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GLOBAL STRATEGIC ENVIRONMENT INFORMATION BASE

by

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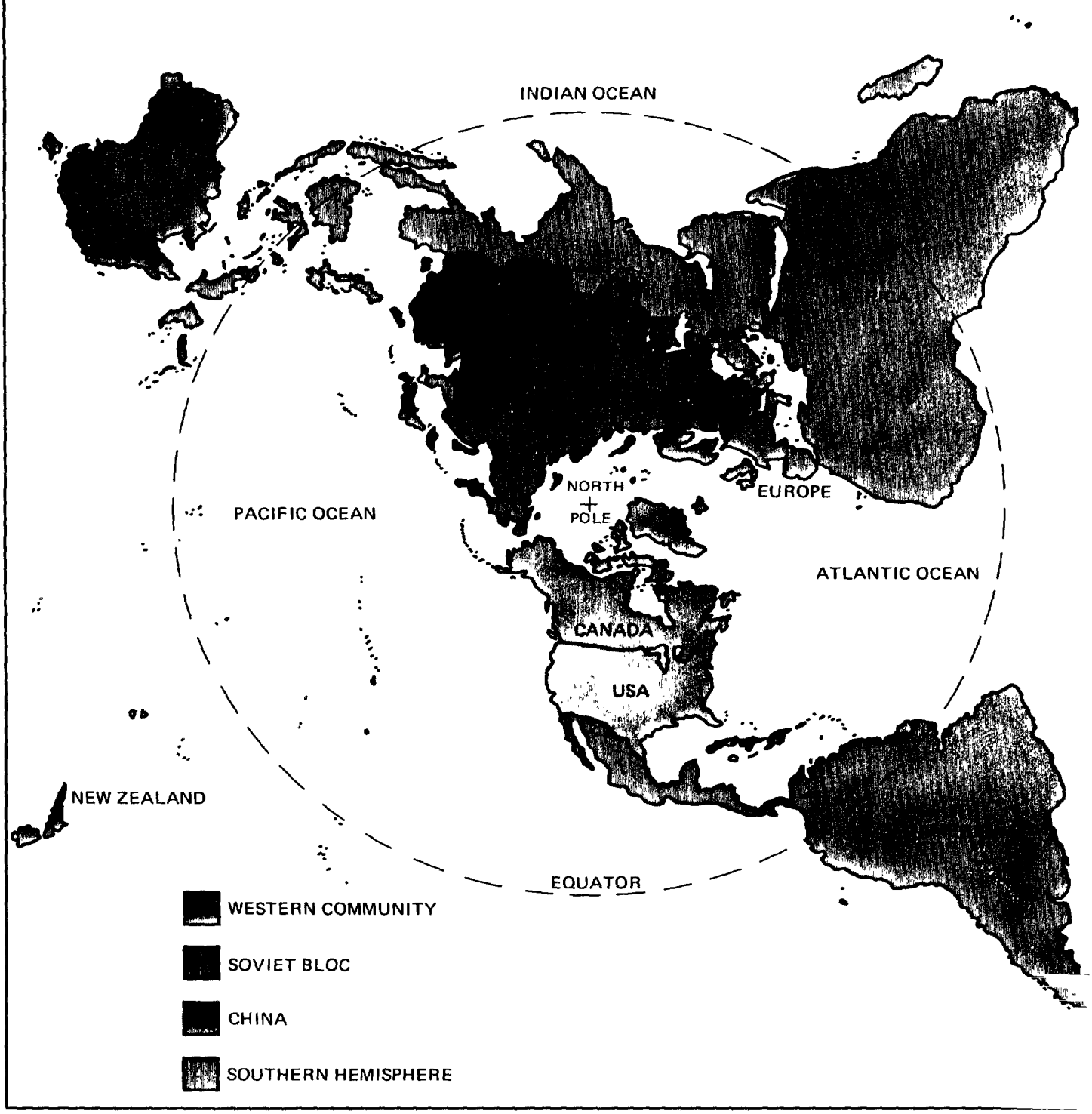
AN ANALYSIS OF CURRENT AND FUTURE WESTERN STRATEGIC OPTIONS

Approved by: _____, Director

for Chief Operational Research and Analysis Establishment

GLOBAL STRATEGIC ENVIRONMENT



ABSTRACT

The purpose of this report is to delineate quantifiable aspects of the global strategic environment.

The distribution of such elements of power as population, territory, economic base and military strength is presented for the Western Community, the Soviet Bloc, China and the Southern Hemisphere. The nuclear relationship between the US and the USSR is then examined. The broad strategic considerations that shape the evolution of the nuclear forces constitute the context within which a detailed evaluation of technical indicators of the strategic balance is undertaken. Finally, additional information germane to Canada's human and material links with the world is given.

Canada's position, interests and alternative security strategies are conditioned by the factors described herein.

RÉSUMÉ

Cette étude tente de cerner les dimensions quantitatives de l'environnement stratégique global.

L'étude décrit, en se basant sur des éléments tels que la population, le territoire, l'économie et la puissance militaire, la répartition de la puissance entre les pays occidentaux, le bloc soviétique, la Chine et l'hémisphère Sud. Le rapport des forces nucléaires Est-Ouest est évalué également en tenant compte des éléments stratégiques qui façonnent son évolution. Ces éléments servent de point de départ pour un examen détaillé des indices de l'équilibre stratégique. En conclusion, des renseignements additionnels sont donnés sur les liens du Canada avec le monde, tant sur le plan humain que matériel.

La position du Canada, ses intérêts et ses options stratégiques sont influencés par les facteurs que l'on vient de décrire.

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CHAPTER 1

INTRODUCTION

BACKGROUND

1. Planet Earth is a finite globe travelling in an infinite Universe. Its radiant beauty contrasts sharply with the darkness of space and its organic unity and fragility are palpable. The Earth shields its precious cargo, all life, from death by exposure to the absolute cold of space and to the cosmic rays. Space is our ultimate environment but we direct attention here to more earthly concerns, to man and his international environment.

2. Global environment defies a simple characterization. New elements arise amidst the old. One of its significant, modern features is rapid scientific progress. Advances in science and technology have radically increased man's power over nature and opened up the infinite potential of space. Modern means of transport and communications have greatly increased the interaction of people and the flow of goods and information, promoting interdependence of states and fostering a sense of global community. Finally, modern physics has unlocked the secrets of the atom and created a weapon of unlimited power. In doing so, it has given man a means with which to annihilate his entire species.

3. Another important, perhaps crucial, characteristic of international environment lies in the fact that man's progress in social, political, and spiritual domains has not matched his advances in material and technical realms.

4. Disunity and conflict are fundamental facts about the contemporary world. National rivalry and oppression, economic exploitation, class inequality, fundamental differences in world view based on either religion or ideology, are among the deep and durable sources of division and discord. If unrestrained, these factors could lead to war.

5. There is no overarching restraining power on the global scene. In fact, its absence is inseparably linked with the principle of sovereignty which is at the very foundation of the modern state system. Sovereignty is the sine qua non condition for war among the states.

STRATEGIC

6. There is no universally agreed definition of the terms 'strategy' and 'strategic'. It is possible to use the term 'strategy' in the very broad sense to describe the use of available resources to gain any objective, from winning at bridge to selling soap; it is equally possible to use it in the traditional sense only: that is, as meaning the art of the strategon, or military commander.[1] The traditional meaning focuses on the part which is played by force, or the threat of force, in the international system.

7. In this report, the term 'strategic' refers to those aspects of the international environment that affect the power of states and thus, directly and indirectly, their capacity to use or threaten the use of force. If one accepts the proposition that 'war has its roots in the mind of man'[2], then strategic aspects of international environment necessarily include the thoughts and feelings of

people and their governments. Governments define and choose goals, and devise strategies for achieving them. The determination with which goals can be pursued ultimately depends on the people as a whole. National morale and national strategy are intangibles which profoundly affect the capacity of states to use or to threaten the use of force and the will to resist such threats.

8. These qualitative factors are essential components of strategic environment. Material factors that are quantifiable to some degree are no less important in any description of the global scene.

9. The purpose of this report is to provide a description of the global strategic environment along such measurable dimensions of power as population, geography, economic base and military strength.

10. Of prime concern is the distribution of these attributes among four broad groupings of states: Western Community, the Soviet Bloc, China and the Southern Hemisphere[3]. In brief, Western Community consists of countries belonging to the Organization for Economic Co-operation and Development (OECD), plus South Korea and Israel. The Soviet Bloc comprises Warsaw Pact states plus Cuba, Mongolia and Afghanistan. People's Republic of China is treated as a separate entity. Finally, the Southern Hemisphere denotes essentially the rest of the globe. Neither the Western Community nor the Southern Hemisphere is a purely geographic concept. The report focuses on patterns and relationships that exist at the present time but likely trends in their evolution are indicated where warranted.

11. The amount of information from which an incisive view of the world condition might be constructed, is vast. This report is, of necessity, macroscopic in purview and selects only those elements whose influence is critical and long-term. In a very real sense, this report's purpose is to serve as the starting point of analysis and not as its end.

12. The information base is divided into eight separate parts for clarity and ease of use. The first five parts pertain to the international environment as a whole (the geo-demographic factors, economic base, world trade, military manpower and defence expenditures, and strategic nuclear forces), while the last three parts present additional information specific to Canada (population origin, international trade, and international investment). Detailed statistical data are given in the Annex.

13. The latest year for which complete and accurate statistics were available was used in each case. In this way the number of gaps in statistics was minimized. Also, errors were reduced since estimates are always prone to bigger errors for the most recent years than for past years, for which there are more data available.

FOOTNOTES

1 Michael Howard, The Causes of Wars, (London: Unwin Paperbacks, 1984), p. 36.

2 Preamble to the Charter of UNESCO.

3 Countries included in each grouping or zone are listed in detail in Tables 1 and 1A of the Annex. The rationale for these groupings is outlined in associated reports under ORAE Project 96134. See, for instance, George C. Betts, ORAE Project Report No. PR308, Western Community.

CHAPTER 2

THE GEO-DEMOGRAPHIC FACTORS

GENERAL

14. The nation-state embraces all who live within its boundaries at a given time. Population and geography are datum points from which the modern state reckons its political position.

15. Evidently, large population does not automatically indicate great strength.[1] This is particularly so in the nuclear age. However, among states fairly evenly matched in technological skills and material resources, superiority in manpower constitutes a potential that can be translated into military, economic, and political preponderance. The size of the armed forces depends greatly upon the size of the population. The quality of weapons depends on the level of industrial development attained by that population.

16. History of a people is inseparable from its geographical setting. Characteristics such as size, topography, the nature of borders and neighbours, all influence state's position and power. The unequal distribution of natural resources upon the earth's surface is also a geographic reality that influences potential power of states and national policy.

17. Geography is perhaps the most stable factor upon which the power of a nation depends but its meaning and influence are not immutable - they must be interpreted in light of the evolution of military technology. Conventional force projection is still a function of traditional geographic considerations. Nuclear threat embodied in ballistic missile forces is largely ageographical. The space dimension continues to gain prominence with advances in technology that exploit it.

WORLD POPULATION DISTRIBUTION

18. The 1985 world population is estimated at 4.8 billion. This figure is an extrapolation from World Bank figures for 1981, the latest year for which complete and accurate statistics were available. The discussion that follows is based on these figures (Tables 1 and 1A, Annex).

19. In 1981 global population was four and a half billion people, distributed as shown in Table 1 and Figure 1. Western Community countries had a combined population of 830 million, less than one-fifth of the global total. Soviet Bloc population of 406 million was less than one-tenth of the world's total. Western Community and the Soviet Bloc taken together account for about one quarter of all humanity. Fully one half of the world's people live in countries grouped in this report as the Southern Hemisphere. Lastly, China's approximately one billion population represents some 22 percent of the total, but its population density was three to six times higher than that of the other zones.

Table 1

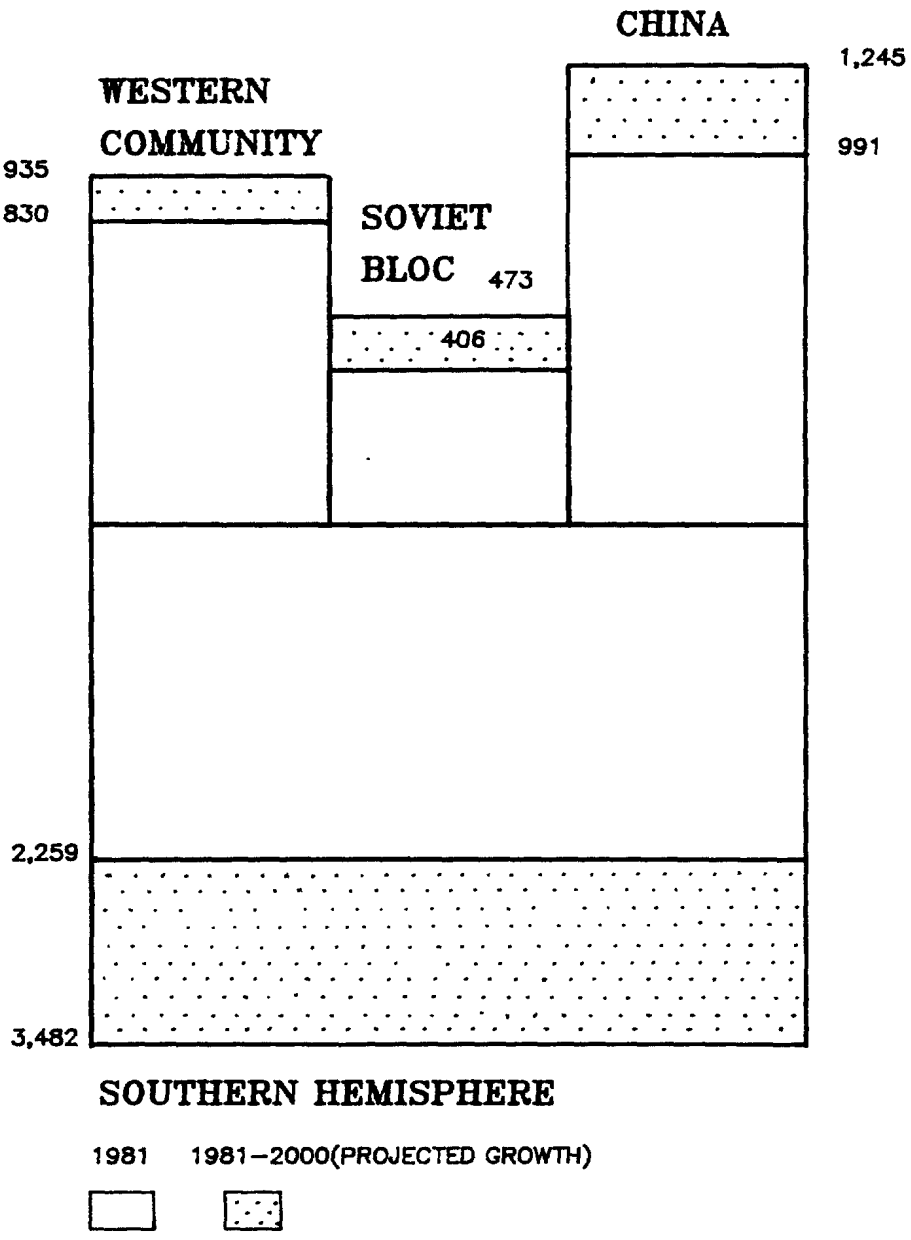
World Population Distribution

Zone	Population				
	1981			1985	2000
	millions	% world total	Persons per sq. km.	millions	millions
Western Community	830	18.5	25.8	850	935
Soviet Bloc	406	9.0	15.8	420	473
China	991	22.1	103.7	1,040	1,245
Southern Hemisphere	2,259	50.4	34.9	2,475	3,482
World Total	4,486	-	33.9	4,785	6,135

FIGURE 1

WORLD POPULATION DISTRIBUTION

(MILLION PERSONS)



20. By the year 2000, global population is expected to exceed six billion. Three-quarters of the increase is projected to occur in the Southern Hemisphere countries. To put the Southern Hemisphere population growth into perspective, it should be noted that its projected population increase of 1.2 billion equals the combined 1981 population of the Western Community and the Soviet Bloc. The already severe problem of scarcity of food, energy, capital and other resources will be exacerbated. Human misery and social injustice are likely to increase, providing a fertile ground for exploitation by totalitarian ideologies.

21. Population growth rates in other zones are comparable in aggregate terms. However, some regions (Western Europe) and groups (European portion of the Soviet Union's population) are expected to approach zero population growth. This leads to an ageing population and will make it more difficult to sustain economic growth and to meet the manpower needs of the military forces in both of the major power blocs. Greater demand on social and medical resources will put increasing strains on budgets. These fundamental demographic and economic constraints will influence the magnitude of the conventional forces option open to the Western Community and thus also the nuclear threshold. They will also shape the structure of conventional forces and the strategies for their employment.

MAJOR COUNTRIES IN TERMS OF THE POPULATION

22. The distribution of people among the states is very uneven. China and India alone account for one-third of humanity. Half of the world's people lives in only five states (China, India, USSR, USA and Indonesia). Countries with population of more than 50 million are listed in Table 2. These 17 nations account for 72 percent of the world's population.

Table 2

Most Populous Countries

Rank	Country	1981 Population (millions)
1	China	991
2	India	690
3	USSR	268
4	USA	230
5	Indonesia	149
6	Brazil	121
7	Japan	118
8	Bangladesh	91
9	Nigeria	88
10	Pakistan	85
11	Mexico	71
12	Germany, FR	62
13	Britain	56
14	Italy	56
15	Vietnam	56
16	France	54
17	Philippines	50

DISTRIBUTION OF THE WORLD TERRITORY

23. There are approximately 150 million square kilometers of land surface in the world versus about 360 million square kilometers of ocean surface.[2] Countries for which data are presented in this report occupy 132 million square kilometers of the Earth's landmass (Table 1, Annex). Major exclusions from the report are Antarctica (14.1 million square kilometers) and Greenland (2.2 million square kilometers). Other exclusions are listed in Table 1A, Annex.

24. The distribution of the world territory is summarized in Table 3 and Figure 2. Southern Hemisphere countries occupy some 43 percent of the world landmass, almost as much as the combined territory of Western Community, Soviet Bloc and China. Western Community ranks second in terms of the territory, followed closely by the Soviet Bloc. China, with an area of 9.6 million square kilometers, is the smallest of the four zones. The value of any given territory depends on many factors in addition to simply size. A more comprehensive analysis would need to consider factors such as climate, soil, accessibility, and others.

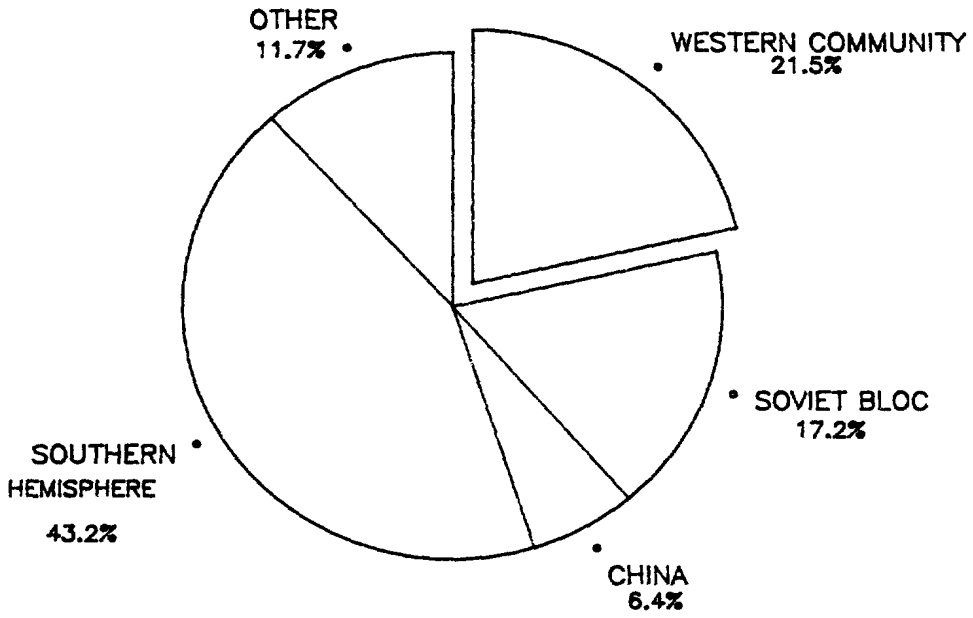
Table 3

Distribution of World Landmass

Zone	Size (millions of sq.km.)	% world total
Western Community	32.2	21.5
Soviet Bloc	25.7	17.2
China	9.6	6.4
Southern Hemisphere	64.7	43.2
Other	17.6	11.7
World Total	149.8	

FIGURE 2

RELATIVE SHARE OF WORLD TERRITORY



MAJOR COUNTRIES IN TERMS OF THE TERRITORY

25. The distribution of territory among nations is also uneven. Ten largest countries in terms of area are listed in Table 4. The Soviet Union (22.4 million square kilometers) is by far the largest state, extending over more than one-seventh of the Earth's land surface. Canada is second, followed by China, USA, Brazil, and Australia. These six nations occupy 45 percent of the world territory.

26. Comparison of major countries in terms of territory and population is interesting. It shows that USSR and USA, the two superpowers, are on both lists. China, India, and Brazil are the only other common members.

Table 4

Largest Countries

Rank	Country	Size (million of sq. km.)
1	USSR	22,402
2	Canada	9,976
3	China	9,561
4	USA	9,363
5	Brazil	8,512
6	Australia	7,687
7	India	3,288
8	Argentina	2,767
9	Sudan	2,506
10	Algeria	2,382

CANADA, SUPERPOWERS AND RELATED GROUPS

27. A more detailed comparison between the Western Community and the Soviet Bloc is useful. Relevant population and size statistics are summarized in Table 5 and Figures 3 and 4. NATO statistics are for all of its sixteen member states. The complete list of countries grouped as Western Europe, Western Community, Eastern Europe, and Soviet Bloc is given in Table 1 of the Annex.

28. The Western Community has twice as many people as the Soviet Bloc and occupies one-and-a quarter times as large an area. These disproportions are reduced if one restricts attention to NATO and the Warsaw Pact. In fact, territory belonging to NATO states is slightly smaller than the territory of the Warsaw Pact states, but NATO's population of 620 million is still some 64 percent greater than the Warsaw Pact population of 378 million. Geography favours the Warsaw Pact operationally - it has interior lines of communication while NATO's territory is divided by the Atlantic.

