm of the index.

Energy consumption is included as the third element of the economic power base in order to give added weight to the industrial aspects of a nation's economy. Industrialization contributes not only to economic strength, but the industrial sector is also more readily transformed into military strength in time of need than is the agricultural sector. Especially in the event of major and prolonged mobilization of resources for military purposes, the industrial sector takes on major importance because, in the main, military supplies are manufactured. Moreover, industrialization is indicative of labor mobility and managerial versatility, both necessary for transfer to essential production in time of need.[15]

The fourth element, GNP per capita, reflects the quality factors of economic power base that enhance the overall operation of a nation's economy in the same way that military expenditures per man in the armed forces represent the quality factors of the armed forces. High GNP per capita reflects abundant capital, advanced technology, high labor productivity, ample education and research, and administrative skill. And, as high GNP per capita usually indicates an advanced level of economic and technological development, it is also an index of the ability to produce and use complicated military material.[16]

The economic power base index is computed by transforming the first three elements -- population, GNP, and energy consumption -- into percentage shares as was done above with armed forces and military expenditures. The three percentages are averaged and then multiplied by the qualitative factor, GNP per capita.

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[15] Knorr, Military Power and Potential, p. 68.

[16] Ibid., p. 51.

$$EPB = \frac{\%POP + \%GNP + \%EN\ CON}{3} \times \frac{GNP}{POP}$$

Rankings on the economic power base dimension for 1967, calculated in the manner described above, are shown in Table 2.

3. Nuclear Weapons

Nuclear weapons constitute the most powerful means of destruction ever to come under the control of men. Five nations now include nuclear armaments in their military configurations: the United States, the Soviet Union, Great Britain, France, and China. The first three are capable of launching these weapons against any country in the world.

Of equal importance is the fact that an increasing number of nations are becoming financially and technologically capable of building these weapons. Therefore, any forecast of the international environment over the long run must consider the effects of nuclear proliferation.

Although many of the scientific secrets of nuclear explosions have been published by governments, the technology remains extremely advanced. A nation embarking on the construction of nuclear weapons must recognize that such a plan involves building a major modern industry, and makes severe demands on the budget, on technicians, and on scientific manpower.[17] To some extent these demands are ameliorated by the steady

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[17] Leonard Beaton, "Capabilities of Non-Nuclear Powers," in A World of Nuclear Powers?, ed. by Alastair Buchan (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1966), p. 13.

TABLE 2

ECONOMIC POWER BASE RANKINGS

1967

Quintile*	Country	Index Score	Log Index
I	USSR	562.98	6.34
	West Germany	199.98	5.30
	Great Britain	194.44	5.28
	France	186.69	5.23
II	Italy	77.23	4.36
	Sweden	48.92	3.91
III	East Germany	41.95	3.76
	Czechoslovakia	39.09	3.69
	Poland	37.00	3.64
	Netherlands	34.69	3.57
	Belgium	34.05	3.56
	Switzerland	26.26	3.31
	Spain	24.30	3.23
	Denmark	21.98	3.13
	Norway	13.88	2.70
	Yugoslavia	13.65	2.68
	Austria	13.49	2.67
	Hungary	12.76	2.62
	Rumania	12.21	2.58
IV	Finland	9.46	2.35
	Bulgaria	8.27	2.23
	Turkey	6.57	2.02
	Greece	5.82	1.92
	Ireland	3.71	1.55
	Portugal	3.16	1.43
V	Luxembourg	1.47	0.90
	Iceland	1.14	0.76
	Albania	0.44	0.37

*Quintiles have been created by determining the five equal-interval groups, where the interval is calculated based on the logarithm of the index.

growth of peaceful applications of nuclear power that aid in the recruitment of skilled men needed to staff a military program. Moreover, because the development of peaceful nuclear technology is similar to the needs of military development, it contributes to a military nuclear program.[18]

In contrast to the reduced difficulty of manufacturing nuclear explosives, the provision for a means of delivery requires a continuing commitment to a program of technological development. "For even the most modest of nuclear powers must match its delivery systems against those of potential enemies, and these systems are bound to increase in complexity with the years."[19] We refer here not only to the launching of a weapon, but more importantly to the requirement of protection so that the nuclear force maintains its effectiveness as a deterrent.

Leonard Beaton has roughly calculated the costs of producing a modest nuclear force including its own delivery system.[20] The force envisioned in these calculations is substantially inferior to those developed by the British and French. However, it at least presents the prospect of leading to a higher level of sophistication. He concludes that a country embarking on this type of program must spend at least $2.3 billion over a ten-year period.