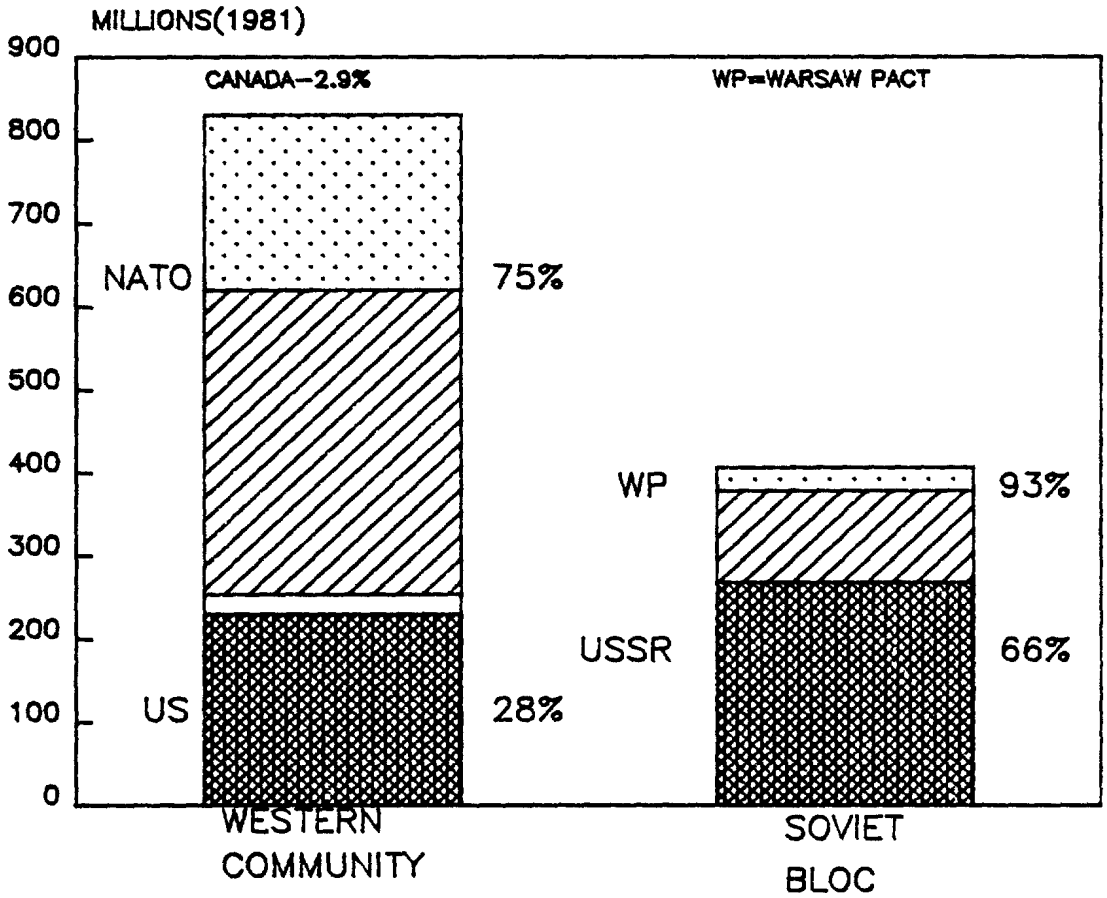
Table 5

Canada, Superpowers and Related Groups
- Population and Area

Country/Group	Population		Area
	1981	2000	(millions of sq.km.)
Canada	24	28	10.0
United States	230	259	9.4
Western Europe	350	372	3.6
NATO	620	704	22.7
Western Community	830	935	32.2
Soviet Union	268	312	22.4
Eastern Europe	110	122	1.0
Warsaw Pact	378	434	23.4
Soviet Bloc	406	473	25.7
World Total	4,486	6,135	149.8

FIGURE 3

WESTERN COMMUNITY,SOVIET BLOC–POPULATION



LEGEND:

CANADA

US,USSR

NATO(less US,CANADA)

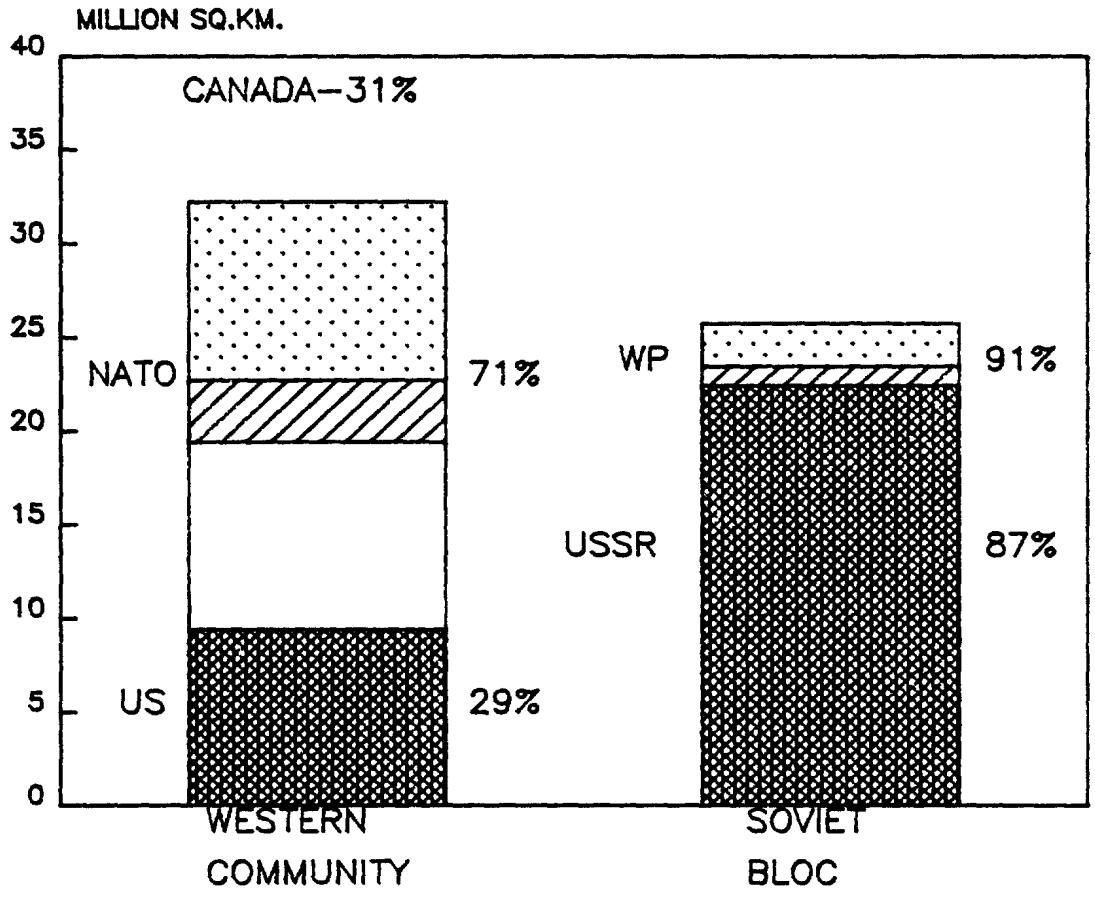
WP(less USSR)

REST OF WESTERN COMMUNITY

REST OF SOVIET BLOC

FIGURE 4

WESTERN COMMUNITY,SOVIET BLOC–AREA



LEGEND:

AS IN FIGURE 3,P.15

29. The two superpowers differ in the relative contribution they make within their zones. The Soviet Union is dominant within its bloc and, even more so, within the Warsaw Pact. It has two-thirds of the Soviet Bloc's population and 91 percent of its territory. The United States, while large, accounts for only about 30 percent of the Western Community's population and area. Relative to NATO, US contributes 37 percent of the population and 41 percent of the area.

30. The population of the United States is 14 percent smaller than the population of the USSR (230 versus 268 million) and this differential is expected to increase only slightly by the year 2000. A significant factor affecting the Soviet demography is the fertility rates of its Central Asian and Moslem populations which are reported to be much higher than in the European regions. This trend will impact on the ethnic composition of the Soviet Union and its armed forces. This can be expected to create additional problems for the Soviets but they have considerable experience in handling multi-national problems.

31. Canada is the second largest country in the world but only occupies position number 30 in terms of the population. It accounts for 3 percent of the population and 31 percent of the territory of the Western Community.

FOOTNOTES

1 For a full discussion of population as a potential source of power, see Dr. G.R. Lindsey, ORAE Memorandum No. M78, The Significance of Population Growth for Future International Relations, August 1976.

2 Total area is approximately $4\pi R^2$, where R is radius of the Earth (6,371 km).

CHAPTER 3

THE ECONOMIC BASE

INTRODUCTION

32. The technology of modern warfare makes military strength ever more dependent on the nation's industrial capacity. Thus state power is a function not only of size and skill of the population and geographical circumstances but also of nation's success in building a modern economy.

33. The high technology sector is especially important from the national security point of view as developments in this area have the potential to affect significantly, and perhaps even decisively, a nation's relative power. Technology is not a panacea for political problems but it does define many of the constraints and opportunities that political leaders and strategists need to take into account.

ECONOMIC OUTPUT

34. The broadest measure of a country's economic capability is its gross national product (GNP). Natural resources, technological skills of the population, fundamental structure of the economy are, of course, significant aspects of a nation's economic strength, actual or potential. Nevertheless, order of magnitude comparisons based on GNP are revealing by themselves. Unless otherwise noted, subsequent discussion is based on statistics contained in Table 2 of the Annex.

35. The world's output of goods and services neared 13 trillion US dollars in 1981, distributed as shown in Table 6. Almost two-thirds of that output ($8.2 trillion) was generated within the Western Community. This was some 3.6 times as much as the economic output of the Soviet Bloc countries ($2.3 trillion). The Southern Hemisphere ranked third in terms of GNP ($2 trillion), an economic output close to that of the Soviet Bloc. China was a distant fourth ($300 billion).

Table 6

Distribution of Global Economic Output Among the Zones

	GNP (1981)		
Zone	US$ billion	% world total	US$ per Capita
Western Community	8,230	64.3	9,916
Soviet Bloc	2,294	17.9	5,649
China	300	2.3	300
Southern Hemisphere	1,983	15.5	878
World Total	12,807	-	2,855

36. Geographic distribution of the GNP is portrayed in Figure 5. Developed NORTH contrasts rather sharply with the developing SOUTH. GNP per unit area (Figure 6)[1] gives an even clearer indication of the spatial concentration of economic activity.

37. This activity density is particularly high in the European Central Region (Federal Republic of Germany, Denmark, Netherlands, Belgium and Luxembourg) and in the compact and economically powerful Japan. The average economic output in these locations exceeds $3 million per square kilometer - surpassed only by the very small but rich states of Bahrain and Singapore.

38. Western Europe as a whole has an economic output of almost $1 million per square kilometer, making it a great economic prize. Eastern Europe's economic activity density is on level with that of South Europe (Greece, Italy, Spain and Portugal). Soviet Union with its vast Siberian expanse, Canada with its Great North and Australia with its Dead Centre do not fare well in terms of this particular indicator. This merely illustrates that too much should not be read into any single indicator, no matter how interesting it might appear.

39. Data on GNP per head provide an index of the comparative wealth and poverty of the countries (Table 6). The disparity between the Western Community and the Soviet Bloc on the one hand, and China and the Southern Hemisphere, on the other, is evident and striking.

40. The developed NORTH has 25 per cent of world's population and accounts for 81 per cent of world's output. Its per capita GNP of $9,147 is 12.5 times that of the per capita GNP of $723 in the developing SOUTH.[2]

41. A note of caution seems opportune. GNP per capita is not considered to be a good index of individual welfare because of the greatly inequitable distribution of wealth in many countries and other reasons.[3]

FIGURE 5

GROSS NATIONAL PRODUCT

(1981–$ BILLION US)

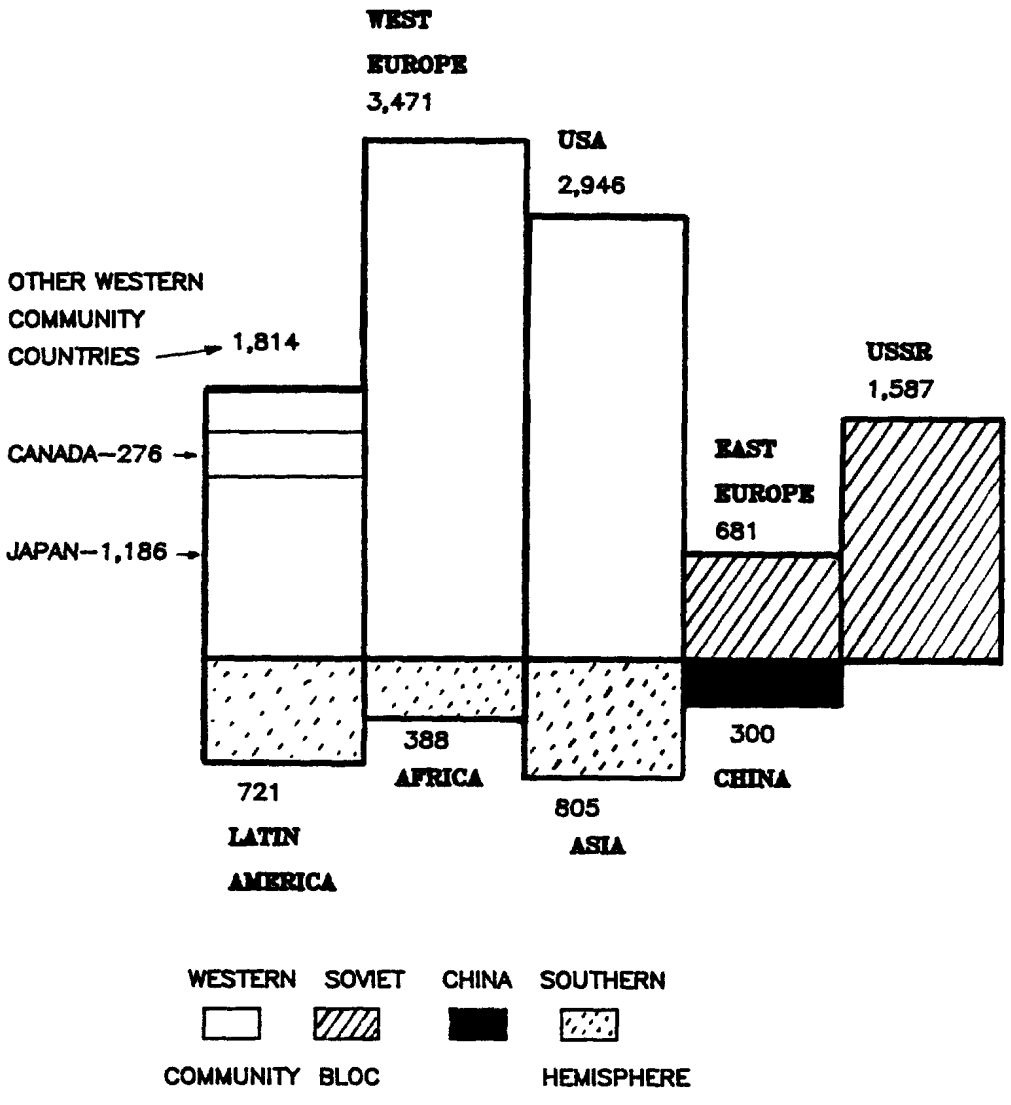


FIGURE 6

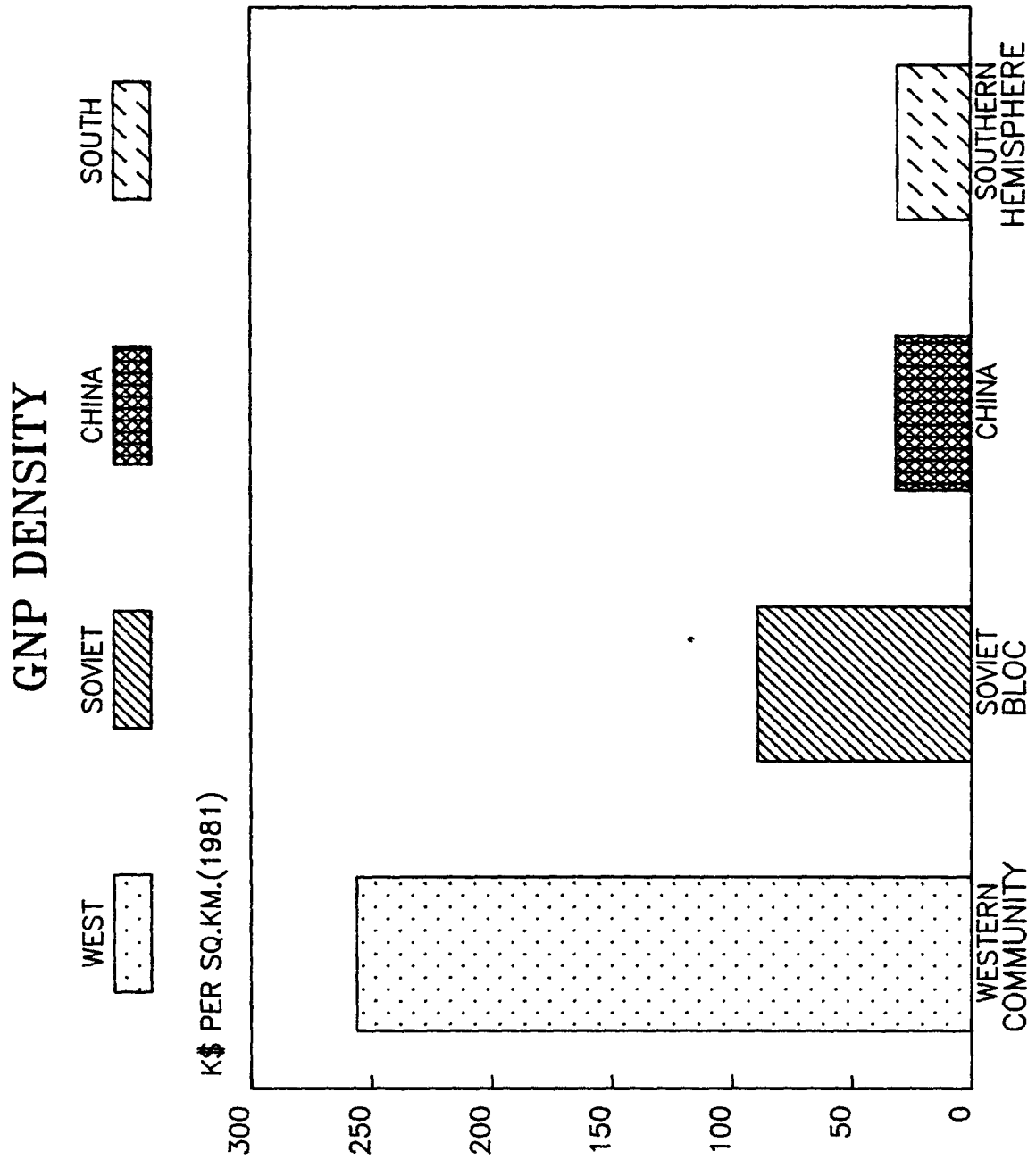
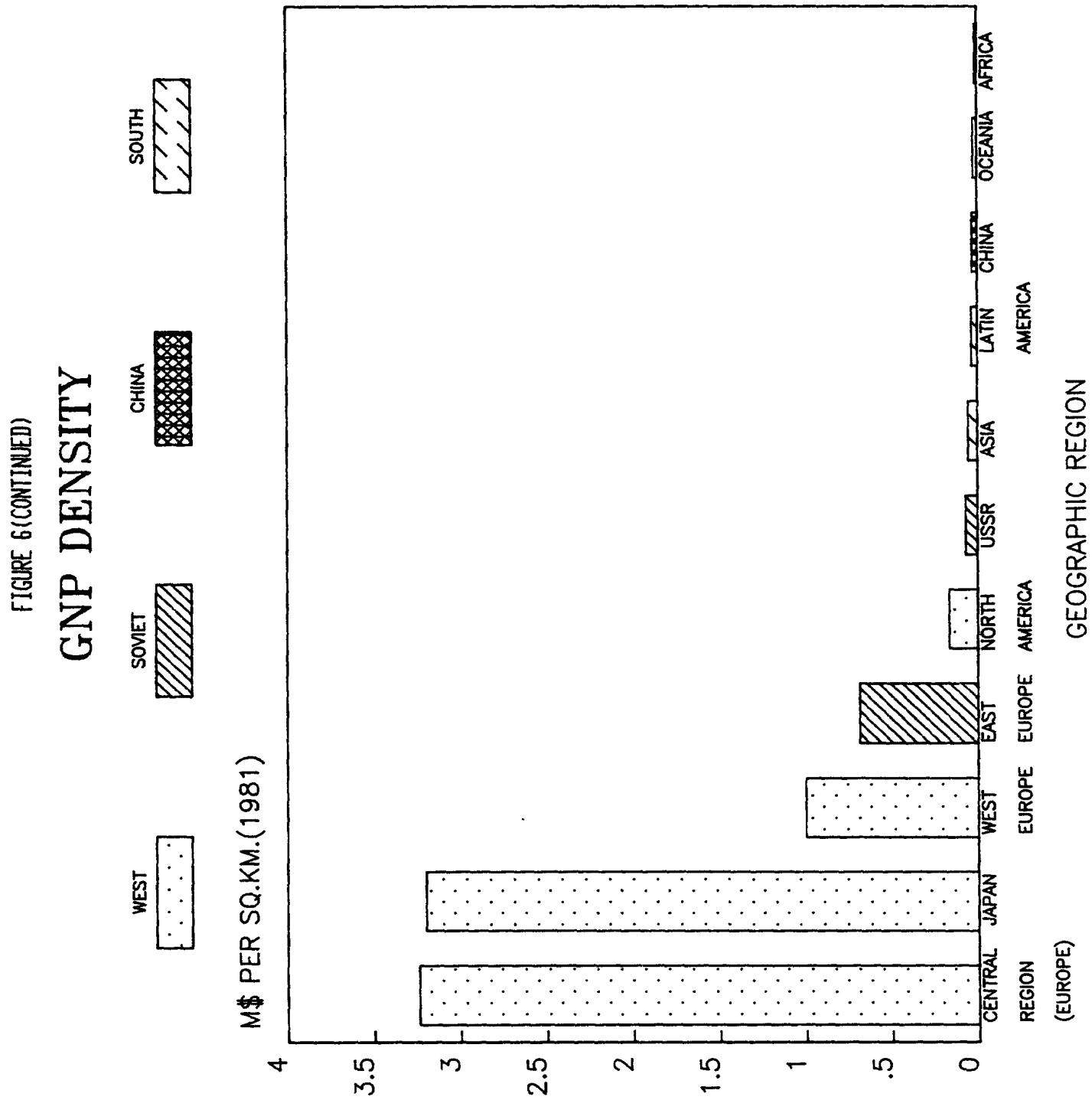

GNP DENSITY
WEST
SOVIET
CHINA
SOUTH
K$ PER SQ.KM.(1981)
300
250
200
150
100
50
0
WESTERN COMMUNITY
SOVIET BLOC
CHINA
SOUTHERN HEMISPHERE

FIGURE 6(CONTINUED)



MAJOR ECONOMIC POWERS

42. As with population and territory, large disparities in economic capabilities exist among individual nations. Leading countries in terms of total economic output are listed in Table 7 below.

Table 7

Leading Economic Powers (based on GNP)

Rank	Country	GNP (1981) (US$ billions)
1	USA	2,946
2	USSR	1,587
3	Japan	1,186
4	Germany, FR	830
5	France	658
6	United Kingdom	510
7	Italy	391
8	China	300
9	Canada	276
10	Brazil	268

43. The United States produces nearly one-quarter of the total world output and is the world's dominant economic power. The world's second largest economy belongs to the Soviet Union and its output is slightly larger than half of the USA output. The third largest economy is that of Japan, followed closely by the Federal Republic of Germany. Together, these four nations produce half of the world's economic output.

44. Only ten countries generate output that exceeds $250 billion. Cumulatively, they produce two-thirds of the world's output.

45. The composition of the leading group is interesting. Seven countries are members of the Western Community. The only non-Western Community powers are the Soviet Union, China, and Brazil. The exact ranking of China is difficult to establish because of large uncertainty in the estimate of its GNP (range $260 - $600 billion in 1982).[4]

POPULATION AND ECONOMIC CAPABILITY

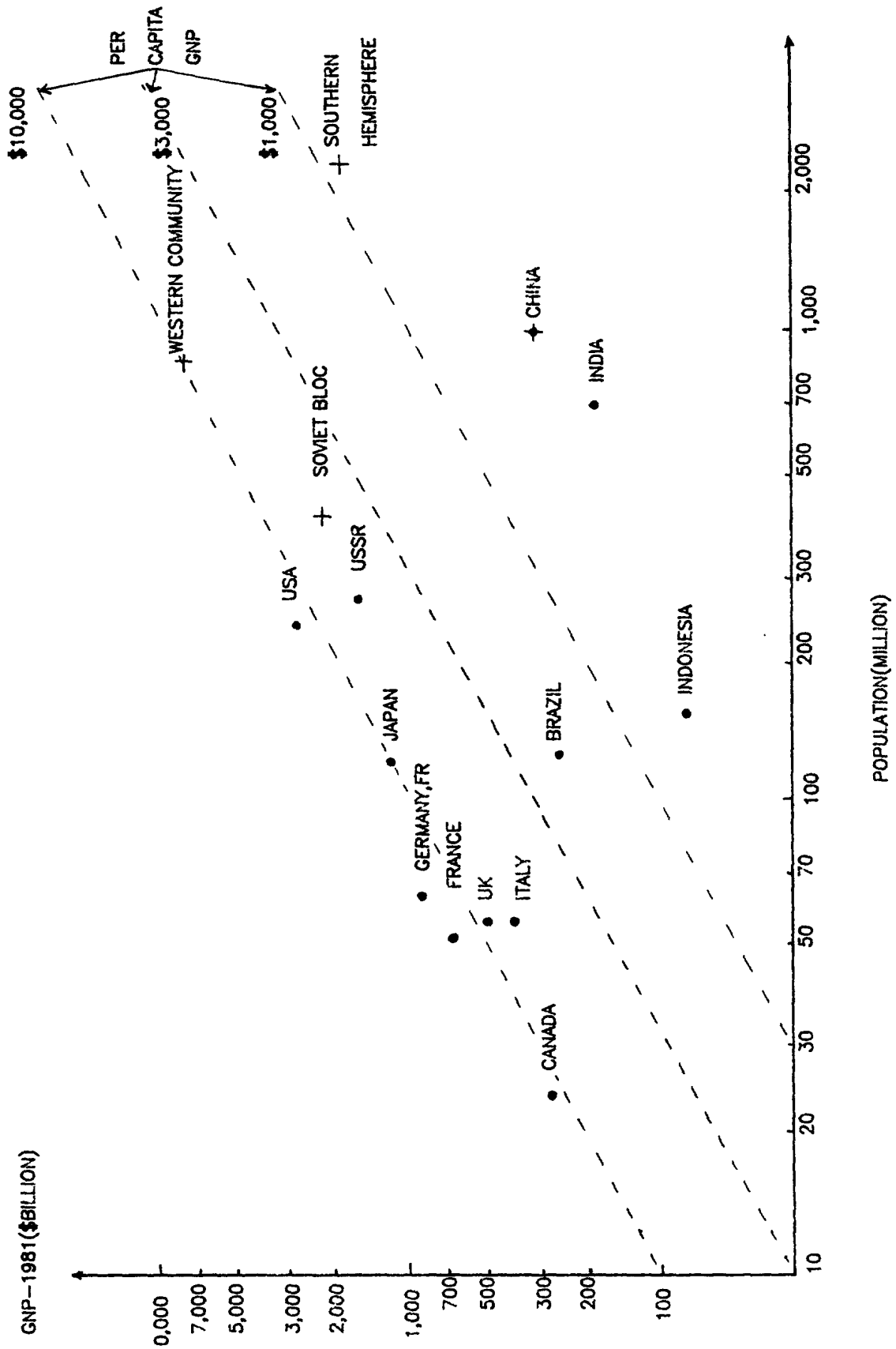
46. Size of the population and economic output are critical components of a nation's strength. These two key variables are displayed in Figure 7 for the four zones as well as for twelve major countries. The twelve comprise ten leading economic powers, plus India and Indonesia. Inclusion of the last two countries allows consideration of all the countries whose population exceeds 100 million people.

47. Countries can be divided into four categories on the basis of their level of industrial development: preindustrial, transitional, industrial and advanced industrial. No single criterion can adequately identify the category to which any given country belongs. Economic historian, W.W. Rostow, in his stages-of-growth theory of national economy,[5] used percentage of investment as a criterion. Per capita income, which is highly correlated with percentage of investment, is used here.

48. There is a degree of arbitrariness in the choice of the dividing lines and the correlation is far from complete. In some cases country's high GNP per capita is

FIGURE 7

POPULATION AND ECONOMIC CAPABILITY



solely due to the sale of its natural resources, such as oil, and the country may be devoid of an industrial base. In other cases a country may have a relatively low GNP per capita but still have a strong industrial sector imbedded in an otherwise primitive economy. This 'dual economy' phenomenon applies to partially industrialized states (e.g. China) in particular but can also be evident in industrialized states some of which have an advanced military industry but relatively backward civilian sector (e.g. USSR). Other indicators such as production of steel and energy consumption,[6] could be used in an attempt to define the level of industrialization more precisely.

49. For our purposes the significant feature lies in the broad pattern that emerges from the combined consideration of the economic and demographic dimensions. The two superpowers stand clearly apart. Another distinct cluster of power is formed by the four major European countries (Federal Republic of Germany, France, United Kingdom, and Italy). Japan lies in between these two major groupings and Canada trails behind the European group. Brazil is on a distinctly lower level and China, India, and Indonesia lower still.

50. Transition to a higher level of industrialization demands sustained effort. Change is measured in terms of decades, not years.

ECONOMIC GROWTH PROJECTION

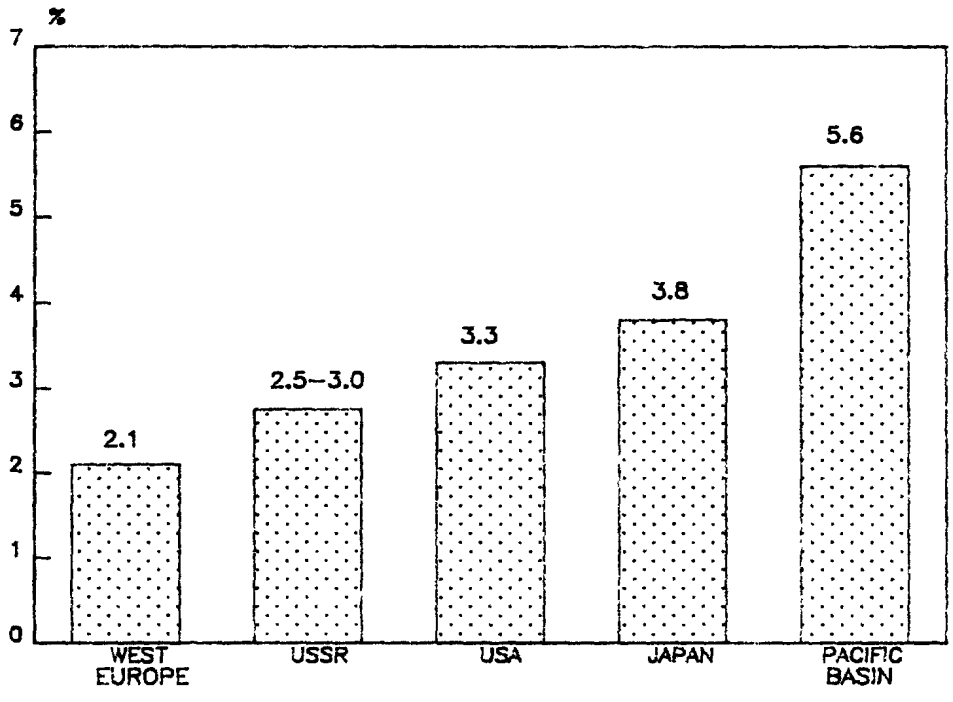
51. Developed market economies have been experiencing economic problems during the past few years. Indeed, it was only in 1983 that they emerged back from a deep recession (1980-82).

52. Declining rates of growth have also been a feature of developed socialist economies. In particular, Soviet industrial growth has slowed down during the past ten years because of serious structural problems. These have been extensively analyzed in "Novosibirsk Report",[7] a confidential Soviet paper on the USSR's economic problems, and elsewhere.[8] Without substantive reforms, the prospects for Soviet economic growth are not encouraging. With the advent to power of Mr. Gorbachev, these cannot be excluded.

53. The projected growth rates of major world economies are shown in Figure 8. They imply that the economic gap between the Soviet Union and the United States will remain but Japan will narrow the gap that separates it from the USSR. West Europe is expected to grow relatively slowly compared to other clusters of power. The broad pattern portrayed in Figure 7 is likely to evolve very slowly and its major features can be expected to persist into the next century.

FIGURE 8

PROJECTED GROWTH RATES 1985–89[9]



(AVERAGE ANNUAL GROWTH IN REAL GNP)

54. The capability of the economies to sustain military strength in the long-term is thus unlikely to undergo a dramatic shift. Of course, the extent to which economic resources are actually channelled into military production is a product of a nation's history, perception of a threat and political ambition. Centrally planned economies, where the state owns all the means of production, can allocate more easily their more limited resources to military production and do so on a sustained basis than free-enterprise consumer-oriented economies.

55. The greatest relative change in the economic sphere may well come from the developing economies. For instance, the Pacific Basin is projected to have relatively high rates of growth in the next five year period. China's 'Four Modernizations' may allow it to achieve relatively high growth rates. Brazil, which has just returned to civilian government, may also achieve significant growth, although its enormous debt will act as a brake on the economy.

56. The debt problem alluded to above confronts many countries in Latin America, Asia, Africa, and Eastern Europe. It makes it even more difficult for them to achieve economic development goals and raises concern about their ability to maintain debt payments. The total debt of less developed countries was US$ 530 billion at the end of 1981.[10] Countries with the largest total foreign debt are listed in Table 8 along with two indicators useful in evaluating the seriousness of debt problem. These are the ratios of foreign debt to gross national product and the ratio of foreign debt to exports. The debt-export ratio shows clearly the concentration of risk in a few large debtor countries. It is this concentration which poses a serious threat to the stability of the international financial system.[11] The reasons for the debt problem are analyzed in both of the above-cited references. The two oil price rises (1973 and 1979) are singled out as particularly

important factors inasmuch as many of the developing countries are extremely dependent on oil imports and sharply increased oil costs hit them particularly hard. The indirect impact of oil price increases was equally significant - it manifested itself in shrinking markets, plunging commodity prices, a rising dollar and high real interest rates and graphically demonstrated the strength and complexity of global economic linkages.

Table 8

Major Debtor Nations as of the End of 1981

Country	Debt[12]		
	Absolute Size	Relative Size	
	US$ billion	As % GNP per annum	As % annual Exports
1. Mexico	73.0	45.6	364
2. Brazil	71.4	26.7	309
3. Argentina	35.6	49.4	389
4. Venezuela	26.0	40.0	129
5. Poland	26.0	14.2	196
6. Spain	25.0	11.7	123
7. Yugoslavia	19.3	30.7	177
8. India	19.0	10.8	253
9. Indonesia	18.0	22.9	72
10. Algeria	17.0	40.5	117
11. South Korea	16.9	25.6	80
12. Philippines	16.0	41.0	280

57. The prospects for growth in the developing countries depend on many internal factors. They are also heavily influenced by the health of the developed economies. The recent recession in the developed countries was accompanied by a fall in the demand for and prices of many primary commodities on whose exports many developing countries depend. The adverse impact of recession was aggravated by the heavy dependence of many developing countries on a single commodity for exports. With recovery of developed economies in progress, developing countries' prospects should also improve.

INDUSTRIAL CAPACITY

58. Modern warfare is highly dependent on national industrial and technological resources. An index which focuses on this aspect of economic strength is total industrial production. A recent study by a Swiss expert on industrialization, Paul Bairoch,[13] presents an analysis of pertinent statistical data from the start of the Industrial Revolution until 1980. His list of ten leading economic powers in terms of the total manufacturing output is reproduced as Table 9 below.

Table 9

Leading Industrial States

Rank (1980)	Country	Level of Industrialization (relative to the U.K. in 1900 = 100)			Ratio 1980 to 1913
		1980	1953	1913(rank)	
1	USA	3,475	1,373	298 (1)	11.7
2	USSR	1,630	328	77 (4)	21.2
3	Japan	1,001	88	25 (8)	40.0
4	Germany, FR	590	180	138 (2)	4.3
5	China	553	71	33 (7)	16.8
6	United Kingdom	441	258	127 (3)	3.5
7	France	362	98	57 (5)	6.4
8	Italy	319	71	23 (9)	13.9
9	India	254	52	13 (11)	19.5
10	Canada	220	66	9 (13)	24.4

59. Rankings based on the 1980 manufacturing output are practically identical to those based on the total 1981 economic output (GNP - Table 7). China ranks fifth in terms of manufacturing output but the degree of uncertainty associated with China's statistics and position is just as high here as was the case with the GNP. Another difference is the appearance of India in the top 10 instead of Brazil.[14] With these caveats in mind, it is clear that Paul Bairoch's results support the broad pattern portrayed previously in Figure 7.

60. The composition of the leading group of industrialized states changed remarkably little from 1913 to 1980. Eight of the present top ten states were members of the leading group prior to World War I. The United States retained its lead position but relative standings of other countries did change over this period. The major European states declined in standing, surpassed by the USSR and Japan. The Soviet Union advanced from Russia's position number four in 1913 to being the world's second industrial power. Japan's rise was perhaps even more spectacular - its manufacturing output increased by a factor of 40 between 1913 and 1980 and it advanced from position number eight to three.

61. High technology is fuelling a new wave of the industrial revolution. The major new technologies - electronics, telecommunications, industrial materials, biotechnology, automation and artificial intelligence - promise to alter significantly the economies of all countries. Their increasing importance is demonstrated by the trade in high-technology products in the OECD area as shown in Table 10.

Table 10

Exports of High-Technology Products[15]

Country/Group	Percent of Exports of Total Manufactured Products	
	1962	1982
USA	28	40
Japan	17	30
EEC	18	23
OECD	21	26

62. The share of high-tech products in total manufacturing trade has increased during the 20-year period (1962-82), up to 40 percent in the case of the USA. The marked difference between the two largest OECD countries on the one hand, and the average EEC and OECD levels on the other, is apparent and shows that countries differ significantly in their ability to develop and exploit technologies.

63. Another indication of perceived capabilities of some OECD countries in different areas of high technology is given by Table 11. It is based on the judgments of managers from more than 200 large companies in Europe. As a minimum, this collective judgment reflects a concern that wide 'technological gaps' are developing which could lead to a permanent state of technological dominance and dependence.

Table 11

Ranking in High Technology[16]

An Assessment by Chief Executives
of More than 200 European Firms

Technology	United States	Japan	Germany, FR	Scandinavia	United Kingdom	France
Computing	1	2	3	4-5	6	4-5
Electronics	1-2	1-2	3	4	6-7	6-7
Telecommunications	1	2	3	4	5-6	5-6
Biotechnology	1	2	3	4	5	n.a.
Chemicals	1	2	3	4	5	6-7
Metals/Alloys	2	1	3	4	5-6	5-6
Engineering	1	2	3	4	5	6
Manufacturing	1-2	1-2	3	4	5	6
Robotics	2	1	3	4	6	5
Mean Rank	1.3	1.7	3.0	4.2	5.4	5.8

n.a. - not available

64. Soviet efforts to develop and exploit technology, as measured by the number of scientists and engineers employed in all research and development (R&D), are considerable. Table 12 portrays estimates of scientists and engineers engaged in R&D in the USSR and the USA from three separate sources. Both of the series, adjusted to approximate US concepts, show lower numbers for the USSR initially but higher from about 1970 on.

Table 12

Estimates of Numbers of Scientists and Engineers in R&D in the USSR and the USA, 1950-80[17]

(Figures are in thousands)

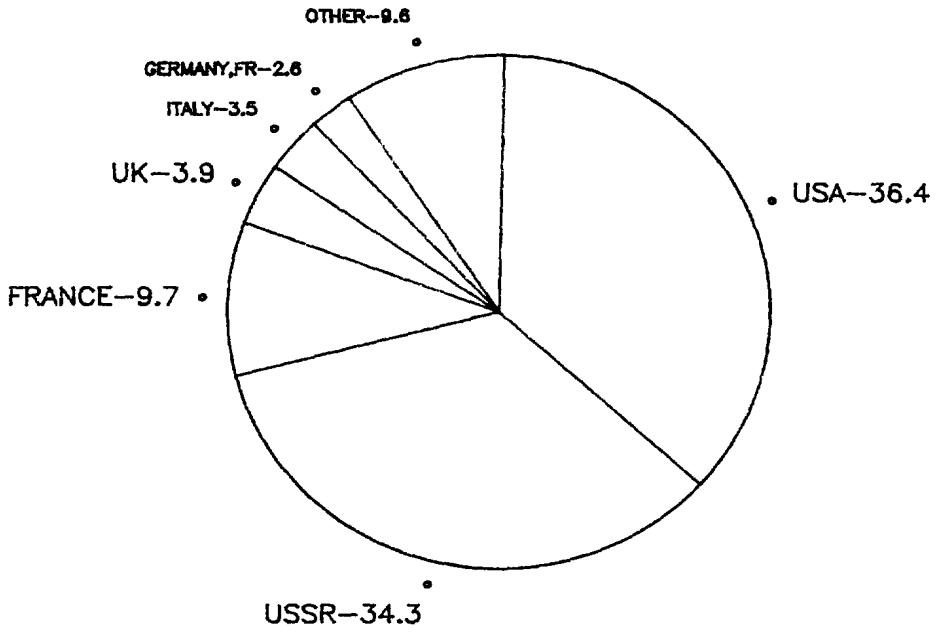
Year	USSR: scientific workers			USA: scientists and engineers, NSF estimate
		Adjusted to approximate US concepts by:		
	As published in USSR	Nolting & Feshbach (1979)	Campbell (1978 & 1980)	
1950	163	112		159
1960	354	244	296 - 328	381
1965	665	423	522 - 561	495
1970	928	591	733 - 807	547
1975	1,223	779	1,061 - 1,188	535
1978	1,314	828	1,179 - 1,327	595
1980	1,371		1,254 - 1,412	610

65. A dramatic illustration of the linkage between the level of industrial development and the modern defence industry is provided by the world armament trade. The pattern for the five-year period, 1978-82, is shown in Figure 9.[18] The United States and the Soviet Union dominate the scene and account for about one third each of the arms exports. The four major European countries account for one-fifth of the total, leaving less than ten percent for all the other countries. Japan, an emergent economic superpower, is notable by its absence from this activity.

66. The Soviet Union is the largest supplier to the Third World, accounting for 37 percent of deliveries, while the US share is 32 percent. Soviet arms exports are also more concentrated - the US has three times as many recipients for its exports as the USSR. On the other hand, the United States is the largest supplier to the industrialized countries - 45 percent - while the Soviet share in this comparison is 30 percent.[19]

FIGURE 9

SHARES OF WORLD EXPORTS OF MAJOR WEAPONS 1978-82,BY COUNTRY



TOTAL VALUE=$74.2BILLION(1975US)

CANADA, SUPERPOWERS AND RELATED GROUPS

67. Comparative economic statistics are extracted from Table 2 of the Annex and summarized in Table 13 and Figure 10. Countries included in each group are the same as in Chapter 2 previously, and these groupings will remain the same throughout the report. The Western Community's economic output was 3.6 times as large as that of the Soviet Bloc. NATO countries' output of $6,380 billion was slightly more than three-quarters of the Western Community's GNP.

68. The economic output of NATO was 2.8 times as large as that of the Warsaw Pact. The potential of NATO economies is thus considerable. The extent to which this potential will be translated into military strength to deter aggression is, however, another question.

69. The American economy, large as it is, accounted only for about one-third of the Western Community's output. The USSR, with its considerably smaller economy, was relatively more dominant in its bloc, accounting for about two-thirds of the total output.

70. Canada ranked ninth in the world in 1981 in terms of economic output. Its GNP of US$ 276 billion constituted 3.4 percent of Western Community's economic output and 4.3 percent of NATO's.

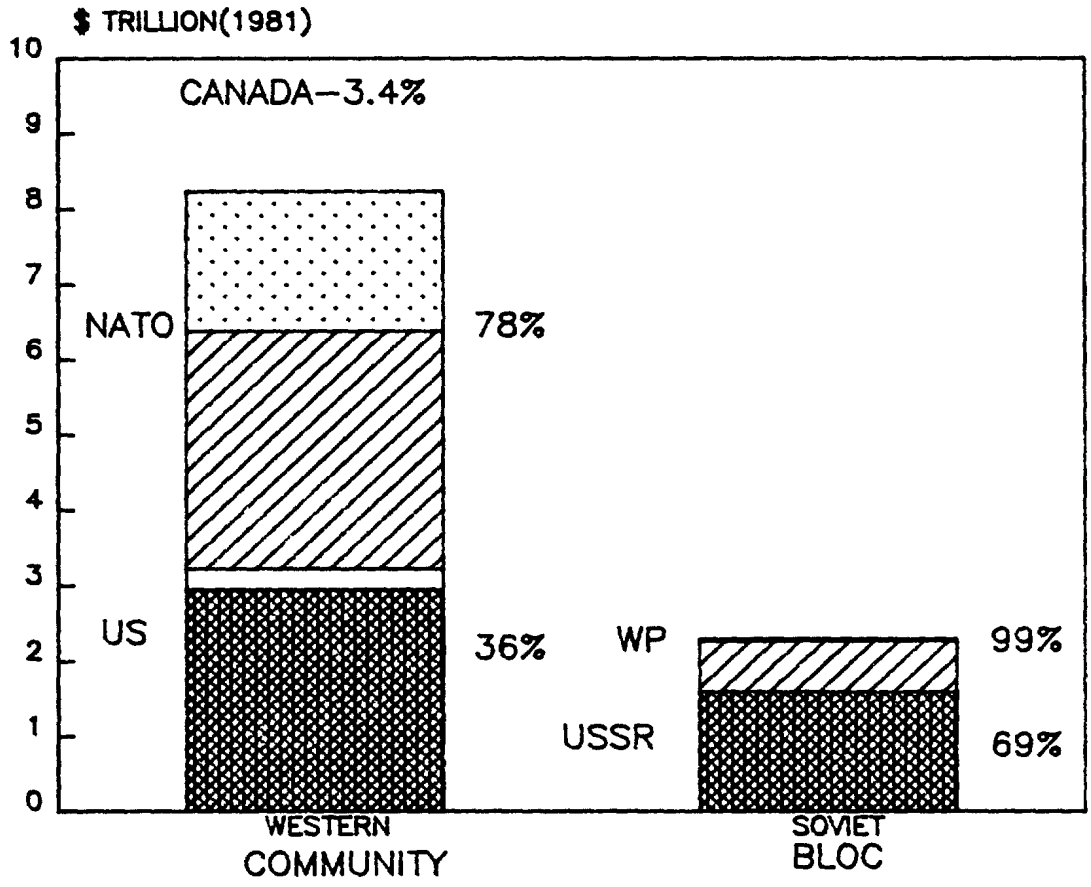
Table 13

Canada, Superpowers and Related Groups - Economic Output

Country/Group	GNP (1981)	
	US$ billions	$ per capita
Canada	276	11,400
United States	2,946	12,820
Western Europe	3,471	9,916
NATO	6,380	10,290
Western Community	8,231	9,916
Soviet Union	1,587	5,928
Eastern Europe	681	6,193
Warsaw Pact	2,268	6,001
Soviet Bloc	2,294	5,649
World Total	12,807	2,855

FIGURE 10

WESTERN COMMUNITY,SOVIET BLOC–GNP



LEGEND:

AS IN FIGURE 3,P.15

FOOTNOTES

1 See Table 2 and notes, Annex.

2 Figures are based on Tables 1 and 2, Annex.

3 For a more detailed discussion of measures of individual welfare see World Development Report, 1982, (Washington: The World Bank, 1982), pp. 20-23.

4 The International Institute for Strategic Studies, The Military Balance 1984-1985, (London, Autumn 1984), p.91.

5 W.W. Rostow, The Stages of Economic Growth, (Mass: Cambridge University Press, 1960). A summary of stages-of-growth and a description of limitations of this generalization can be found on pages 1-16. The term transitional as used in this report encompasses two of Rostow's categories: the preconditions for take-off and the take-off.

6 Ray S. Cline, World Power Assessment, (Washington: The Center for Strategic and International Studies, Georgetown University, 1975), pp. 41-5.

7 Tatyana Zaslavskaya, "Doklad o neobkhodimosti bolee uglublennogo izucheniya v SSSR sotsial'nogo mekhanisma razvitiya ekonomiki", AS 5042, 33 pp., 26 August 1983. As reported in SURVEY, (Spring 1984), pp. 83-108.

8 Stanley H. Cohn, "Soviet Capital Productivity and the Soviet Military Industrial Complex", World Expenditures and Arms Transfers 1972-1982, US Arms Control and Disarmament Agency, April 1984, pp. 111-116.

9 Wharton, World Economic Outlook, December 1984 and The Economist, October 6, 1984. p.71.

10 Sylvia Ostry, "The World Economy in 1983: Marking Time", Foreign Affairs, 62:3 (1984), pp. 533-560.

11 F. John Mathis, "You Can't Foreclose a Country", Encyclopaedia Britannica, 1983, pp. 60-64. Debt-to-export and debt-to-GNP ratios in Table 8 are based on debt figures from this reference and GNP and export figures given in Tables 2 and 3 of the Annex.

12 Table 8 displays dimensions of debt in absolute and relative terms. For example, Mexico's debt of US$ 76 billions is such that this country would have to divert 24 weeks of its National Product or 3.6 years of its exports to liquidate the debt. Mexico's level of indebtedness in terms of GNP (45.6%) would have meant in Canadian terms a debt of US$ 126 billion in 1981.

13 Paul Bairoch, "International Industrialization Levels from 1750 to 1980", Journal of European Economic History, 11:2 (Spring 1982), pp. 269-333. Austro-Hungary was in the top ten in 1913 - it ceased to exist after WWI.

14 India ranked 12 in terms of GNP. Brazil ranked 12 in terms of industrial output.

15 J. Marcum, "High Technology and the Economy", The OECD Observer No. 131, November 1984, p. 4. The high-tech products used in this table include aircraft parts, office, computing and accounting equipment, communications equipment and electronic components, professional and scientific instruments, drugs, plastic materials and synthetics, engines and turbines, agricultural chemicals, industrial inorganic chemicals, radio and television receiving equipment.

16 Ibid, p. 5.

17 Stockholm International Peace Research Institute. World Armaments and Disarmament: SIPRI Yearbook 1983, (New York: Taylor and Francis, Ltd., 1983), pp. 230-3.

18 Ibid, p. 268.

19 Ibid, Table 11.1, p. 269.

CHAPTER 4

WORLD TRADE

INTRODUCTION

71. Trade among nations is a tangible demonstration of their interdependence. It is a means of fostering domestic economic growth and prosperity as well as an important tool of foreign policy.

72. Too great a degree of dependence on external sources for critical raw materials, equipment, or technology implies vulnerability to economic pressure in peacetime and risk of disruption or cutoff in time of war. Traditional methods to reduce vulnerability have included the development of one's own resources, diversification of supplies, materials substitution, and stockpiling.