Therefore, it is clear that only the very large or the very developed nations endowed with substantial economic, technological, and manpower

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[18] Leonard Beaton and John Maddox, The Spread of Nuclear Weapons (New York: Frederick A. Praeger Co., 1962), p. 186.

[19] Ibid., p. 4.

[20] Beaton, "Capabilities of Non-Nuclear Powers," pp. 32-33.

resources have the option to embark on a nuclear weapons program. Among those nations so endowed, the decision is a matter of political will. While the incentives to exercise the nuclear option may vary among nations, the major motivation for such a decision is security needs. A nation that feels threatened is likely to seek nuclear weapons unless it feels confident that its major-power ally will provide protection.

The hazards of predicting so momentous a decision as the acquisition of a military nuclear capability are formidable. Nevertheless, the planner must, in some way, account for the effect of such weapons. The Long-Range Environmental Forecasting model, then, will be developed so that the user is offered two options. First, the model will forecast the probability that a nation will develop nuclear weapons. The forecast will be based on three other central environmental descriptors. The probability that a nation will decide to become a nuclear power is determined by its economic and technological capability (economic power base),[21] the conflict it experiences, and the degree of its alignment with a major power. We hypothesize that the probability that a nation will develop nuclear weapons will vary directly with its economic power base and its conflict experience, and will vary inversely with its degree of alignment with a major power.

$$P = (POWER/12.5)^{1.25} \times \left((CONFLICT/(2 - CONFLICT)) \right) / \left((ALIGNMENT + 1) \times 50) \right)$$

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[21] 12.5 on the economic power base index would include all the European nations considered by the Atomic Energy Commission to have industrial economies able to support a nuclear weapons program. United States Senate Committee on Foreign Relations, Hearings on the Nonproliferation Treaty, 90th Congress, Second Session (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 30-31.

The second option will allow the user to determine the probability that a nation will develop nuclear weapons. In this way, changing conditions can be factored into the determination, and alternate futures can be forecast.

The nuclear dimension will be used in the Long-Range Environmental Forecasting model as a multiplier of the military power base dimension. However, the nuclear dimension may not be relevant in all situations. Therefore, our intent is to develop two indexes for the military power base dimension. The first will be the index produced by the calculation described in the military power base section and illustrated in Table 1. A second index will be developed that explicitly uses nuclear power as a multiplier for those nations that now possess nuclear weapons and those that are predicted to have them (based on either of the two options presented above) during the period being forecast. The second index will be constructed by simply multiplying the initial military power base index by one, plus the probability score as determined above. Those nations that already have developed nuclear weapons (in the European system--USSR, Great Britain, and France) are assigned a 100% probability. Therefore, their military power base is doubled (1+100% probability=2). This estimated weighting factor is tentative and may be modified in use. Table 3 presents the index for ranking the nuclear military power base dimension. The choice of which index to employ will be user-determined based on situational factors.

TABLE 3

NUCLEAR MILITARY POWER BASE RANKINGS

1967

Quintile*	Country	Index Score	Log Index
I	USSR	14737.80	9.60
II	Great Britain	1914.56	7.56
	France	1498.52	7.31
	West Germany	673.51	6.51
III	Italy	191.22	5.26
	Sweden	131.78	4.89
	Poland	131.72	4.89
	Czechoslovakia	123.72	4.83
	East Germany	98.38	4.60
	Netherlands	88.74	4.50
	Spain	75.52	4.34
	Rumania	66.10	4.21
	Belgium	52.82	3.99
	Switzerland	49.71	3.93
IV	Denmark	33.31	3.54
	Turkey	33.21	3.53
	Norway	32.42	3.51
	Yugoslavia	26.86	3.33
	Portugal	24.04	3.22
	Hungary	23.30	3.19
	Greece	22.11	3.14
	Bulgaria	16.10	2.84
	Finland	11.66	2.54
	Austria	11.14	2.50
V	Albania	3.94	1.60
	Ireland	3.22	1.44
	Luxembourg	0.88	0.63
	Iceland	0.00	0.00

*Quintiles have been created by determining the five equal-interval groups, where the interval is calculated based on the logarithm of the index.

III. PREDICTORS OF POWER BASE

This section of the paper will describe the relationships which we believe are important in determining future values of national power base. These relationships are taken primarily from scholarly studies of national power in international relations, although we express them differently. Since the model will be expressed as a set of equations (see the following section), we will need to state the relationships verbally in such a way as to facilitate the translation into symbolic terms. This is rarely done in the theoretical literature. There are two broad categories of relationships that affect national power base: effects resulting from other environmental descriptors (endogenous); and effects resulting from external (exogenous) variables. They will be discussed in that order.