WORLD TRADE DISTRIBUTION

73. World trade volume approached the US$ 2 trillion level in 1981, some 15 percent of the world's GNP (see Table 14 and Figure 11 below). The Western Community accounted for two-thirds of the volume. The Southern Hemisphere's trade volume was second, close to one-quarter of the world's total. The Soviet Bloc ranked third with its share of 8 percent, while China's trade involvement was low at 1 percent. The ratio of trade to GNP was lowest for the Soviet Bloc and China and highest for the Southern Hemisphere. Table 3 of the Annex gives detailed import-export statistics.

Table 14

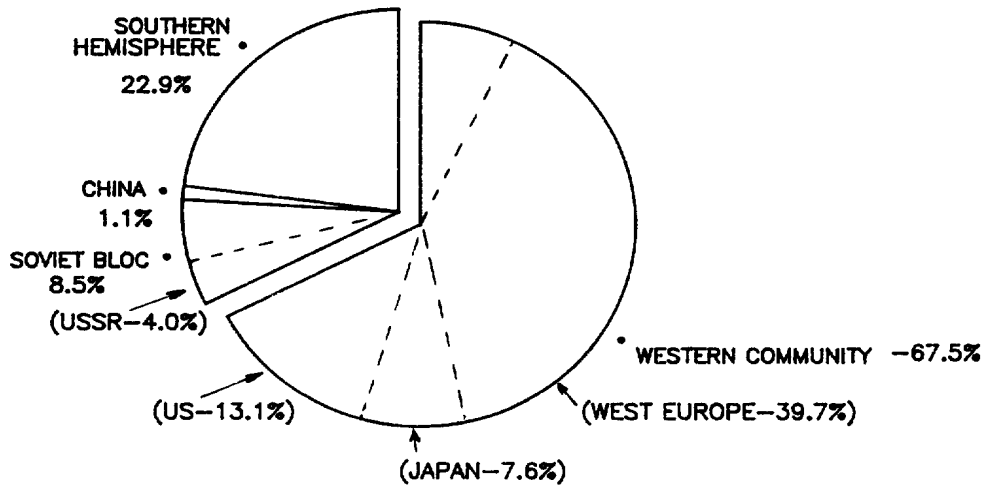
World Trade Distribution, 1981[1]

Zone	Volume (US$ billions)	% World Trade	% Domestic GNP	$ per Capita
Western Community	1,304	67.5	15.8	1,571
Soviet Bloc	163	8.5	7.1	401
China	22	1.1	7.2	22
Southern Hemisphere	442	22.9	22.3	196
World Trade	1,931	-	15.1	430

FIGURE 11

SHARE OF WORLD TRADE

(1981)



TRADE LINKAGES

74. The extent of commercial interaction within and between the zones is portrayed in Table 15 and Figure 12.

Table 15

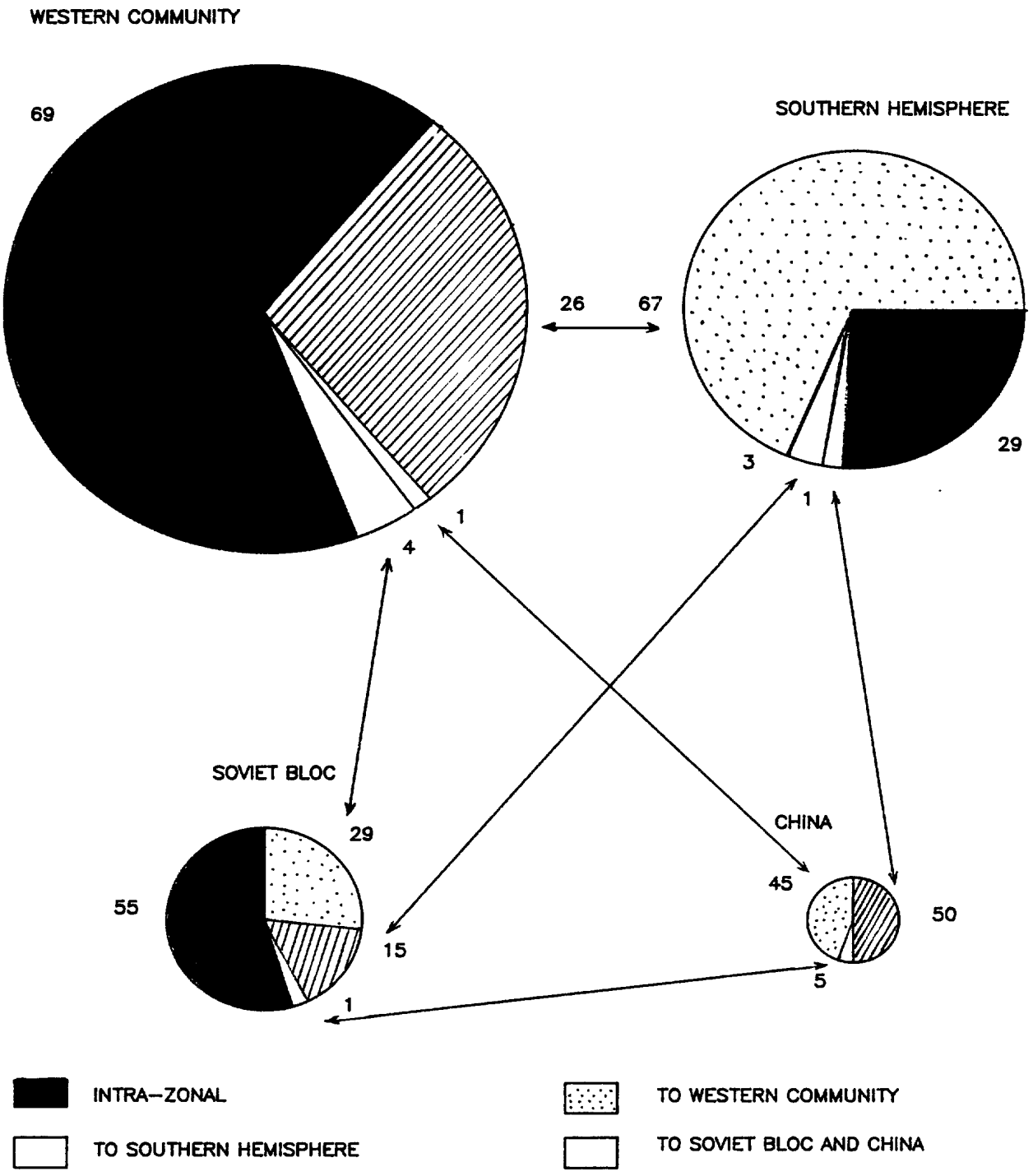
1981 World Exports by Zones (billion US dollars)[2]

FROM \ TO	Western Community	Soviet Bloc	China	Southern Hemisphere	Total	
					Value	% world
Western Community	863	45	14	318	1,240	63.7
Soviet Bloc	49	92	1	26	167[3]	8.6
China	10	1	--	11	22	1.1
Southern Hemisphere	349	13	4	152	518	26.6
Total	--	--	--	--	1,947	--

FIGURE 12

TRADE FLOWS

(APPROXIMATE PERCENTAGES OF TOTAL ZONE EXPORTS IN 1981)



75. Almost seventy percent of the Western Community's trade is with member countries. Soviet Bloc countries also have extensive trade links among themselves, some 55 percent of their trade is internal to the Bloc. Southern Hemisphere countries are a much less integrated group, with only approximately 30 percent of the trade being intra-zonal.

76. Inter-zonal trade is largest between the Western Community and the Southern Hemisphere. Export volumes of 318 and 349 billion dollars represent one quarter of the Western Community's trade and two-thirds of the Southern Hemisphere's trade, respectively.

77. The annual trade volume between the Western Community and the Soviet Bloc is of the order of 50 billion dollars. It constitutes close to 30 percent of the Soviet Bloc's trade but only 3.6 percent of the Western Community's trade. Of course, aggregate figures such as those above can conceal as well as reveal. For example, they can mask the economic impact and political significance of trade linkages which become more clearly apparent when one examines the individual countries involved.

78. The volume of trade between the Soviet Bloc and the Southern Hemisphere countries is relatively small, about 20 billion dollars. Close to 16 percent of the Soviet Bloc's exports are destined for the Southern Hemisphere and only about 3 percent of the Southern Hemisphere's total exports flow to the Soviet Bloc.

79. Finally, more than half of the relatively small Chinese trade is with the Western Community and almost a half is with the Southern Hemisphere. China's trade with the Soviet Bloc was small in 1981 (about 5 percent) but it has since increased very rapidly as a result of the political decisions of the Soviet Union and China to ease tensions and to return to more pragmatic relations.

MARITIME TRADE

80. Geography dictates the extent of a nation's dependence on the sea for food, trade and protection. The sea has constituted a formidable barrier to invading armies from time immemorial and thus served as a source of strength. It has also been a source of vulnerability inasmuch as the flow of vital supplies could be interrupted and maritime powers could use it as a means of access to weak coastal states.

81. The extent of regional dependence on the seas for the flow of peacetime commerce is indicated by the Table 16. It shows the percentage of exports, in terms of dollar value, that reaches their markets by land (and coastal waters) and by deep-sea transit. For island states such as Japan and Australia this dependence is virtually complete, with air transport accounting for only a very small fraction of the total trade. It is also very high (about 90 percent) for Africa, the Middle East, the Persian Gulf, and South America. About four-fifths of the US and two-thirds of the Chinese trade flows by the sea. The only major regions where sea-borne commerce is relatively small are Canada and West Europe (about one-third each), East Europe and the Soviet Union (about one-fifth each).

82. Most of the world's oil, grain, and raw material trade depends on the deep-sea transit. A look at breakdown of tonnage transported by the sea is revealing. Table 17 shows the top 20 countries in terms of sea traffic tonnages. These 20 countries account for two-thirds of the world's sea traffic. The table clearly shows the critical importance of the seas to the Western Community and to the Southern Hemisphere. The continental character of the Soviet Union also stands out - it accounted for only 2.5 percent of the world sea traffic.

Table 16

Exports among Major Regions:

Seaborne and Other Trade 1981[4]

Region	Total Exports ($ billion) (US)	Intra-regional Exports (% of total)	Inter-regional Exports (% of Total)	
			Markets reached primarily by land or coastal water	Markets reached primarily by deep-water transit
United States	231	0	21.2 (Canada, Mexico)	78.8
Canada	68	0	67.0 (US, Mexico)	33.0
West Europe	746	63.7	4.5 (East Europe, USSR)	31.8
Japan	152	0	0	100
Australia-New Zealand	27	0	0	100
Soviet Union	79	0	77.5 (East & West Europe, bordering Asian states)	22.5
East Europe	78	22.9	58.3(West Europe)	18.8
China[5]	22	0	34.8	65.2
Mexico	19	0	58.6 (US,Canada)	41.4
South America	68	14.5	0	85.5
Africa[6]	77	4.0	2.3 (Middle East)	93.7
Middle East and Persian Gulf	203	7.8	2.5 (Africa)	89.7
Rest of Asia	152	21.5	5.5 (Middle East)	73.0
Other[7]	28	0	50.0	50.0

Table 17

World Sea Traffic, 1979[8]

Rank	Incoming (million tonnes)		Outgoing (million tonnes)	
1	Japan	608	Saudi Arabia	410
2	United States	549	United States	275
3	Netherlands	274	Iran	220
4	Italy	224	Australia	166
5	France	184	Soviet Union	154
6	United Kingdom	157	Venezuela	132
7	Germany, FR	121	Canada	117
8	Spain	84.2	Kuwait	103
9	Korea, South	73.0	Nigeria	101
10	Brazil	69.8	United Kingdom	101
11	Taiwan	62.4	Indonesia	100
12	Canada	61.8	Utd Arab Emirates	95.6
13	Belgium	58.7	Libya	92.9
14	Sweden	56.4	Brazil	87.5
15	Singapore	49.2	Netherlands	84.3
16	Netherlands Antilles	38.6	Japan	82.6
17	Greece	34.8	Algeria	49.8
18	Denmark	34.5	South Africa	47.2
19	Soviet Union	33.1	Italy	43.7
20	Finland	30.6	Norway	39.4
WORLD TOTAL - 3,780				

ROLE OF TRADE IN THE DOMESTIC ECONOMY

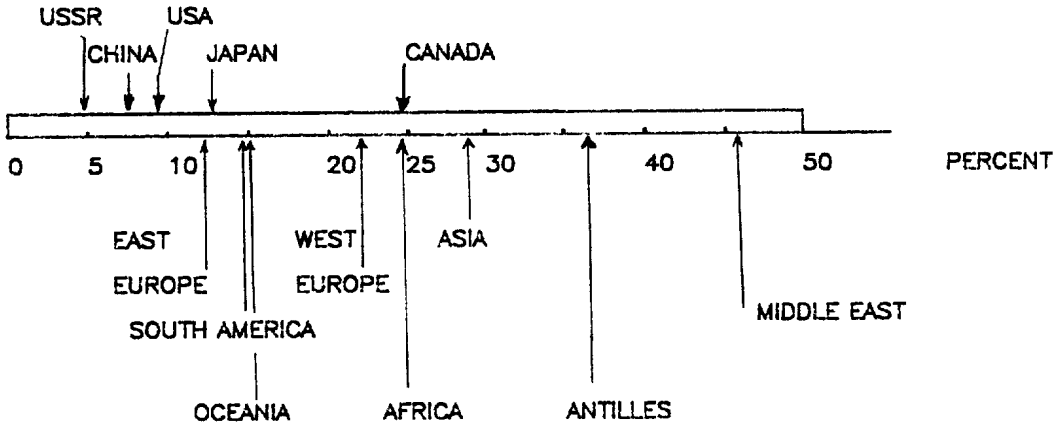
83. The ratio of trade to gross national product is an indicator of the degree of national self-sufficiency. China and USSR are nearly autarchic while the Middle East is at the other end of the spectrum in terms of dependence of economy on trade (Figure 13). United States trade, large as it is, represents less than 10 percent of its GNP. The economies of Western Europe and Canada are relatively much more dependent on trade, with trade to GNP ratio of 22 and 25 percent, respectively.

84. High degree of self-sufficiency in three areas -food, oil, and strategic minerals, is especially important. Military preparedness and ability to prosecute war depend on the possession of, or the continued access to, these strategic resources. The spectre of resource wars has joined the line of possible causes of conflict.

FIGURE 13

TRADE AS PERCENTAGE OF GNP

(1981)



85. Oil is to industry, what food is to man. Without it modern economies and war machines would quickly grind to a halt. Possession of this indispensable raw material enhances the power of a state. It is noteworthy that both superpowers rank high as oil producers. In 1983, Soviet Union ranked first in crude oil production (11.8 million b/d) and United States second (8.7 million b/d), both well ahead of Saudi Arabia (4.9 million b/d).[9]

86. Table 18 provides data on import independence of the Big Seven western nations, who generate half of the world's economic output. The United States, United Kingdom and Canada are among the major world oil producers. Japan, France, Federal Republic of Germany, and Italy, on the other hand, are practically completely dependent on imports. Most of Japanese and much of West European oil imports originate in the Middle East and Persian Gulf states. The steep rise in oil price engineered by OPEC starting with the Yom Kippur war of October 1973 clearly demonstrated the vulnerability of nations to external oil dependence.

Table 18

Production and Imports of Crude Oil by the Big Seven

(1983 - in thousand b/d)

Country	Production	Imports	
		Total	% From Middle East
United States	8,680	3,329	12
United Kingdom	2,299	456	25
Canada	1,356	247	21
Germany, FR	81	1,307	21
France	--	1,429	34
Italy	--	1,523	44
Japan	--	3,567	65

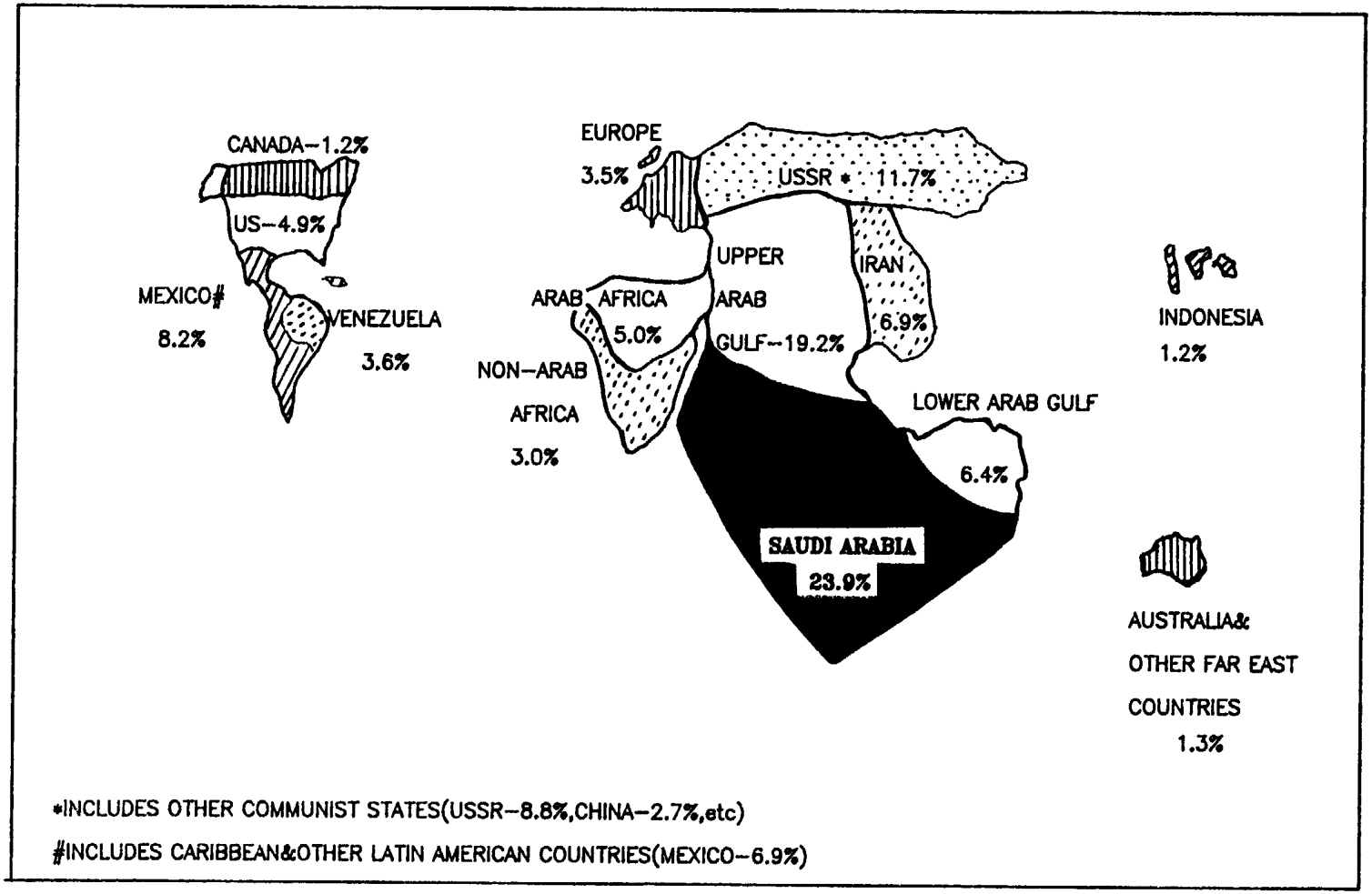
87. From longer-term perspective, the location and size of reserves are even more important than import dependence and cartel strength at a particular moment. The Middle East and the Persian Gulf dominate the global oil scene, accounting for 56.4 percent of the total known oil reserves. This is more than six times the oil reserves of the Soviet Union and almost twelve times the U.S. oil reserves. The world seen from Saudi Arabia does, indeed, look different (Figure 14).[10] It is a vantage point of great wealth - nonetheless, the possession of such a large share of a resource vital to both the industrialized West and East must give rise to serious security concerns. Furthermore, its economy, like that of many other OPEC states, is extremely dependent on oil exports and the price of oil and, hence, vulnerable.

88. Nuclear energy is one of the alternatives to dependence on oil. Supplies of uranium are important for this reason and, even more so, because of its nuclear weapon potential.

FIGURE 14

HOW THE SAUDIS SEE THEMSELVES

OFFICIAL OIL RESERVES:1984



*INCLUDES OTHER COMMUNIST STATES(USSR–8.8%,CHINA–2.7%,etc)

#INCLUDES CARIBBEAN&OTHER LATIN AMERICAN COUNTRIES(MEXICO–6.9%)

89. In discussions of Western minerals vulnerability eleven minerals are normally included, namely, bauxite, chromium, cobalt, copper, iron ore, manganese, nickel, platinum group, tin, tungsten, and zinc[11]. Four minerals are particularly critical not only because of numerous industrial uses and the difficulties of effecting substitution but primarily because the sources of supply are largely located in a few non-Western countries. Canada and its allies are almost completely dependent on imports of these four 'strategic' minerals - chromium, manganese, bauxite, and tin (Table 19).

Table 19

Estimated Import Dependance of Canada, the USA, the EEC and Japan[12]

Imports as Percentage of Apparent Consumption (late 1970)				
Mineral	Canada	USA	EEC	Japan
Chromium	100	90	100	100
Manganese	100	98	100	98
Bauxite	100	93	95	100
Tin	95	82	88	98

90. Chromium and manganese are perhaps the most susceptible to supply dislocations. This is so primarily for two reasons. First, production and reserves are highly concentrated with South Africa and the Soviet Union clearly pre-eminent. Second, both chromium and manganese are important in steel production and substitution is not possible in most of the current processes. Current production shares and distribution of reserves are summarized in Table 20.

Table 20

Shares of World Chromium and Manganese

Production and Reserves

Mineral	Country	Production (% world)	Reserves (% world)
Chromium[13]	Soviet Union	34.4	0.4
	South Africa	22.0	68.1
	Albania	12.0	0.1
	Brazil	9.6	0.1
	Zimbabwe	4.3	29.9
	Finland	4.0	0.7
	Turkey	3.8	0.1
	Philippines	3.6	0.1
	Other	6.3	0.5
Manganese[14]	Soviet Union	40.0	44.6
	South Africa	21.4	41.0
	Brazil	8.0	1.8
	China	6.8	0.9
	India	6.4	0.9
	Gabon	6.3	3.0
	Australia	6.0	6.1
	Other	5.1	1.7

91. The search for new sources of 'strategic' and other minerals goes on continuously. So does the search for substitute materials and new industrial processes. In the case of manganese an exciting future possibility is undersea mining for manganese modules which are scattered throughout the ocean floors. These developments are expensive and it will take considerable time for the basic patterns of reserves, production, and import dependence to change.

MAJOR TRADING NATIONS

92. Western Community countries dominate the list of the leading trading nations. Ten out of top twelve are members of the Western Community. The Soviet Union and Saudi Arabia are the exceptions (Table 21). These twelve nations are major players in the world economy and account for about two-thirds of the world trade.

Table 21

Major Trading Nations, 1981

Rank	Imports (US$ billion)		Exports (US$ billion)	
1	USA	273	USA	234
2	Germany, FR	164	Germany, FR	176
3	Japan	143	Japan	152
4	France	121	Saudi Arabia	120
5	UK	103	UK	103
6	Italy	91	France	101
7	USSR	73	USSR	79
8	Canada	66	Italy	75
9	Netherlands	66	Canada	70
10	Belgium-Luxembourg	63	Netherlands	69
11	Saudi Arabia	35	Belgium-Luxembourg	56
12	Spain	32	Sweden	29

CANADA, SUPERPOWERS AND RELATED GROUPS

93. Comparative trade statistics for 1981 are summarized in Table 22 and Figure 15. Western Community trade was eight times that of the Soviet Bloc. The disproportion between the superpowers was not as striking. Nonetheless, the US volume of trade was some 3.3 times greater than the Soviet Union's (US$ 254 billion vs US$ 76 billion) and its influence on the world economy correspondingly greater. Major trading partners of the US and the USSR in 1983 are indicated in Figures 16.15,16 The importance of the Pacific Rim to the US economy is rather apparent. Some 32.6 percent of the US imports was from Japan and the Far East compared to 21.4 percent from all of Europe.

94. Large as the American trade was, it amounted to only one fifth of the Western Community's trade. Western Europe's volume of trade was 3 times as great as the US trade volume. Soviet trade was slightly smaller than East European trade in terms of volume and 2.5 times smaller on a per capita basis. Although trade is not a major source of the Soviet Union's leverage on the world scene, it is a significant mechanism of economic integration within the Soviet Bloc. It also serves to reduce Eastern European orientation to Western markets, ties and influence.