A. OTHER CENTRAL ENVIRONMENTAL DESCRIPTORS

Of the four central environmental descriptors aside from power base, three appear to bear on the growth of a nation's power base. Specifically, the country's degree of international alignment, the amount of conflict that it engages in, and the amount of its domestic stability all affect the rates at which economic and military power base change.

1. International Alignment

We hypothesize that the smaller a nation is and the more it is aligned with major powers, the less it will tend to spend on defense in both absolute terms and in terms of percentage of GNP. Generally, the defense

effort of a smaller state "will vary inversely with its confidence in the big power's guarantee (closeness of alignment) and the disparity in size between the two."[22] This hypothesis is based on the theory of public or collective goods first suggested by Paul Samuelson,[23] a theory that has more recently been applied to alliances[24] by Mancur Olson and Richard Zeckhauser and by Bruce Russett.[25]

The notion of public or collective goods assumes that a voluntary organization, in this case an alliance, serves the common interest of all members. For example, the proclaimed purpose of NATO is to protect its member nations from aggression by a common enemy. From this assumption we define a public or collective good by two properties: 1) all who share the common goal automatically benefit when the goal is achieved, i.e., "non-purchasers cannot feasibly be kept from consuming the good,"[26] and 2) when the good is available to one member it is available to all others in the group without decreasing the amount available to any other.[27]

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[22] Bruce M. Russett, What Price Vigilance (New Haven: Yale University Press, 1970), p. 93.

[23] Paul A. Samuelson, "The Pure Theory of Public Expenditure," Review of Economics and Statistics, 36 (1954).

[24] In the LREF Project we view international alignment with a major power as having properties similar to alliances in regard to the theory of public or collective goods.

[25] Mancur Olson and Richard Zeckhauser, "An Economic Theory of Alliances," in Economic Theories of International Politics, ed. by Bruce M. Russett (Chicago: Markham Publ. Co., 1968); and Bruce M. Russett, What Price Vigilance.

[26] Russett, What Price Vigilance, p. 94.

[27] Ibid., and Olson and Zeckhauser, Economic Theories, pp. 26, 27.

Olson and Zeckhauser hypothesized that the larger a nation is, the more it will value the alliance. Therefore, they anticipated a significant positive relationship between the GNP of a nation and the percentage of GNP that the nation spends on defense. Using NATO data for 1961 they found this to be the case.[28] This result is supported by the findings of Ypersele using data for 1955 and 1963,[29] and by Pryor using data for 1956 and 1962.[30] Russett further substantiates the theory for NATO using data for the period 1950-1967. For the Warsaw Treaty Organization he finds the predicted positive relationship between GNP size and defense share to begin in the mid 1960's, when, as he suggests, the Warsaw Pact became a voluntary association at least in terms of defense contributions.[31]

Based on the theory of collective goods we hypothesize that the percentage of GNP a nation spends on defense (D/GNP) will vary with the size of its GNP and will be affected inversely by the degree of a nation's major power alignment.

$$D/GNP = f(GNP/ALIGN)$$

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[28] Ibid., p. 39.

[29] Jacques M. Von Ypersele de Strihou, "Sharing the Defense Burden Among Western Allies," Yale Economic Essays 8 (Spring 1968), pp. 261-320.

[30] Frederic L. Pryor, Public Expenditures in Communist and Capitalist Nations (Homewood, Illinois: Richard D. Irwin, Inc., 1969).

[31] Russett, What Price Vigilance, pp. 102-107 and pp. 112-116.

2. Conflict

In addition to public goods, we hypothesize that private goods in the defense area have an impact on a nation's level of defense spending. Private goods refer to that defense allocation a nation makes either as a result of threats outside the situations covered by alliances or when its perception of threat is greater than those of its allies within the alliance. Thus a nation will allocate more to defense when it has experienced or is threatened by direct conflict.[32] We hypothesize that a nation's allocation of resources to military needs will be affected by the levels of conflict experienced in the past. Specifically, percentage of GNP devoted to military spending will vary with conflict.

$$D/GNP = g(\text{conflict})$$

However, as the time since that nation was last involved in conflict increases, we expect a relaxation and a decreasing preoccupation with defense. Therefore, the percentage of GNP devoted to the military will vary inversely with time since the last conflict. The equation becomes:

$$D/GNP = h\left(\frac{\text{conflict}_t}{\text{conflict}_{t-1}}\right)$$

It is not clear what effect increased spending on the military will have on the economic power base or on economic growth rates. World War II served as an impetus to bring much of America's idle capacity into use. However, we must remember that the United States entered the war while it was still very much in the throes of a depression. A second factor involves the source of increased military spending. Russett suggests that

[32] Ibid., p. 113, and Olson and Zeckhauser, Economic Theories, pp. 34, 36.

when increases in military spending come at the expense of investment (fixed capital formation) rather than at the expense of current public consumption, the result will be a smaller productive capacity in future years.[33] Therefore, it appears that the economic power base is affected by conflict, but that the direction of the effect is contingent on other variables.

3. Domestic Instability

The domestic instability descriptor is expected to have an effect on both dimensions of a nation's power base. First, instability will cause the regime to allocate more resources to the military establishment in order to sustain itself. Therefore, we expect military spending as a percentage of GNP to vary with levels of domestic instability.

$$D/GNP = i(\text{domestic instability})$$

Second, domestic instability is expected to cause disruption in the nation's economic system. Investment, from both internal and external sources, is likely to decrease as a result of investors' fears of loss. Moreover, the labor force size may be affected as potentially productive workers join the opposition. In addition, those workers who remain at their jobs are subject to harassment and threat, while capital equipment may be sabotaged. Therefore, productivity will decrease. We hypothesize then that economic power base will vary inversely with domestic instability.

$$GNP = j(\text{domestic instability}_{t-1})$$

[33] Russett, What Price Vigilance, pp. 143, 144.

B. EXOGENOUS PREDICTORS OF POWER BASE

1. Armed Forces and Military Expenditures

Levels of armed forces and military expenditures are initially considered to be constant percentages of population and GNP respectively. Changes in these levels result from the effect of other descriptors as discussed above.

2. Gross National Product (GNP)

GNP will be forecast on the basis of previous values of GNP and the rate of GNP growth or shrinkage. Thus, GNP at time t-1 is exogenous in that it is already determined at time t. The predictor for GNP growth rates will be determined by econometric analysis which is independent of the Long-Range Environmental Forecasting model. The growth rate will also be affected by the other descriptors as described above.

3. Population

Population size is a highly autocorrelated time series, i.e., population size at time t predicts population at time t+1. In short, population is forecast by applying experienced or externally forecast growth rates to previous population size.

4. Energy Consumption

Future levels of energy consumption will be exogenously determined via some exponential function. This procedure is based on the fact that in the past, energy consumption has grown at a faster rate than GNP.

IV. STRUCTURE OF THE POWER BASE EQUATION

Eight variables, including three other central environmental descriptors, have been tentatively selected to forecast power base rankings for the European inter-state system. Hypothesized relationships have been organized into the linkages among the eight variables and the two dimensions of the power base descriptors. Each predictor variable will be subject to examination to determine the direction and magnitude of its effect on the power base measure. Parameter estimates generated from the equations will be used to forecast the power base index of the European nations for the period of the 1980's.

$$Y_1 = \beta_{10} + \beta_{11} Y_{1_{t-1}} - \gamma_{16}\left(\frac{Y_6}{Y_{1_{t-1}}}\right) + \gamma_{17} Y_{17} - \beta_{17}\left(\frac{Y_{t-1}}{Y_{1_{t-1}}}\right) + \epsilon_1$$

$$Y_2 = \beta_{20} + \beta_{22} Y_{2_{t-1}} + \epsilon_2$$

$$Y_3 = \beta_{30} + \beta_{33} Y_{3_{t-1}} + \epsilon_3$$

$$Y_4 = \beta_{40} + \beta_{44} Y_{4_{t-1}} + \gamma_{41} Y_1 - \gamma_{48} Y_8 + \gamma_{47}\left(\frac{Y_{7_t}}{Y_{7_{t-1}}}\right) + \gamma_{46} Y_6 + \epsilon_4$$

$$Y_5 = \beta_{50} + \beta_{55} Y_{5_{t-1}} + \gamma_{52} Y_2 - \gamma_{58} Y_8 + \gamma_{57}\left(\frac{Y_7}{Y_{7_{t-1}}}\right) + \gamma_{56} Y_6 + \epsilon_5$$

where:

Y_1 = GNP

Y_2 = Population

Y_3 = Energy consumption

Y_4 = Defense expenditures

Y_5 = Military manpower

Y_6 = Instability

Y_7 = Conflict

Y_8 = Alignment (major power alignment level)

These equations will be evaluated to determine which predictors evidence strong linkages with a nation's power base. Estimates of the direction and strength of these linkages will be developed with minimum-information, maximum-likelihood methods. These estimates will be used to generate forecasts of the power base for each European nation during the 1985-1994 time period.