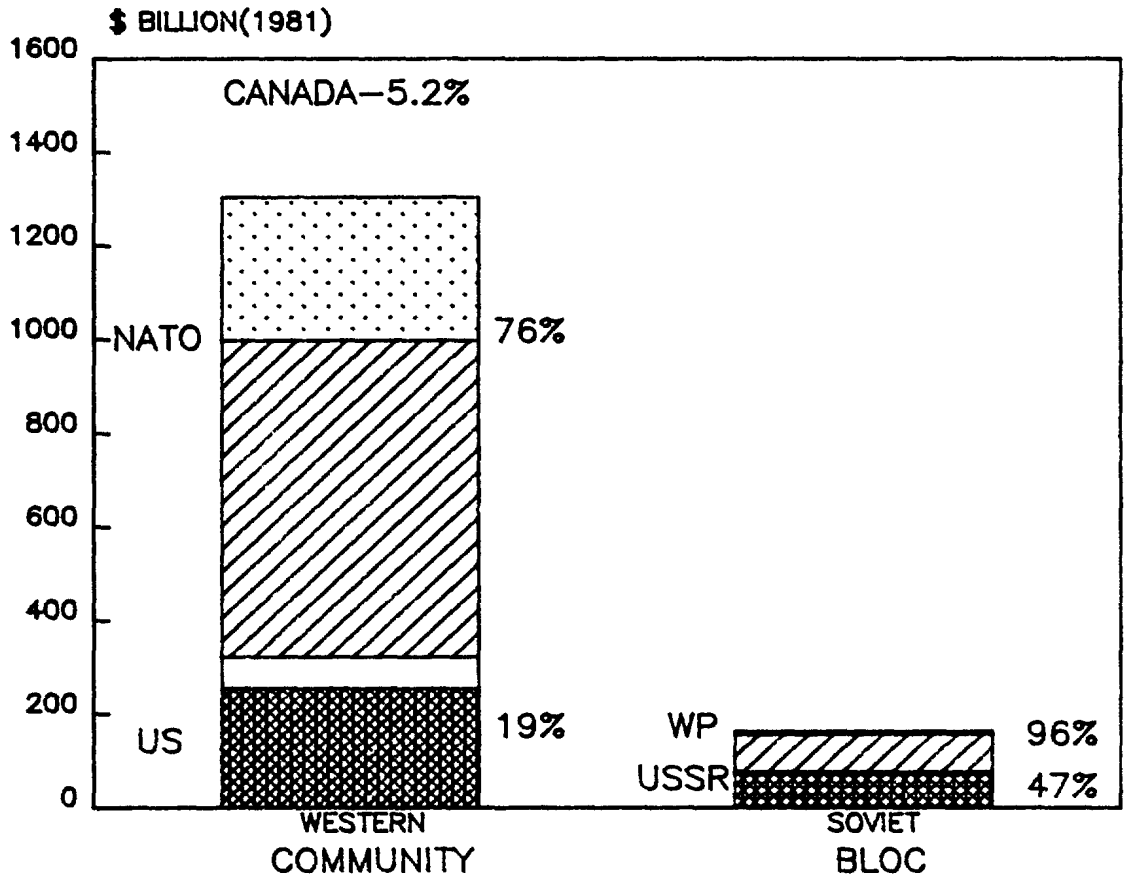
95. Canada's trade volume in 1981 was US$ 68 billion and accounted for 3.5 percent of the world trade and 5.2 percent of the Western Community's trade. Trade played a significant role in Canada's economy as can be seen from our trade to GNP ratio of 24.7 percent and trade per capita of $2,833. Canada ranked eighth in the world in terms of imports and ninth in terms of exports.

Table 22

Canada, Superpowers and Related Groups - Trade (1981)

Country/Group	Volume (US$ billions)	% World Trade	% Domestic GNP	$ Per Capita
Canada	68	3.5	24.7	2,833
United States	254	13.1	8.6	1,104
Western Europe	767	39.7	22.1	2,191
NATO	997	51.7	15.6	1,608
Western Community	1,304	67.5	15.8	1,571
Soviet Union	76	4.0	4.8	284
Eastern Europe	80	4.1	11.7	727
Warsaw Pact	156	8.1	6.9	413
Soviet Bloc	163	8.5	7.1	401
World Total	1,931	--	15.1	430

FIGURE 15
WESTERN COMMUNITY,SOVIET BLOC–TRADE



LEGEND:

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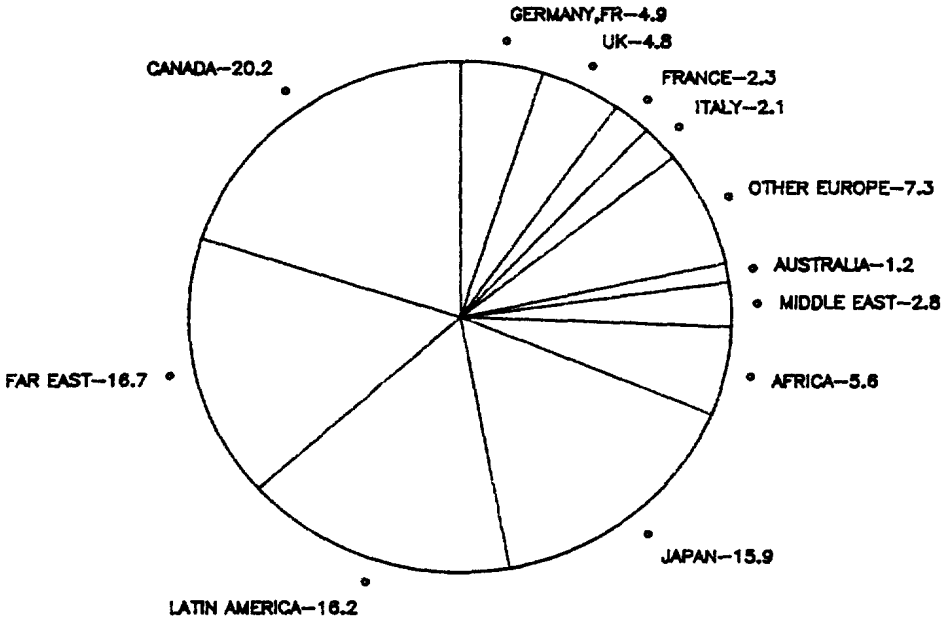
FIGURE 16

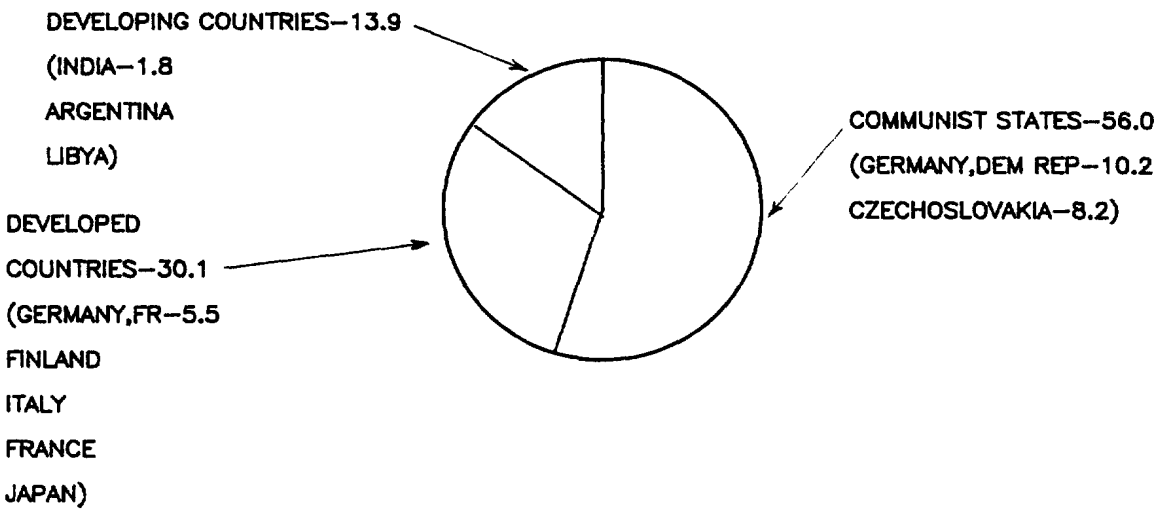
TRADE PATTERN OF THE SUPERPOWERS
UNITED STATES



(1983 IMPORTS—$258 BN)

FIGURE 16(CONTINUED)

TRADE PATTERN OF THE SUPERPOWERS
SOVIET UNION



(1983 TRADE VOLUME—$86BN)

FOOTNOTES

1 Based on World Bank Statistics (Table 3, Annex) which are incomplete for many of the Southern Hemisphere countries. The trade volume for the Southern Hemisphere is closer to US$ 500 billion as given in the UN statistics (Table 15).

2 Based on an analysis of statistics contained in United Nations, Yearbook of International Trade Statistics, 1982, Vol.1: Trade by Country, (New York: United Nations, 1984).

3 Rounded independently.

4 Same source as 2. Insignificant fraction of all trade is transported by air.

5 Conservative estimate for deep-water transit.

6 Excludes Republic of South Africa which forms part of "other".

7 Conservative estimate for deep-water transit.

8 The World in Figures, The Economist Newspaper Ltd., London, England, 1981, p. 41.

9 Central Intelligence Agency, International Energy Statical Review, 25 February 1985. USSR, US and Saudi Arabia produced almost half of the world's crude oil in 1983 (total production was 52.6 million b/d). Other nations in the group of top ten oil producers were Mexico, Iran, United Kingdom, China, Venezuela, Indonesia, and Canada. Middle East countries as shown in Table 18, comprise those grouped under Middle East and Persian Gulf in Tables 1-4, Annex.

10 BP Statistical Review of World Energy, June 1985. London: The British Petroleum Company p.l.c., p. 2. Proved reserves of crude oil are generally taken to be those quantities which geological and engineering information indicate with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions. Total world proved reserves at end of 1984 were 707.2 thousand million barrels.

11 J. Finlayson, "Canada and Strategic Minerals", International Perspectives, Sep/Oct 83, pp. 18-21.

12 Ibid., p.18.

13 Sources: "Chromium: An Imported Mineral Commodity", Energy, Mines and Resources (Ottawa, 1982), p.19. Papp, John, "Chromium - Reprint from 1982 Minerals Yearbook", US Bureau of Mines (Washington, 1983), p.13. Total world chromite reserves are 3,360 million metric tons. Production figures are for 1982 when 10.9 million short tons of chromite ore were mined.

14 Sources: "Three Sub-Saharan Minerals", (U.S. Army War College: 1983), p.32.
Law-West, D.G., "Manganese 1982", Energy Mines and Resources (Ottawa: 1983), p.27.4. Total world manganese ore reserves are 4,879 million metric tons. Production figures are for 1981 when 23.5 million tons of manganese ore were mined.

15 OECD as reported in The Economist, September 29, 1984, p.70.

16 Soviet monthly journal Foreign Trade, No.3, 1984.

CHAPTER 5

MILITARY MANPOWER AND DEFENCE EXPENDITURES

INTRODUCTION

96. Nations of the world spent US$ 800 billion for military purposes in 1982. This represents 6.2 percent of global annual GNP, or an expenditure of US$ 174 for every human being.

97. An estimated 28 million people served in the armed forces in 1984. For each 1,000 persons, 6 were in uniform. The above figures do not include paramilitary or reserve forces, which are estimated to total more than the regular forces.

DISTRIBUTION OF MANPOWER AND EXPENDITURES

98. The distribution of defence expenditures and military manpower is summarized in Table 23 and Figure 17. Detailed country statistics are contained in Table 4 of the Annex. The Western Community and the Soviet Bloc accounted for approximately 79 percent of total world military expenditures and slightly less than half of its military manpower. The Southern Hemisphere ranked third of the four groupings in terms of defence expenditures but first in terms of manpower. This pattern shows a different emphasis on manpower versus sophisticated equipment and is a reflection of the difference in industrial development between the North and the South. China was last on both counts, although it devoted a larger proportion of its GNP to defence than did the other groups.

Table 23

Distribution of World Military Manpower

and Defence Expenditures

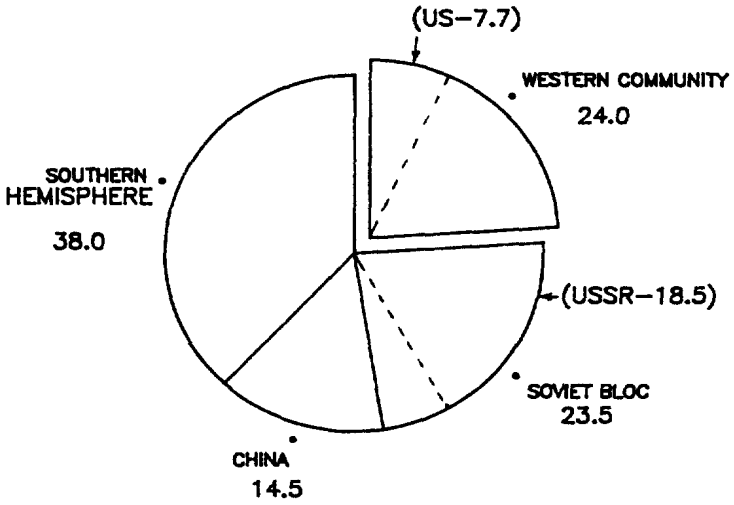
Zone	Military Manpower (1984)			Defence Expenditure (1982)		
	Number (Million)	% World Total	Per 1000	Value ($ billion) US	% GNP	% World Total
Western Community	6.6	24.0	8.0	343	4.2	43.2
Soviet Bloc	6.5	23.5	15.7	280	12.2	35.4
China	4.0	14.5	4.0	49	16.5	6.2
Southern Hemisphere	10.5	38.0	4.3	120	6.1	15.2
World Total	27.6	-	5.9	792	6.2	-

99. In considering the pattern of global spending on defence it should be recognized that there are serious problems of reliability concerning data measuring security expenditures in the third-world countries and in the Soviet Bloc. The question of how much of its resources a country devotes to military-related activities is, of course, often considered sensitive and subject to secrecy on the part of governments.

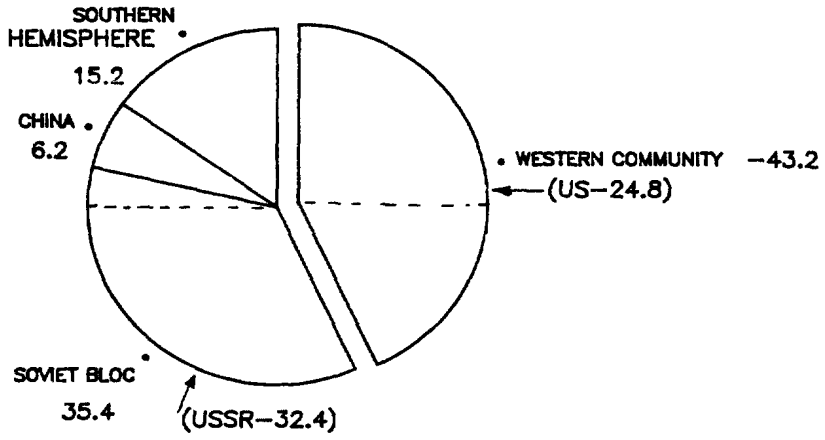
100. In spite of the emphasis on manpower in the developing South, the manpower burden of the military effort was low there (4 per 1000). It was twice as much for the Western Community and almost four times as much for the Soviet Bloc.

FIGURE 17

SHARE OF WORLD MILITARY MANPOWER(1984)



SHARE OF WORLD DEFENCE EXPENDITURE(1982)



101. The economic burden of military expenditures, as measured by the ratio of military expenditures to gross national product, was almost three times higher for the Soviet Bloc (12.2 percent) than for the Western Community (4.2 percent). It was also relatively high for China although the figure of 16.5 percent is less reliable than statistics for other zones due to combined uncertainties in the estimates of Chinese GNP and defence expenditures. Southern Hemisphere's military expenditures are averaged at 6.1 percent of GNP but they ranged from 1.1. percent of GNP for Oceania to 20 percent of the GNP for the Middle East and Persian Gulf.

102. To be sure, both military manpower and defence expenditures are measures of economic inputs devoted to military security, or lost opportunity costs in other sectors. They are useful but by no means complete measures of comparative or absolute military power. A more comprehensive analysis would have to include outputs in the form of major weapon systems as well as qualitative factors such as organization, strategic doctrine, leadership and morale.

MAJOR MILITARY POWERS

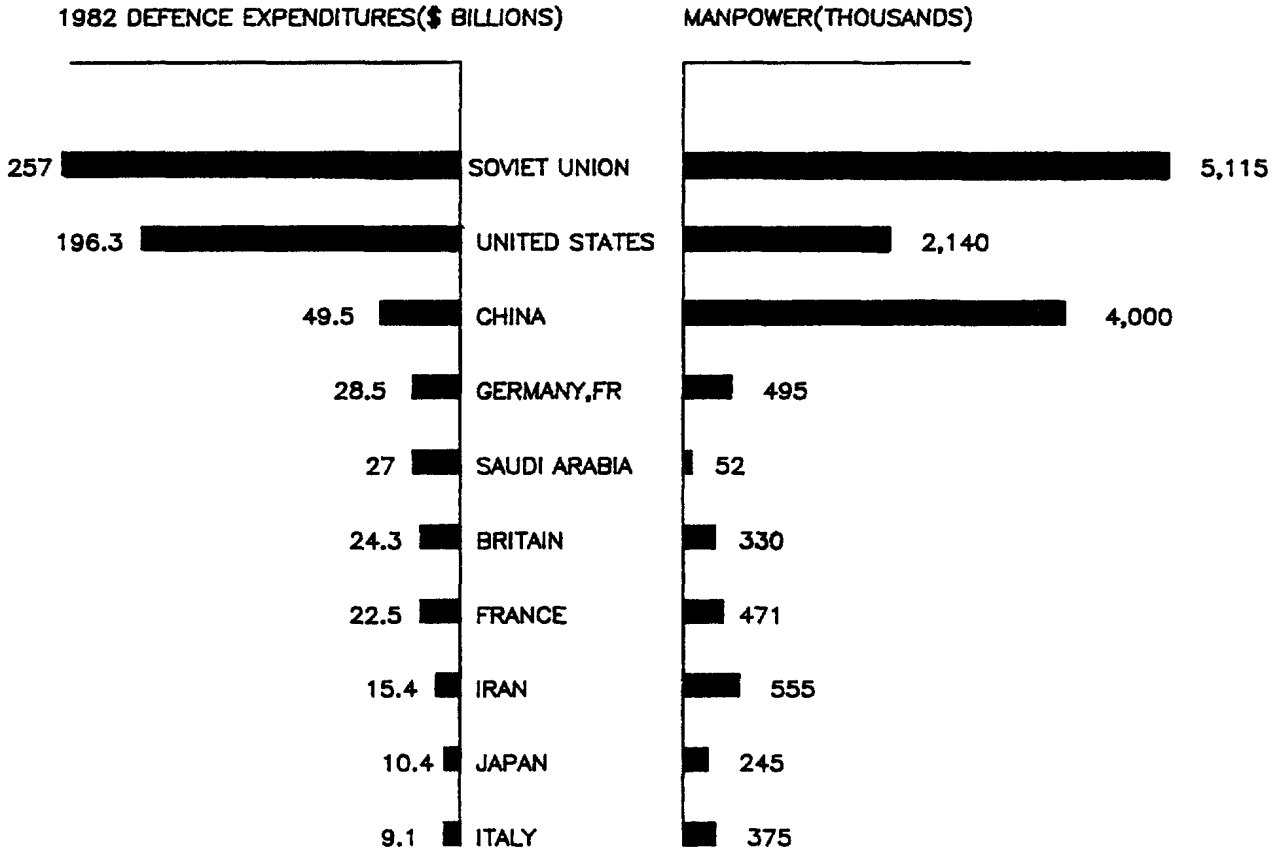
103. The top ten countries in terms of military expenditures and their military personnel levels are portrayed in Figure 18. The Soviet Union ranks first along both dimensions. The United States is second in terms of expenditure, and third in terms of manpower. China's position is the converse of the US position - it ranks second in terms of military manpower but third in terms of military spending.

104. The remaining seven countries include five Western Community nations (Federal Republic of Germany, United Kingdom, France, Italy and Japan) plus Saudi Arabia and Iran. These ten states account for 81 percent of world military expenditure and half of its military manpower.

105. The pattern of military power exhibits some similarities and some differences when compared to the pattern of economic strength (See Figure 7). The two superpowers and the four large European states occupy the

FIGURE 18

LEADING COUNTRIES IN MILITARY EXPENDITURES AND SIZE OF THEIR ARMED FORCES



same relative position along both the military and the economic dimensions of power. Japan, an economic giant, has been clearly less prominent in the military sphere. On the other hand, China ranks relatively high in terms of military manpower and expenditure although it is relatively weak economically. Finally, oil - rich Saudi Arabia is a large spender on the military (mostly on infrastructure) and so is war - torn and oil - rich Iran (mostly on weapons).

106. The ten leading countries in terms of size of the armed forces are listed in Table 24. Other than the two superpowers, all of them are part of the developing world. Regional strength of Vietnam and India, the tense situation on the Korean peninsula, and Persian Gulf war are clearly reflected in the composition of this list. Taken together, these ten states account for 61 percent of the world military manpower. It is logical that countries with a low per-capita GNP have manpower intensive armed forces. However, a country having relatively large GNP but a low-per-capita GNP (e.g. India, China) could have a higher degree of flexibility in the structuring of their forces.

Table 24

Leading Countries in Terms of Military Manpower, 1984

Rank	Country	Military Manpower (in thousands of persons)
1	Soviet Union	5,115.0
2	China	4,000.0
3	United States	2,135.9
4	Vietnam	1,227.0
5	India	1,120.0
6	North Korea	784.5
7	Iraq	642.5
8	South Korea	622.0
9	Turkey	602.0
10	Iran	555.0

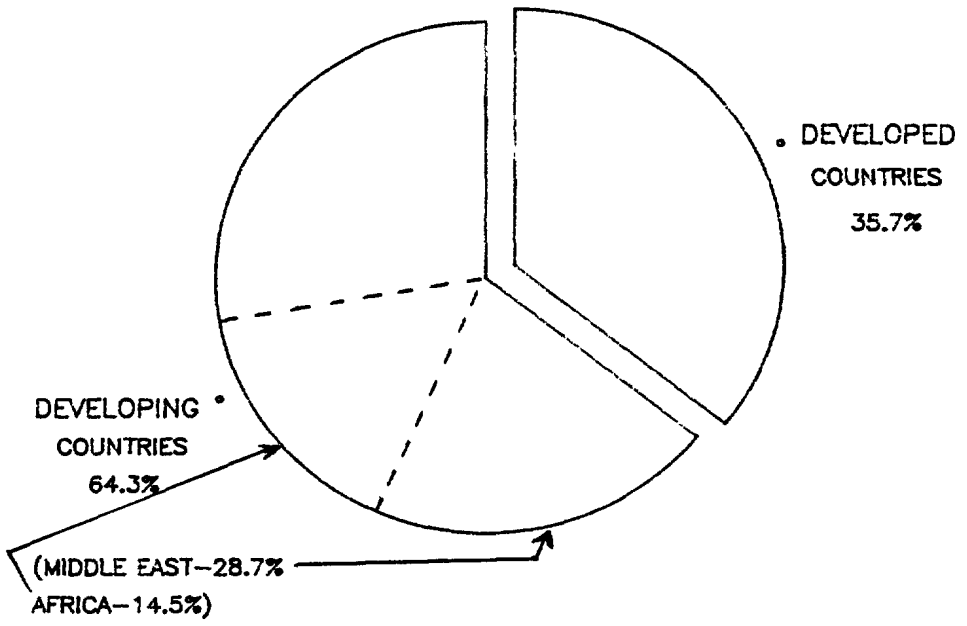
107. Armed forces of the developing world are increasingly well-equipped thanks to large and sustained arms transfers from the developed world. The flow of arms for the five year period 1978-82 is portrayed in Figure 19.1 Two-thirds of all the arms transfers during this period were directed to the developing countries. The volatile Middle East and famine - torn Africa figure prominently in the arms trade in recent years. Also, arms supplies to Latin America increased significantly towards the end of this period.

DEFENCE BURDEN

108. Expenditures on defence represent diversion of resources from potential civilian uses to the military sector. Figure 20[2] shows the number of countries with military expenditure to gross national product ratio in a given range. It should be noted that each shift to the right on the graph represents a doubling of the burden. Israel, with 35.7 percent, is highest in terms of this indicator followed mostly by other Middle Eastern states. Japan, with a ratio of 1 percent, is at the low end of the scale.

FIGURE 19

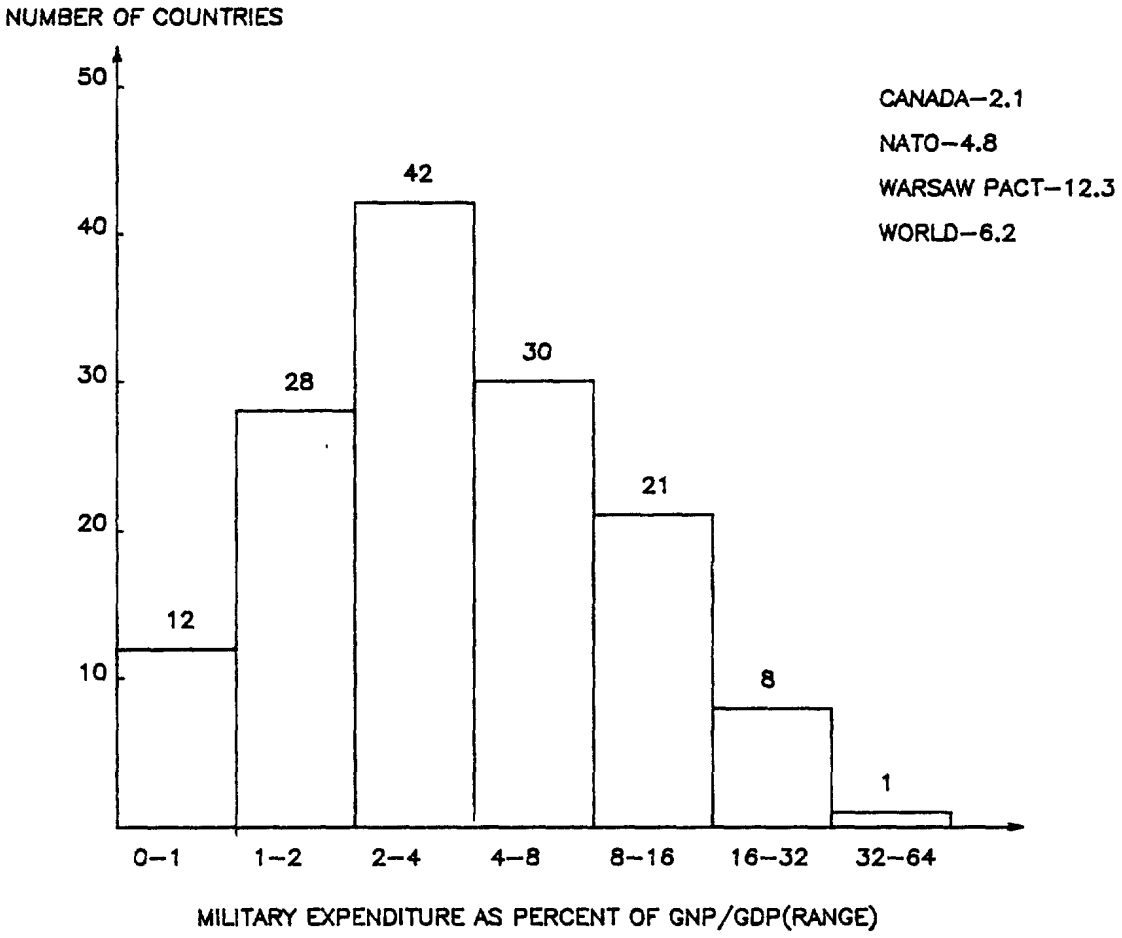
SHARES OF WORLD IMPORTS OF MAJOR WEAPONS
1978–82, BY REGION



TOTAL VALUE=$74.2 BN(1975 US)

FIGURE 20

RELATIVE BURDEN OF MILITARY EXPENDITURES, 1982

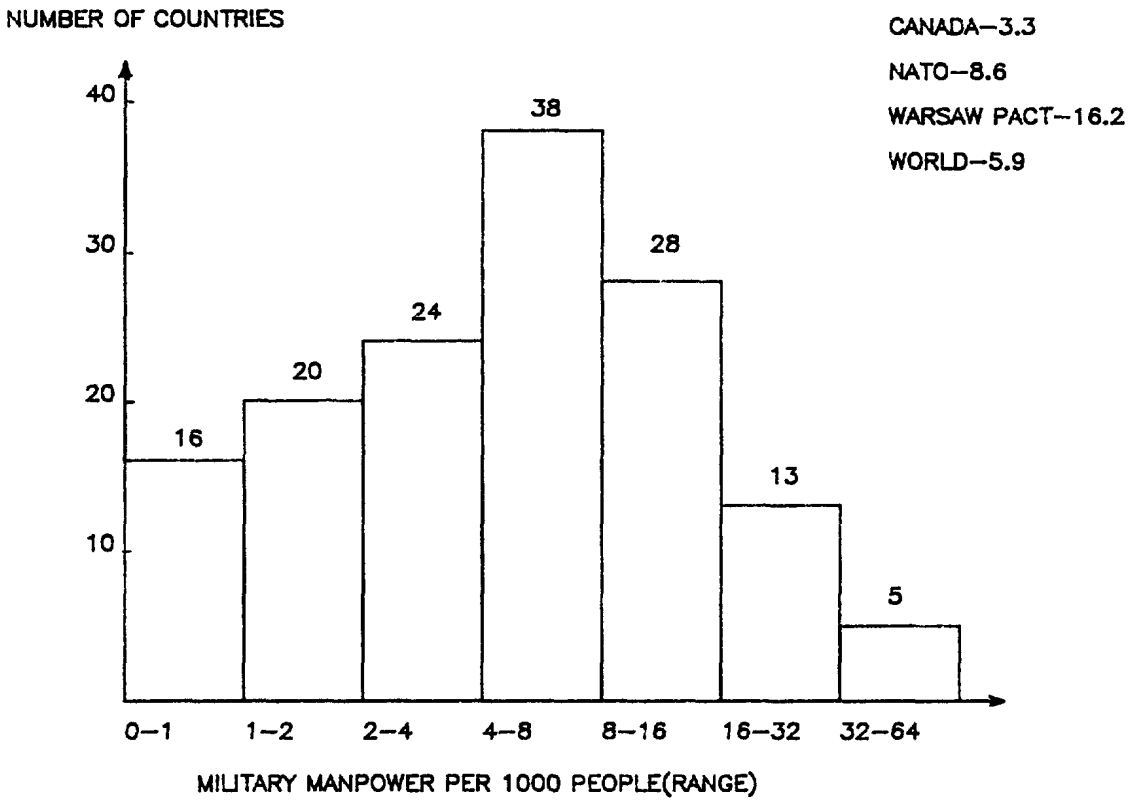


109. Per capita spending on defence varied greatly around the globe. It ranged from some US$ 3,000 per person for oil-rich Saudi Arabia, Qatar, and the United Arab Emirates to about $10 dollars per person for much of Africa and Mexico. The two superpowers, not surprisingly, are at the high end of the spending range (approximately US$ 1,000 per citizen). The global average in 1982 was US$ 174 per person.

110. Proportion of personnel in the armed forces also varied extensively. Iraq, North Korea, Syria, Israel and the United Arab Emirates bear the heaviest manpower burden with more than 33 persons per 1,000 people serving in the military. Populous India, Indonesia, Mexico, Nigeria and Ghana are at the low and of the range with fewer than 2 persons per 1,000 in the armed forces. The global average is 5.9 persons, per 1,000. The distribution of countries with respect to manpower burden is given in Figure 21.

FIGURE 21

RELATIVE BURDEN OF MILITARY MANPOWER,1984



CANADA, SUPERPOWERS AND RELATED GROUPS

111. Comparative statistics on military manpower and expenditures for the Western Community and the Soviet Bloc are summarized in Table 25 and displayed in Figures 22 and 23. The Western Community spent US$ 343 billion in 1982 for military purposes, exceeding by 22 percent the Soviet Bloc's expenditure of US$ 280 billion. Their manpower levels were almost identical in 1984 (6.6 and 6.5 million, respectively).

112. The picture changes somewhat when attention is restricted to the major military organizations within these zones. While NATO countries outspent the Warsaw Pact by 30 billion dollars (US$ 308 billion versus US$ 278 billion) they have almost a million men fewer in their armed forces (5.32 vs 6.26 million). In fact, the USSR alone has almost the same number of troops as does the whole of NATO.

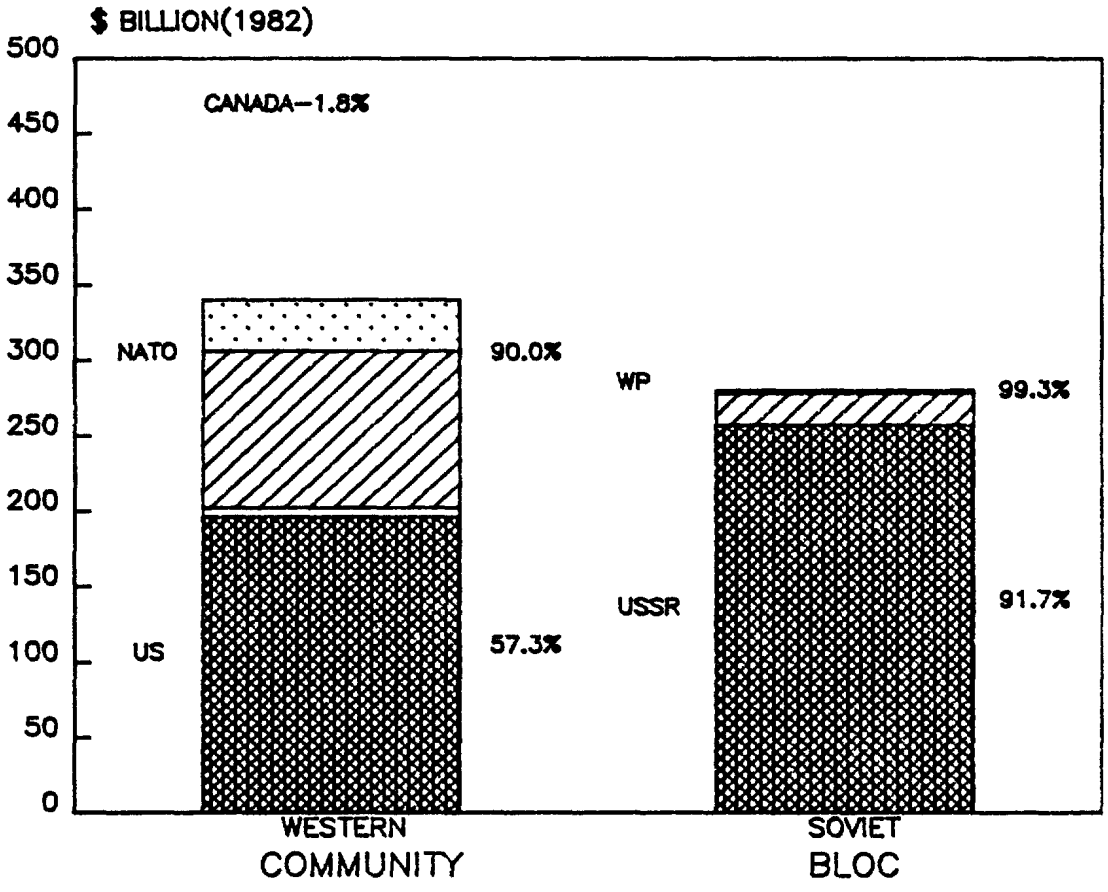
Table 25

Canada, Superpowers and Related Groups - Military Manpower and Expenditures

Country/Group	Armed Forces (thousands- 1984)	Defence Expenditures (US$ million - 1982)
Canada	82.9	6,182
United States	2,135.9	196,345
Western Europe	2,503.3	102,827
NATO	5,324.1	308,109
Western Community	6,641.0	342,525
Soviet Union	5,115.0	257,000
Eastern Europe	1,144.1	21,322
Warsaw Pact	6,259.1	278,322
Soviet Bloc	6,494.6	280,147
World Total	27,646.0	792,367

FIGURE 22

WESTERN COMMUNITY,SOVIET BLOC– DEFENCE EXPENDITURES

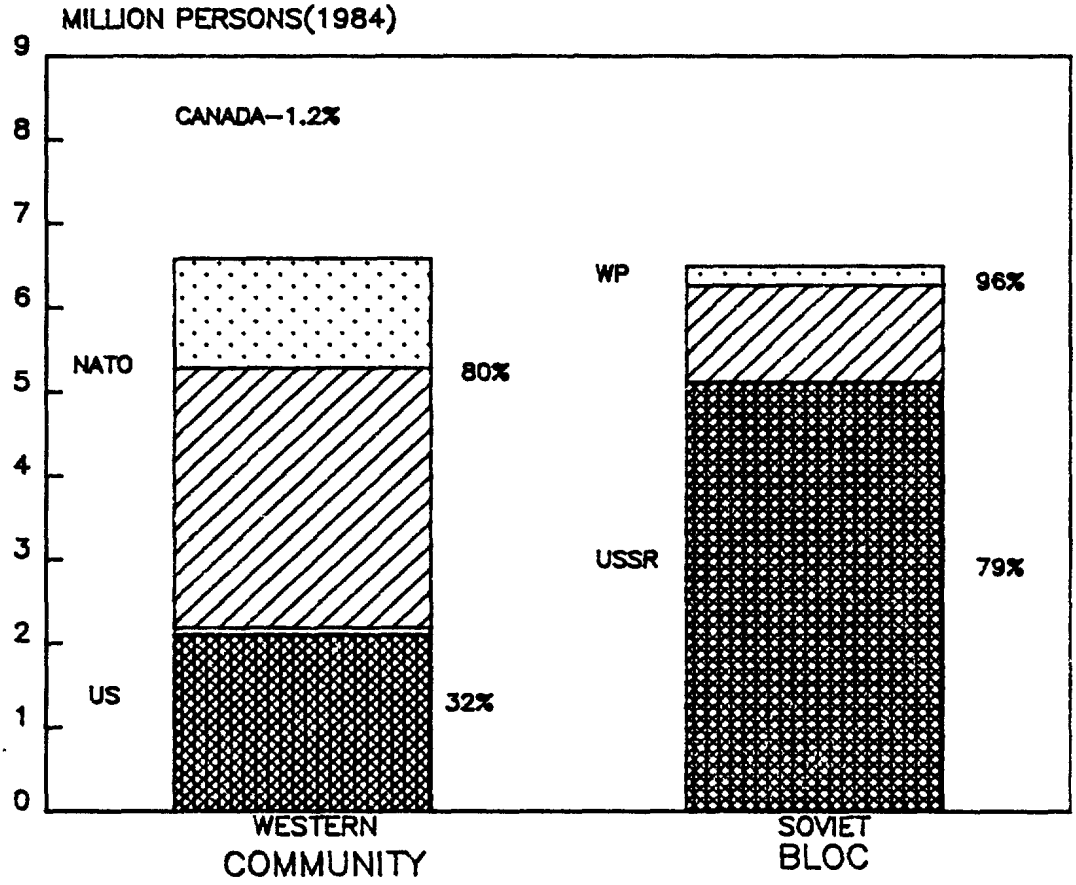


LEGEND:

AS IN FIGURE 3,P.15

FIGURE 23

WESTERN COMMUNITY,SOVIET BLOC– SIZE OF ARMED FORCES



LEGEND:

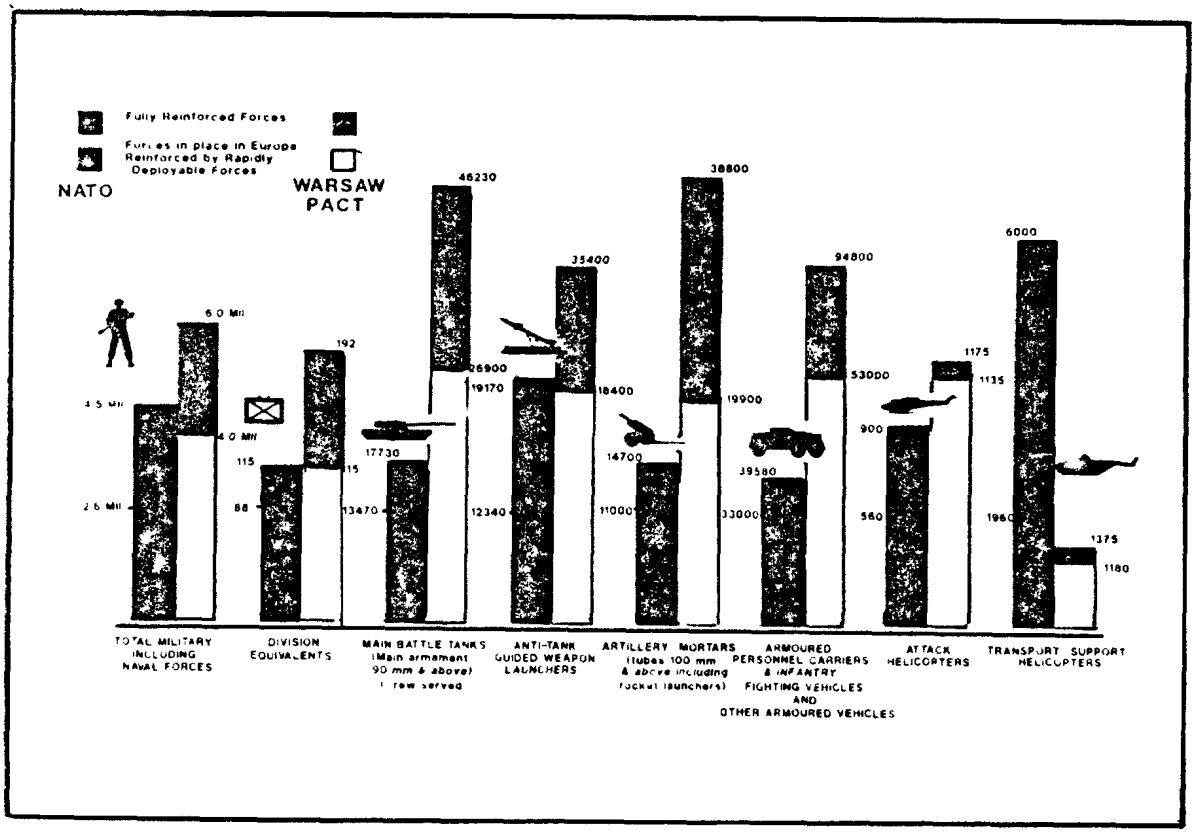
AS IN FIGURE 3,P.15

113. Taken together, NATO and Warsaw Pact countries have less than one quarter of the world's population (1 billion people or 22 percent) but they account for almost three-quarters of its military expenditures (US$ 586 billion) and more than forty percent of its military manpower (11.6 million).

114. As noted previously, military manpower and defence expenditures measure resource inputs to the defence sector. Figure 243 portrays some of the resulting outputs in NATO and the Warsaw Pact. It should be added that three NATO countries - United States, United Kingdom, and France - manufacture their own nuclear weapons and that the Soviet Union has a nuclear monopoly within the Warsaw Pact.

FIGURE 24

NATO–WARSAW PACT FORCE COMPARISON

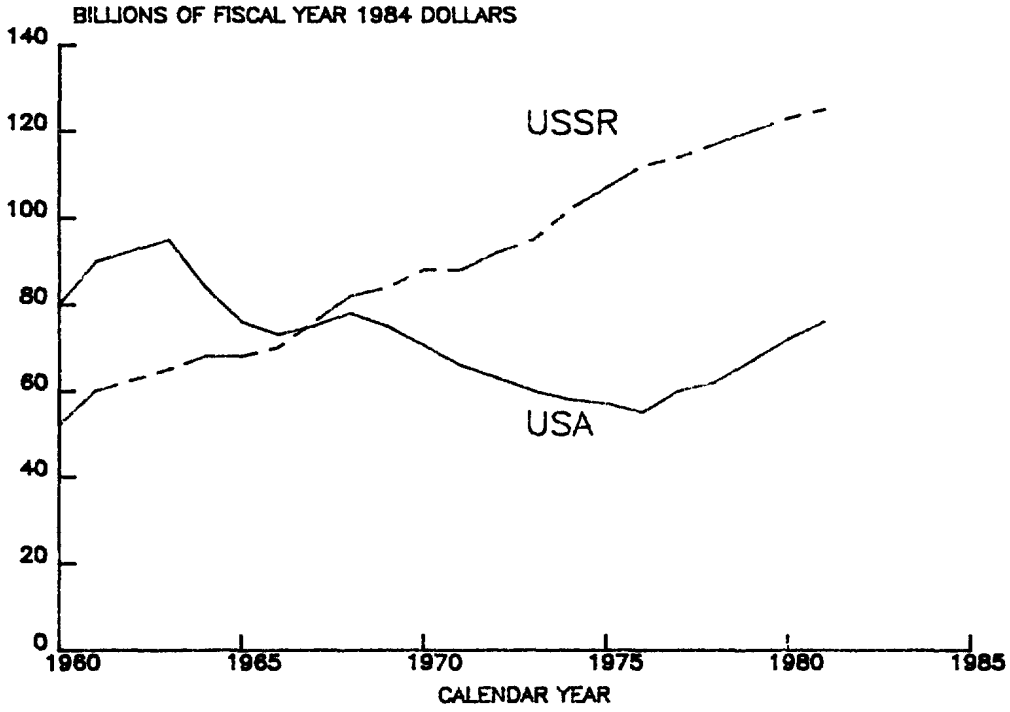


115. It is axiomatic that the two superpowers play major roles within their military alliances. Nevertheless, the nuclear dimension aside, their relative contributions differ significantly. The USA share of NATO military expenditure was 63.7 percent or 1.8 times as much as its allies combined, while the USSR accounted for 92.3 percent of Warsaw Pact's military expenditure or more than 12 times as much as her Eastern European allies. The US share of NATO manpower was 40.1 percent. The Soviet Union's military manpower is 81.7 percent of the Warsaw Pact's total - it has 4.5 times as many troops as East Europe. These figures clearly demonstrate the significance of military strength as an element of Soviet power both within the Soviet bloc itself and on the global scene. Comparison of military with economic and trade statistics (Figures 22, 23 and 10, 15) clearly shows the rather unidimensional nature of Soviet power.

116. The build-up of Soviet military power is not a new phenomenon. Soviet investment in the military sector shows remarkable continuity and steady growth over decades (Figure 25).[4] From about the year 1967 it has exceeded American defence outlays. In effect, with détente US defence efforts were reduced while USSR's investment in the military continued to grow. This sustained concentration on military investment has allowed the Soviet Union significantly to outproduce the United States in the production of practically all major weapon systems and improve its present and future capabilities correspondingly. USA military investment bottomed out in 1976 and started to increase during the Carter Presidency. The election of President Reagan in 1980 accelerated the effort to rebuild American defences and resulted in significant defence spending increases (7.8 percent in 1980,81; 9.3 percent in 1982; 11.1 percent in 1983).

FIGURE 25

US AND SOVIET MILITARY INVESTMENT TRENDS



117. It is worth noting that there is a legitimate controversy about the relative levels of the two countries expenditures. Even institutions that use the same methodology and have the same institutional bias exhibit uncertainty as to the accuracy of their estimates. For instance, in November 1983, the CIA announced that total Soviet military spending between 1976 and 1981 had grown by 2 percent a year in real terms, and not 3-4 percent originally estimated.5 The general relationship between the two spending profiles over a twenty year period, which is at issue here, is not altered by this adjustment.

118. A major source of the difficulty in estimating Soviet expenditures is the fact that budgetary practices covering defence expenditures in a closed society are cloaked in secrecy. Another factor, which compounds this problem, stems from the fundamental difference in the structure of the Soviet and the American economies. In a planned economy prices are centrally determined and do not bear the same relationship to supply and demand as they do where the market mechanism is involved.

119. A brief look at the Canadian position will conclude this section. Canada's defence effort, like that of all nations, is shaped by perceived needs, resources, and strategy. National security goals must be closely integrated with an industrial strategy and coordinated with social policy goals pursued by the government. In an alliance, effort is divided among member nations. In 1982, Canada ranked sixth out of sixteen in NATO in terms of total defence expenditure, tenth in terms of per capita expenditure on defence, eleventh in terms of the size of armed forces, and fourteenth in terms of ratio of military expenditure to GNP. Our territory is the largest in NATO, and in terms of economic and human resources we ranked as number six and eight, respectively.

FOOTNOTES

1 Stockholm International Peace Research Institute. World Armaments and Disarmament: SIPRI Yearbook 1983, (New York: Taylor and Francis Inc., 1983), pp. 268-271 and Table 11.A.1, pp. 290, 291.

2 Total number of countries reported is 142 as no estimate for Vietnam and Kampuchea was available.

3 NATO and the Warsaw Pact: Force Comparisons, NATO Information Service, Brussels, 1984.

4 U.S. Secretary of Defense, FY84 Annual Report to the Congress. Investment comprises outlays for Procurement, Military Construction and RDT&E. USSR Investment is an estimate of what it would cost US to duplicate Soviet investment activity. USA investment shown excludes Vietnam-war related investments. OMB figures are quoted for USA defence spending increases from 1980 to 1983.

5 The Economist, November 10, 1984, p.54.

CHAPTER 6

STRATEGIC NUCLEAR FORCES

INTRODUCTION

120. The state of the nuclear relationship between the superpowers is of vital importance to every human being on Earth. Does an equilibrium of nuclear forces exist and how can its stability be assured are questions that concern the policy-maker and the citizen alike.

121. The purpose of this chapter is to present several indicators of the strategic balance. The meaning, implications, and limitations of these technical measures can best be appreciated if the broader aspects of the strategic situation are kept in view. A sketch of some of the major features of the nuclear landscape is included for this reason.

DETERRENCE

122. Deterrence consists in preventing an adversary from attempting to impose his will.[1] This definition highlights the psychological aspect of the relationship which hinges on two factors - the estimation of the capability of the opponent's forces in relation to one's own and on the perception of the opponent's will to use his forces.[2]

123. The calculation of force capabilities is largely a technical issue. Estimation of credibility of a threat to use force, on the other hand, involves predominantly political and psychological factors. One must try to calculate what the opponent believes deterrence to be, not

what we believe it to be. One must also calculate what the opponent's political interests, goals, and strategies are - a daunting but critical task where certitude is elusive and ambiguity is the norm.

124. The measurement of the strategic balance is thus a complex undertaking. It is necessary to quantify what is possible - it is essential to remember that measurable elements are only part of the situation in which intangible factors play an indispensable role.

STRATEGIC OFFENSIVE AND DEFENSIVE SYSTEMS

125. Account must be taken of the offensive and defensive strengths of both opponents and their interactions. Soviet and American offensive strategic forces form a Triad comprising land-based intercontinental ballistic missiles (ICBMs), sea-based missiles submarine-launched ballistic (SLBMs), and bombers.

126. Offsetting defensive systems are four in number. Active defences include air defence against bombers, anti-submarine defence against submarines, and ballistic missile defence against both ICBMs and SLBMs. Finally, civil defence - a passive measure, opposes all three offensive systems.

127. The chief characteristics of offensive strategic forces that have a direct bearing on their capability are lethality, survivability, penetrability, and connectivity.[3]

128. Lethality is the ability of forces to destroy an assigned target even if the target is hardened; it depends on missile accuracy, the number of warheads, their yield, and the hardness of the target.

129. Survivability is the ability of delivery systems to survive a surprise attack while at or near the home base. The fear of vulnerability of the American ICBM force to a disarming Soviet first strike has prompted an extensive search for solutions. Proposals for enhancing ICBM survivability have included deployment of small, mobile ICBMs, deceptive basing, dense spacing, and active defence. The objective is to ensure the ability of the strategic force, even after absorbing a well co-ordinated surprise strike, to inflict unacceptable damage on the attacker. This retaliatory second strike capability has been the cornerstone of deterrence stability for decades, through the threat of mutual assured destruction.

130. President Reagan's landmark speech of 23 March 1983 unveiled the Strategic Defense Initiation (SDI) which, inter alia, can be seen as a revolutionary attempt to move away from a strategic posture where stability is enshrined in a mutual suicide pact to a posture where denial, and not retaliation, predominates and mutual assured survival is a promise. The strategic concept embodied in SDI has been summarized in four sentences:

> For the next ten years, we should seek a radical reduction in the number and power of existing and planned offensive and defensive nuclear arms, whether land-based, space-based or otherwise. We should even now be looking forward to a period of transition, beginning possibly ten years from now, to effective nonnuclear defensive forces, including defenses against offensive nuclear arms. This period of transition should lead to the eventual elimination of nuclear arms, both offensive and defensive. A nuclear-free world is an ultimate objective to which we, the Soviet Union and all other nations can agree.[4]

131. It seems clear that Strategic Defence Initiative and the Soviet Union's own long-standing and ambitious strategic defence program will shape the evolution of the US-Soviet strategic relationship for years to come. Because of this, SDI is subject of intense debate. Its impact on the stability of deterrence is certainly a contentious issue. In addition, there are serious questions concerning technical feasibility of point and area defences that the current research program is attempting to resolve. According to the President's chief advisor on SDI, Paul Nitze, the criteria by which the feasibility of technologies will be judged are demanding - defensive systems must be survivable and cost-effective at the margin.[5] Finally, impact on arms control and political implications for relations with adversaries and allies are also subjects of debate.

132. Another characteristic of offensive systems is penetrativity, that is, the ability of missiles and aircraft to defeat countermeasures and carry out assigned missions. The development of the cruise missile and the Stealth bomber are attempts to ensure a high degree of penetrativity.

133. Finally, connectivity refers to the ability of national command authority to exercise control over strategic forces under all circumstances. The strategic modernization plan launched in 1982 recognized problems with nuclear forces command, control, and communications systems (C^3) and assigned the highest priority to their resolution.

134. This brief summary does not exhaust the issues inherent in the nuclear domain. Nonetheless, it gives a vantage point from which numerical indicators may be viewed.

INDICATORS OF THE STRATEGIC BALANCE

135. The basic data pertaining to the strategic weapon systems include numbers of launchers and their throw-weight, as well as the number of warheads. Detailed statistics are contained in Table 5 of the Annex. In addition, indicators are presented which are concerned with measuring two specific dimensions: soft-area destruction capability and hard-target kill capability.

NUMBER OF LAUNCHERS

136. This indicator constitutes a gross measure of the strategic offensive capability. It is useful in measuring general perceptions of the strategic balance but lacks in details which determine the effectiveness of the individual elements of the strategic balance and the overall strategic balance itself. The United States possesses 1,870 launchers in its central strategic arsenal while the Soviet Union has 2,522. They are distributed among the components of the Triad as shown in Figure 26.

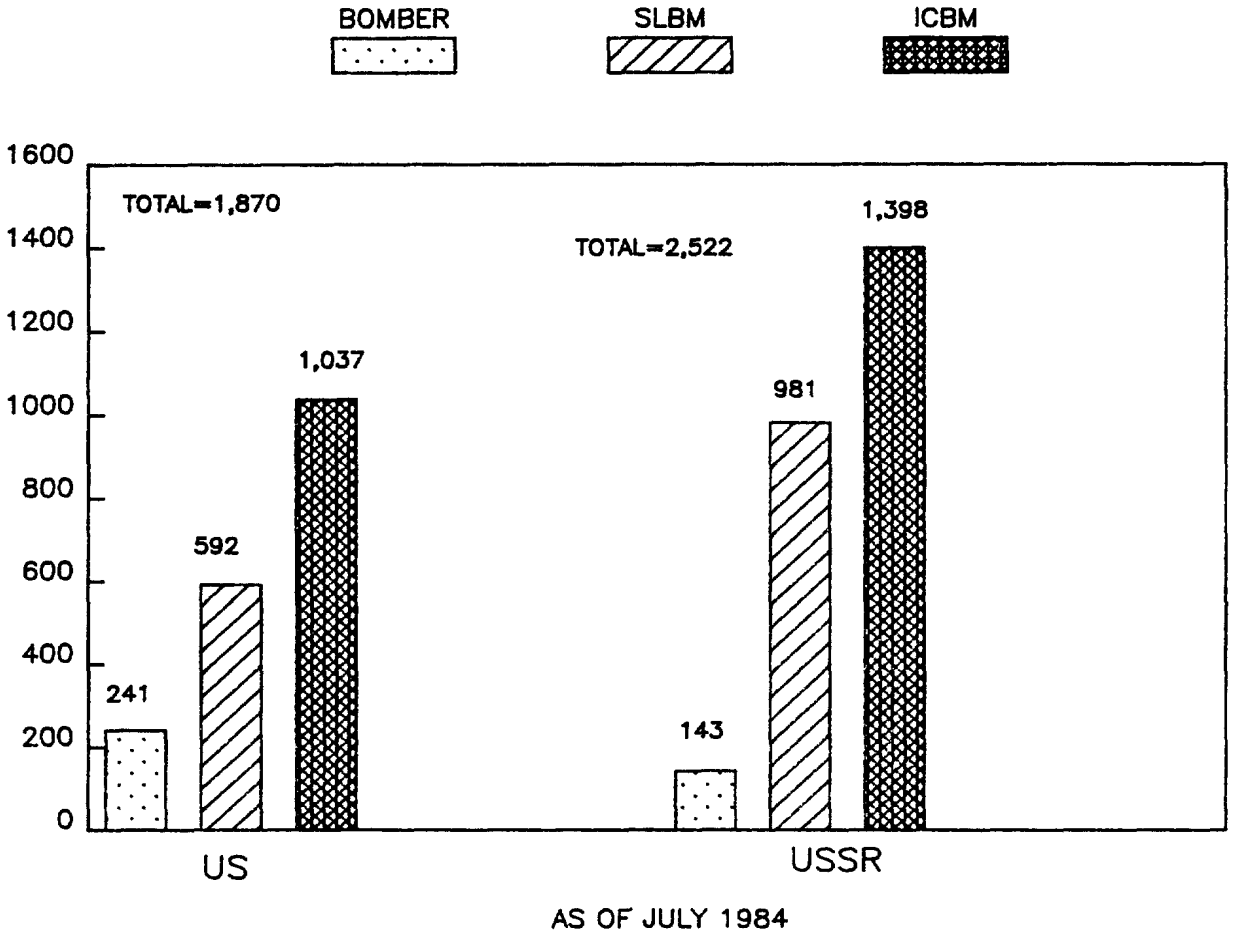
137. At present, superior ICBM accuracy makes the number of ICBM launchers a basic input to calculations that emphasize counterforce capabilities (as well as vulnerability to opponent's first strike). The USSR possesses 361 ICBM launchers more than the USA. Less accurate but relatively invulnerable (at the present state of technology) SLBMs[6] and relatively slow bombers and cruise missiles are more clearly indicators of retaliatory countervalue capability.

THROW-WEIGHT (ICBMs and SLBMs)

138. The throw-weight is the weight of the post-boost vehicle (warheads, guidance system, penetration aids) deliverable over a given range. It is a general measure of the potential force capability and, as such, enters into arms control negotiations that seek to limit and stabilize arms competition. Conclusions about the actual force effectiveness are sensitive to assumptions about the level of technological sophistication as reflected in a system's accuracy and reliability and to assumptions on force loadings.

FIGURE 26

NUMBER OF STRATEGIC LAUNCHERS



AS OF JULY 1984

139. The Soviet Union has a clear advantage over the United States in terms of the throw-weight indicator (Table 26).

Table 26

Throw-Weight Comparison

(in '000 lb, July 1984)

Category	US	USSR	Ratio
ICBM	2,120	9,926	1:4.7
SLBM	1,870	2,918+	1:1.6+

NUMBER OF WARHEADS

140. The United States has close to ten thousand warheads in its arsenal and the Soviet Union slightly more than nine thousand. Their aggregate yield of about 10,000 megatons means that a 'typical' thermonuclear weapon has a yield of about 500 kilotons (US average - 380 KT, USSR average 720 KT).

141. The distribution of warheads clearly shows the asymmetry of force structures with most of the Soviet warheads being land-based and most of the American assets submarine-based. There also is a more balanced distribution of warheads among the American components of the Triad (Table 27 and Figure 27).

Table 27

US and USSR Strategic Nuclear Warheads, July 1984

Category	US		USSR	
	Number	% of Total	Number	% of Total
ICBM	2,137	22	5,618	62
SLBM	5,344	54	2,911	32
Bomber	2,400	24	572	6
Total	9,881	-	9,101	-

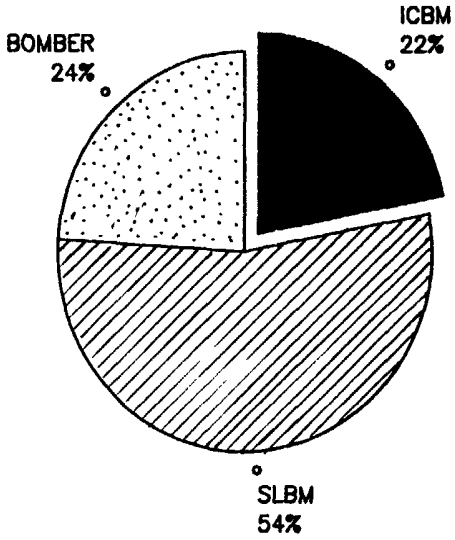
142. The uncertainty in the number of warheads is greater than that associated with launchers due to greater difficulties in verification by national technical means (NTM). For instance, silos for the Soviet SS-19 single warhead model are outwardly similar to its MIRVed version. Also, SS-18(4) has the capability to carry more than its nominal load of 10 warheads, as many as 30. What to count, how to verify it, and how to negotiate it are some of the issues at the heart of arms control.

143. The number of nuclear warheads defines the upper limit of the number of targets that can be attacked. Actual targeting plans depend on the strategic goals pursued, perception of the opponent's hierarchy of values (population, industry, nuclear forces, leadership), and incorporate technical factors such as range, MIRV pattern, fratricide effects, and others.

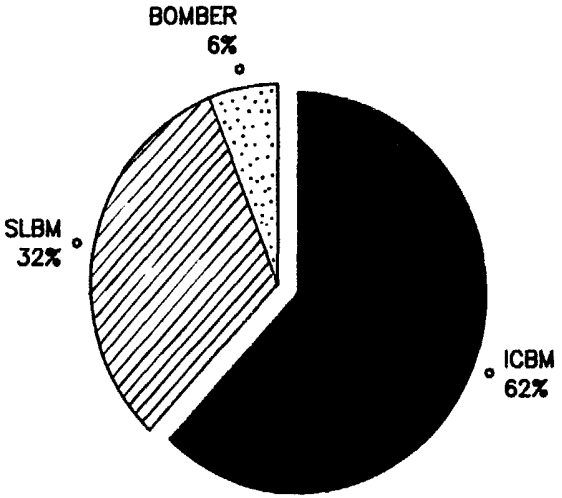
FIGURE 27

DISTRIBUTION OF STRATEGIC WARHEADS

(JULY 1984)



UNITED STATES



SOVIET UNION

144. Accepting that the number of targets destroyed does not necessarily equal the number of targets attacked, (especially if military targets are hardened, or mobile and populations sheltered) the destructive potential inherent in the current warhead inventory can only be described as awesome.

145. In fact, the number of strategic warheads is a critical index of the world nuclear arsenals in terms of the Nuclear Winter hypothesis.[7] Its central finding is that the long-term consequences of a nuclear war could constitute a global climatic catastrophe and lead to the extinction of the human species. A threshold appears to exist (500 - 2,000 strategic warheads) at which this catastrophe could be triggered. If one accepts Clausewitz's thesis that war is continuation of politics by other means, then no rational political purpose could justify use of such force.

146. 'That nuclear weapons present policy makers with a "clear and present" danger is not a revelation to the strategic analyst.'[8] The terrible destructiveness of an all-out nuclear war is beyond imagination. The scientific validity of these apocalyptic predictions is still a subject of intense debate.[9] Just how cold, dark, and hostile our world is likely to be after a nuclear war must, hopefully, never be put to test. Nonetheless, the Nuclear Winter threshold hypothesis provides yet another element to be factored into the equation of how nuclear weapons are managed. It adds impetus to the search for strategic stability at the lowest possible level.

SOFT-AREA DESTRUCTION CAPABILITY

147. A brief summary of nuclear explosion effects is useful prior to consideration of indices that measure soft-area destruction capability, that is, the ability to destroy unprotected structures. If a nuclear weapon is exploded in the air at an altitude of less than about 40,000 feet, approximately 50 percent of the exlosive energy is transmitted in the form of air blast (and shock), about 35 percent as radiated heat, and 15 percent as nuclear radiation (of this, 5 percent constitutes the initial nuclear radiation and 10 percent is in the form of the residual nuclear radiation which creates fallout particles).10 Blast and heat destroy life and structures alike but living organisms alone are vulnerable to the nuclear radiation.

148. A full discussion of the effects of nuclear weapons would need to consider the impact of these different energy forms on people and structures and is beyond the scope of this report. It is sufficient to note that in addition to yield other important factors would have to be considered - for example, height of burst, weapon design, weather, degree of protection (clothing, terrain, structures), type of structure, and others. Also significant is the manner in which different effects vary with distance. For instance, the radius of the blast effect varies as the cube root of the weapon yield while the radius of the heat effect varies as the square root of the weapon yield.11 This difference in functional dependence implies that for a multimegaton blast thermal radiation can cover a greater area of damage than blast. For a 5 megaton air burst at an altitude up to 15,000 feet most frame houses would be destroyed by 5 pounds per square inch (PSI) blast out to 7.5 miles but household materials would be ignited by 20 calories per square

centimeter beyond 9 miles (assuming favourable weather conditions).[12]

149. In attempting to capture complex phenomena with a single numerical index simplifying assumptions are made. Effects of nuclear explosions are no exception. Soft-area destruction indices focus on the amount of the direct damage from blast which is considered the most important effect for almost all strategic weapons (the exception is noted in the previous paragraph). An overpressure of 5 PSI will cause moderate to severe damage to most structures in the typical urban area and will cause extensive casualties to the population of the area affected. Area subject to 5PSI overpressure is thus an indicator of soft-area destruction capability.

150. A single 500 KT weapon will subject close to 38 square miles to 5PSI overpressure, an area almost the size of Ottawa.[13]

151. Another, traditional, indicator of soft-area destruction capability is the equivalent megatonnage (EMT).[14] EMT is a value such that the total blast damage done by several weapons adding to one EMT will equal to that done by a single one megaton weapon. It is given by the yield of the weapon in megatons altered by scaling factors which usually are 2/3 for yield less than one megaton and 1/2 for yield greater than one megaton. The two-thirds scaling factor has a physical basis since the damage radius to which a given level of blast damage occurs is proportional to the cube root of the weapon yield. The switch to one half scaling factor at yields above 1 MT is not based on any physical law. It is rather a US convention intended to reflect diminishing returns from using large-yield weapons against cities in the context of sizing a retaliatory

force. This ad hoc adjustment is done primarily because most targets are smaller than the area subjected to 5PSI pressure for very large weapons but it destroys any linear relationship between the equivalent megatonnage and the area subjected to a given level of overpressure.

152. For yields below 1MT the relationship between the two indicators is linear. Given the trend to smaller yield, more accurate, weapons it is not surprising that EMT and 5PSI area indicators give a comparable picture of countervalue capability. Thus, the overall ratio is 1.8 in favour of the USSR in terms of 5PSI area and 1.76 in terms of EMT.

153. Table 28 and Figure 28 summarize soft-area capabilities of both superpowers. Their combined equivalent megatonnage exceeds 10,000 - enough to subject an area of 658,000 square miles to an overpressure of 5PSI.

Table 28

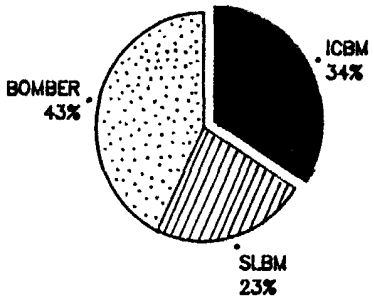
EMT and 5PSI Area Indicators[15]

	US		USSR	
Category	EMT	5PSI Area (1,000sq.mi)	EMT	5PSI Area (1,000sq.mi)
ICBM	1,271	80	4,432	279
SLBM	909	54	1,246	75
Bombers	1,561	101	901	69
Total	3,741	235	6,579	423

FIGURE 28

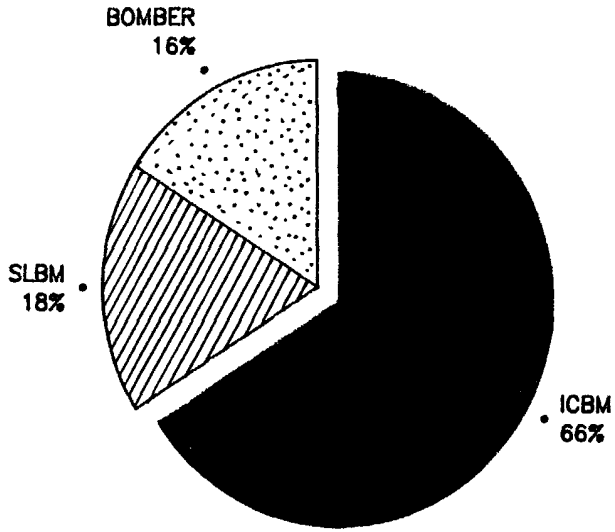
DISTRIBUTION OF SOFT-AREA CAPABILITY AMONG TRIAD COMPONENTS

(BASED ON 5 PSI AREA)



UNITED STATES

(235,000 SQ.MI.)



SOVIET UNION

(453,000 SQ.MI.)

154. These numbers indicate the potential for destruction on an immense scale. To put them into some perspective, it is useful to recall that through most of the 60s and 70s the United States argued that 400 EMT was sufficient to inflict unacceptable damage on the Soviet Union (defined as destruction of about one-third of the population and two-thirds of the industrial base). Also, Soviet soft-area capability (5PSI area of 453,000 square miles) is more than enough to cover every square inch of German, French and British territory. It is also considerably larger than the total US urban, farm and transportation area which is less than 250,000 square miles.[16]

155. Nuclear forces of China, the United Kingdom and France are orders of magnitude smaller than those of the two superpowers.[17] Their soft-area capabilities in terms of EMT are 12, 66 and 102, respectively. In terms of square miles of area subject to 5PSI overpressure they are 850, 3,936 and 5,880, respectively. An area of 850 square miles would include all of Moscow and Leningrad (or New York and Chicago) while 5,880 square miles would cover approximately 80 major Soviet cities and about 25 major American cities[18] (the American cities are more spread out due to their suburban character while the Soviet cities are highly urban).

156. Although medium-range missiles are not considered in detail in this report, their approximate deployment levels are included in Table 5 of the Annex. The Soviet Union has a more than 4 to 1 lead in deployed launchers and an approximately 11 to 1 lead in warheads over the USA. Soviet SS-20s and remaining SS-4s have a combined EMT of 432 - far more than an EMT in the range of 4.4 - 15.2 in the currently deployed Pershing IIs and GLCMs.

HARD-TARGET KILL CAPABILITY

157. Hard-target kill capability refers to the ability to destroy hardened point targets such as missile silos and command and control centres. While the ability to destroy cities and unprotected targets depends primarily on yield, the ability to destroy hardened point targets is highly dependent on accuracy. Yield is, of course, a factor inasmuch as it determines the level and duration of overpressure. Target hardness is also a factor to be considered.

158. Two indicators of hard-target kill capability are counter-military potential (CMP) and single-shot kill probability (SSKP).

COUNTER-MILITARY POTENTIAL

159. CMP has been used quite extensively in literature as an indicator of counterforce capability. It is usually defined by the equation,[19]

$$CMP = \frac{Y^{2/3}}{(CEP)^2}$$

where Y is yield in megatons and CEP is circular error probable in nautical miles. The CMP formula includes only weapon system characteristics (yield and accuracy) but does not account for target characteristics. It is also very sensitive to accuracy, especially as CEP approaches zero. CMP can be viewed as a direct indicator of the technical sophistication of an offensive nuclear force (especially of its guidance system) and as an indirect indicator of its hard-target capability. These points will be elaborated later on when CMP and SSKP are compared.

160. The counter-military potential of US and USSR forces is summarized in Table 29. Cruise missiles rate highest in terms of sophistication. Their speed is very low compared to ballistic missiles, making them a retaliatory weapon rather than a first-strike weapon. SLBM's accuracy is low at present and this is reflected in low CMP. For these reasons counterforce calculations center on fast, accurate (and vulnerable) ICBMs.

Table 29
Countermilitary Potential (thousands of units)

Weapon System Category	US	USSR
ICBM	53.7	126.3
SLBM	15.4	7.0
Bombers - ALCM (only)	583.9	n/a

SINGLE-SHOT KILL PROBABILITY

161. Single-shot kill probability is the probability that a single warhead would destroy a target. It is approximated by the equation,[20]

$$SSKP = 1 - 0.5^{a},$$

where $a = \frac{6\ Y^{2/3}}{H^{2/3}\ (CEP)^2}$; Y is yield in megatons, H is hardness in PSI, and CEP is accuracy in nautical miles. Calculation of SSKP thus takes into account target hardness as well as weapon yield and missile accuracy. Given sufficient yield, as accuracy improves SSKP increases towards unity.

CMP and SSKP Comparison

162. Variations of CMP and SSKP as a function of accuracy for a 500-KT weapon are shown in Figure 29. Target hardness of 2,000 PSI is assumed.[21] A number of CMP and SSKP values is extracted in Table 30. The graph and the table illustrate a number of points. First, as accuracy improves both CMP and SSKP increase indicating improved hard-target kill capability. In this sense both indicators are useful.

Table 30

CMP and SSKP for a 500-KT Warhead and a 2,000 PSI Silo

CEP(m)	SSKP	CMP
400	0.30	13.5
200	0.76	54
100	0.99	216
50	0.99..	864

163. However, SSKP translates fairly directly into probable number of targets destroyed but CMP does not. The two indicators also change at different rates with changes in accuracy. For instance, as CEP improves from 400 m to 200 m, CMP increases by a factor of 4 but the single-shot kill probability increases only by a factor of 2.5. A further doubling in accuracy (CEP of 100 m) results in another increase by a factor of 4 in CMP. On the other hand, SSKP curve starts flattening out and SSKP increases only by a factor of 1.3 (from 0.76 to 0.99). Beyond this point target destruction is, for all practical purposes, certain. That is, SSKP stays constant at 1.0 but CMP

FIGURE 29

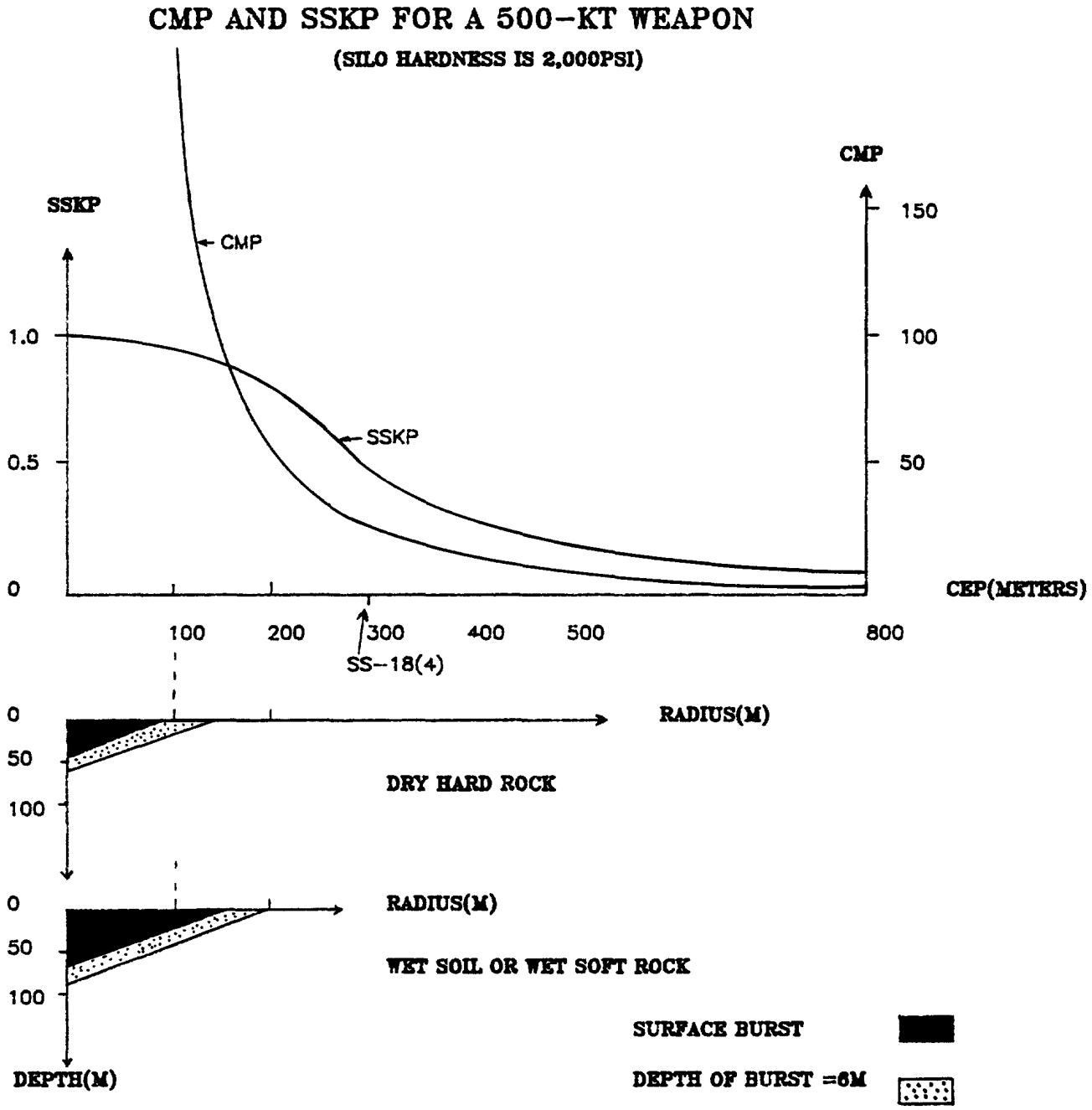


FIGURE 30

CRATER DIMENSIONS

continues to increase without limit making its use in numerical comparisons of dubious validity when high accuracies are involved.

Crater Size

164. The discussion of indicators is less abstract if actual nuclear weapons effects are clearly borne in mind. A nuclear explosion close to the surface creates a crater the size of which depends on the size of the warhead, the type of soil, and depth of the explosion.

165. A 500-kiloton nuclear blast on the surface would create a crater 192 meters in diameter and 43 meters deep in dry hard rock. In wet soil or wet soft rock the crater would be larger, some 322 meters in diameter and 61 meters deep (Figure 30).[22]

166. If the re-entry vehicle (RV), penetrates the earth, the size of the crater increases. For an explosion at 6 meter depth in wet soil or set soft rock, the crater diameter becomes 395 meters and depth 80 m, in effect doubling the volume of the crater. The construction of earth-penetrator casings for the RVs is important for this reason.

167. It can be readily appreciated that as accuracy improves even a warhead detonated on the surface would be virtually certain to have its target somewhere within its crater. At this juncture no amount of silo hardening would help and the race between target hardness and accuracy would be over.

Accuracy

168. Mathematical calculations confirm the dominant role of accuracy. To see the tradeoffs involved, consider the equation for SSKP and suppose that SSKP remain constant while CEP and H are varied. This implies that,

$$Y = k\ H\ (CEP)^3,$$

where k is a number whose value can be determined once the value of SSKP is known or assumed.

169. Three tradeoffs are immediately apparent:

a. Accuracy - Yield.

For a given silo hardness (fixed), one has

$$Y = k_1\ (CEP)^3$$

where k_1 is a number which can be calculated once SSKP and H are known. This implies, for example, that doubling the accuracy (that is, reducing CEP by one half) allows the yield to be reduced by a factor of eight for the same result.

b. Accuracy - Hardness.

For a weapon of given yield, one has

$$H = \frac{k_2}{(CEP)^3}$$

where k_2 is a number that depends on the values of SSKP and yield. This shows that silo hardness must be increased very rapidly to compensate for improvements in accuracy, if its chances of survival are to remain the same. To offset an improvement in missile accuracy by a factor of 2.15 requires that silo hardness be increased by a factor of 10.

c. Hardness - Yield

Assuming constant accuracy,

$$Y = k_3 H$$

where k_3 is again a number whose value can be determined from the values of SSKP and CEP. The relationship is linear, making silo hardening more attractive in this instance.

170. The tradeoff between accuracy and hardness confirms the previous conclusion that accuracy would ultimately win the contest. This explains the intense search for ways to alter the assumptions underlying the calculations and conclusions stated above. Alternatives considered include shifting more assets to submarines, superdeep underground silos, mobility, deception, reducing target value (de-MIRV), defence (SDI), and arms control.

The Number of Warheads Used Per Target

171. Given the current accuracies of missiles and silo hardnesses, as available in open literature, one warhead has approximately a 50 percent chance of destroying a target

silo.[23] Increasing the number of warheads per target increases the chance of target destruction in a highly non-linear fashion as illustrated in Table 31.

Table 31

Terminal Kill Probability and

the Number of Warheads Employed[24]

Number of Warheads	Terminal Kill Probability
1	0.50
2	0.75
3	0.88
4	0.94
5	0.97

172. In practice, the combination of the problem of fratricide with the exceedingly stringent command and control requirements suggests the conclusion that two warheads would, most likely, be planned against a single target.

Uncertainties

173. To say that considerable uncertainties would be involved in planning a pre-emptive nuclear attack undoubtedly understates the case. Would the opponent react by adopting a "launch on warning" or a "launch under attack" strategy is a question that exemplifies a critical psychological uncertainty. Purely technical uncertainties are also considerable and would combine to degrade performance calculated on basis of simplified assumptions.

174. One of the technical uncertainties concerns overall reliability (OAR). For a complex system, an OAR of 0.75 indicates a high estimate of technological performance.[25] Using this OAR terminal kill probability for two independent warheads would be reduced from 75 percent, as shown in Table 31, to 61 percent.

175. Other significant technical uncertainties, distinct from reliability problems, include errors in accuracy, uncertainties in yield and in silo hardness, and effects of fratricide.[26] These uncertainties degrade performance potential of current forces and must be considered.

COUNTERFORCE SCENARIOS

176. It is impossible to know with certainty targeting plans and action strategies of either superpower. Two of the many possible counterforce scenarios are presented here. They correspond to a simplified "worst case" analysis that the Soviets or the Americans might do.[27]

Assumptions

177. It is assumed that the most capable weapons would be used on the most capable weapons of the opponent. For the US, this means Minuteman 3 equipped with MK12A warhead and the MX, if deployed. For the USSR, the 10-warhead SS-18(4) missile leads to best exchange ratios. It is also assumed that the US force has a slight technological edge in terms of overall reliability (an OAR of 0.85 for the US, and an OAR of 0.75 for the USSR). Two warheads per target silo are used. Detailed calculations are given in Table 5B, Annex.

Soviet First Strike

178. Existing American silos are the target set. The attacking force's SS-18s are assumed to be fully MIRVed.[28] The SS-19(3), which has 6 warheads, is employed against Titan II silos as it gives a better match than SS-18(4) between the number of warheads and the number of target silos. The Soviet Union would use about 15 percent of its ICBM force to destroy an expected 65 percent of opposing ICBMs. In relative terms, this is a favourable exchange ratio. Soviet Union's remaining 1,186 ICBMs would constitute a formidable reserve. These results portend the end of US escalation dominance and emergence of the USSR as a formidable nuclear superpower.

179. The remaining US ICBM force, however, could be expected still to be considerable in terms of absolute numbers. Some 366 launchers would be expected to survive. Their 830 warheads have the equivalent megatonnage of 444. This damage potential exceeds the 400 EMT level discussed previously as one of the criteria of assured retaliatory capability.

180. It should be noted that the other two legs of the Triad were not included in the above totals. Three-quarters of American nuclear warheads and two-thirds of EMT reside there. They cannot be assumed to be unaffected. Submarines in home ports are vulnerable and a portion of bombers could be caught on the ground, thus degrading retaliatory capability of these force elements.

American First Strike

181. The existing Soviet silos are the target set. The American force is assumed to include 100 MX missiles with 10 warheads each.29 From the results obtained it can be seen that the United States would use about 80 percent of its ICBMs to destroy an expected 72 percent of the Soviet ICBM force. This less than one-to-one tradeoff can be argued to be unfavourable to the US inasmuch as its ICBM force is smaller than the Soviet force at the outset and the imbalance would increase after the first exchange. The USSR would be expected to have 389 ICBM launchers left carrying some 1,702 warheads with the equivalent megatonnage of 1,340. Its submarine and bomber forces were not included in the above calculation and portions of them could be expected to survive. Figure 31 summarizes the results of the Soviet and the American first-strike scenarios in terms of both ICBM launchers and ICBM warheads.

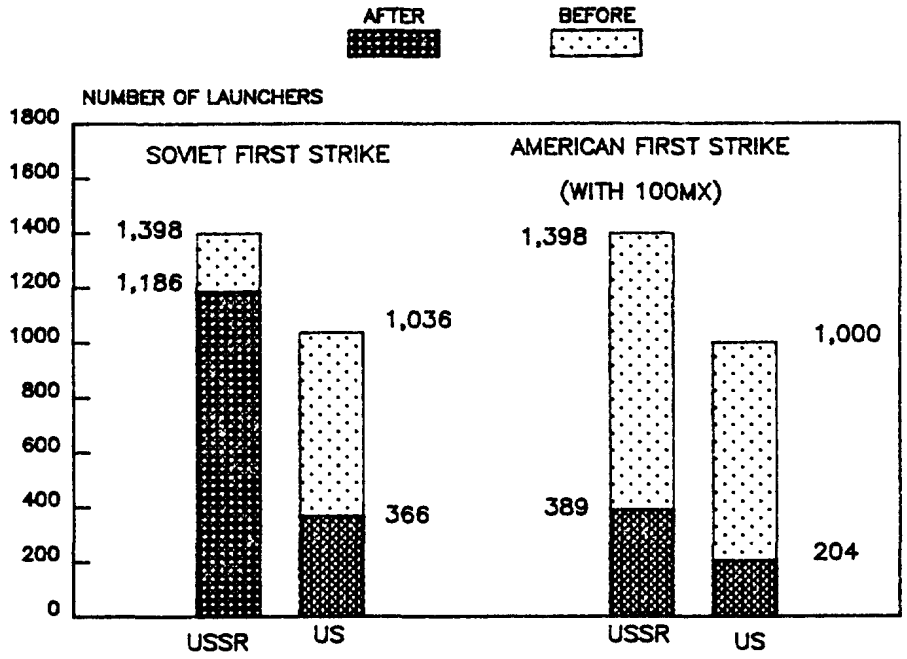
Sensitivity Analysis

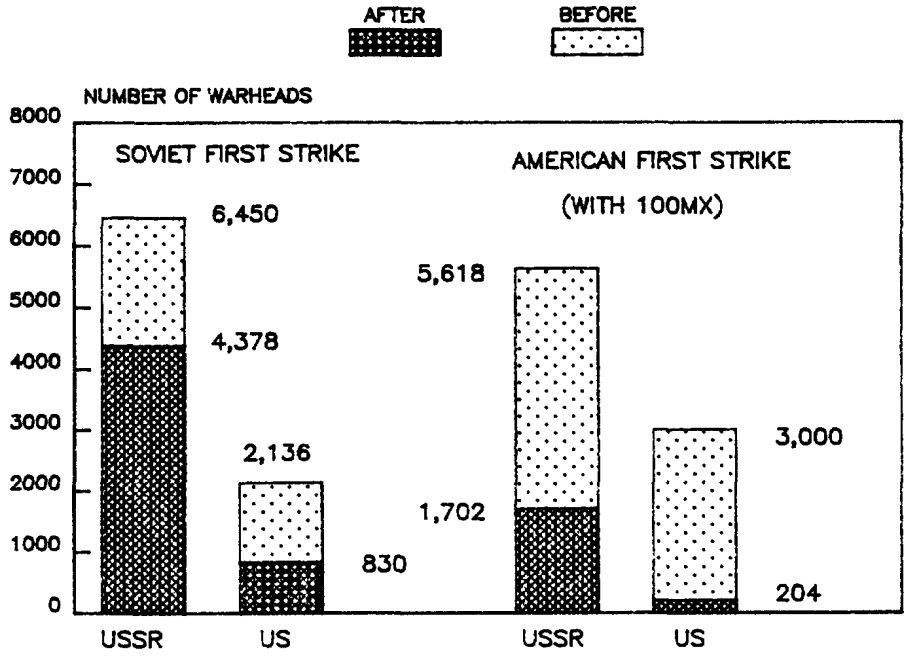
182. To examine the sensitivity of these results to assumptions about Soviet missile systems characteristics, a number of parameters were varied from those of the baseline case (See Sensitivity Analysis of Scenario 1, Table 5B, Annex). As expected, accuracy improvements affect the results greatly. Table 32 summarizes likely outcomes as accuracy improves from 300 m to 220 m, remaining parameters held constant. The size of the surviving American ICBM force decreases rapidly in terms of launchers, warheads, and EMT. Also shown is the case that combines modest improvement in missile accuracy (CEP of 260 m) with an increase in reliability to the level assumed for the US force (OAR of 0.85 vice 0.75). The result is again a

FIGURE 31

COUNTERFORCE SCENARIO RESULTS

(TARGET SET:ICBMs)





significant reduction in the size of the surviving ICBM force. Finally, assuming that SS-18(4) carries its alleged maximum load of 30 warheads, results in an even more favourable exchange ratio. Six percent of Soviet ICBM missile force would destroy 65 percent of the opposing US ICBM force (Table 5B, Annex, baseline case).

Table 32

Surviving US Force as a Function of Different Assumptions about Soviet Force Characteristics

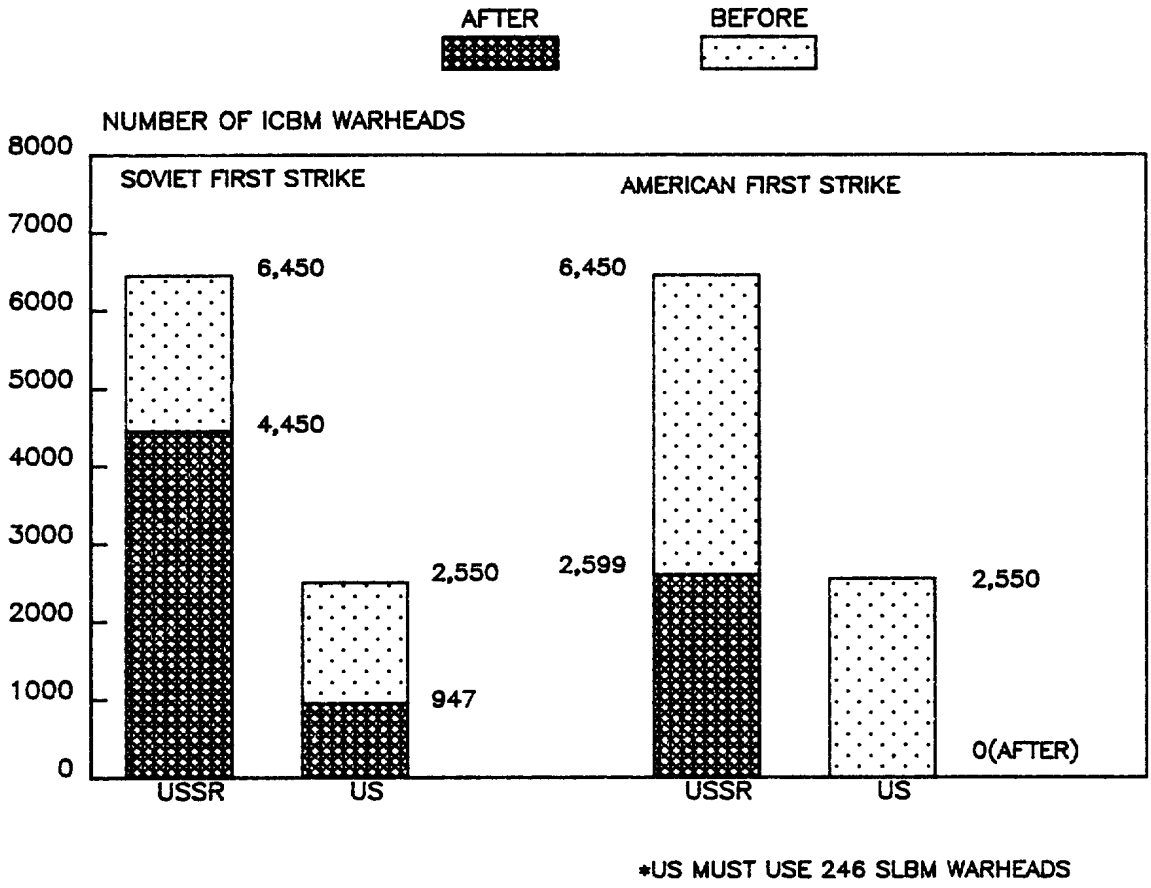
Attacking Force Characteristics		Expected to Survive		
OAR	CEP(m)	Launchers	Warheads	EMT
0.75	300	366	830	444
0.75	260	284	654	345
0.75	220	194	450	237
0.85	260	215	509	261

183. The results are also sensitive to assumptions about the American force posture. An analysis of likely outcomes based on the US deployment of only 50 MX is included in the Annex (see Sensitivity Analysis of Scenario 2, Table 5B) and the expected results are portrayed in Figure 32. The analysis shows that the US ICBM force is insufficient to

FIGURE 32

COUNTERFORCE SCENARIO RESULTS(WITH 50 MX)

(TARGET SET:ICBMs)



*US MUST USE 246 SLBM WARHEADS

attack all of the Soviet ICBM silos with two warheads each. The US has to have a recourse to its SLBMs to provide the second, not very accurate, warhead for 246 of the Soviet targets. Also, Minuteman III (MK 12) warhead is not particularly effective against SS-17 silos. Under these circumstances some 1,031 US missiles would be expected to destroy some 912 Soviet missiles or 65% of the Soviet ICBM force. After such an exchange the US would have no ICBMs left, while 486 Soviet ICBM launchers (2,599 warheads) could be expected to survive.

Conclusions

184. This simplified analysis indicates that the US, even with 100 MX, is highly unlikely to see itself (or the USSR see it) as having a plausible counterforce capability. The issue is less clear in case of the USSR. The proportion of US silos expected to be destroyed relative to the number of Soviet missiles used is very much in the USSR's favour but the capability of the surviving US ICBM force is still substantial in terms of its countervalue capability.

185. These conclusions must be tempered by the very real technical uncertainties that have been excluded from the analysis. 'These uncertainties may be so grave that no prudent planner would permit decision-makers to contemplate a counterforce attack option except in conditions of extremis'.[30]

186. Existence of even a theoretical Soviet advantage affects the perceptions of strategic balance and attitudes to arms control. This psychological dimension of the counterforce issue has to be taken into account.

187. The political impact of these perceptions is no less significant. Fear of what the Soviets might do in a crisis, could severely constrain American options and might lead other states to make decisions amenable to Moscow's interests.

FOOTNOTES

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4 Paul H. Nitze, "On the Road to a More Stable Peace". Department of State Bulletin, 85: 2097, April 1985, pp. 27-29.

5 Ibid., p. 28.

6 Trident II (D-5) SLBM is expected to have an accuracy comparable to the current ICBMs.

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10 Samuel Glasstone, ed., The Effects of Nuclear Weapons, (U.S. Department of Defense and U.S. Department of Energy, 1977), p. 7.

11 Glasstone, ed., op. cit., pp. 100-102 and 316-321.

12 Table 5A, Annex and Glasstone, ed., op. cit., Figure 7.42, p. 291.

13 Statistics Canada No 93-906, Volume 2 gives Ottawa city area as being 110.15 km^2 (approximately 43 sq. mi) in 1981.

14 LCol Gerald T. Rudolf, "Assessing the Strategic Balance" in Anthony H. Cordesman, ed., Measuring the Strategic Balance, (U.S. Department of Defense, 1976), p. 343.

15 5PSI Area Calculations are based on Samuel Glasstone, ed., op. cit., Figure 3.73c, p.115. 5PSI area for a 1KT explosion was rounded off to 0.6 square miles. See also Table 5A, Annex.

16 The Europa Yearbook 1982, (London: Europa Publications Ltd., 1982), Vol. II, p.1644 gives US urban and transportation areas, areas used primarily for recreation and wildlife purposes, military areas, farmsteads and farm roads and lands as being 246,875 square miles.

17 Table 5, Annex gives force compositions for these three states. EMT figures are for strategic forces only (Chinese ICBMs, British SLBMs, and French SLBMs and IRBMs).

18 US city area statistics are found in the US Bureau of Census, Statistical Abstract of the United States: 1985 (105th edition), Washington, 1984, pp. 23-26.

Soviet city area can be estimated using population figures from "Population of Union Republic Capitals and Cities over 500,000 Population" printed in TsSU SSSR, SSSR v Tsifrakh v 1975g (Moscow: Statistiki, 1980) and for cities under 500,000 from Norodnoye Khozyaystvo SSSR v 1978 (Moscow, 1979) and population density figures given in Vestnik Statistiki (Statistical Handbook), No. 11, 1971 (Moscow: Statistiki), p. 88.

19 Countermilitary potential, or lethality, is extensively discussed in Kosta Tsipis: Offensive Missiles (Stockholm: SIPRI, Stockholm Paper No. 5, August 1974). See also Thomas A. Brown, "Number Mysticism, Rationality and the Strategic Balance", ORBIS, Fall 1977, pp. 479-496.

20 L.E. Davis and W.R. Schilling, "All You Ever Wanted to Know About MIRV and ICBM Calculations But Were Not Cleared to Ask", Journal of Conflict Resolution, 17:2 (June 1983), p. 224.

21 These assumptions correspond to an SS-18(4) warhead and a Minuteman III silo.

22 Calculations based on Glasstone, ed., op. cit., Figures 6.72a,c, pp.253-257.

23 SS-18(4) has an SSKP of 0.47 and SS-19(3) of 0.49 against a US silo hardened to 2,000 PSI. Minuteman 3 (MK12A) has an SSKP of 0.50 against a Soviet silo hardened to 5,000 PSI.

24 TKP = 1 - $[(1- SSKP_1 \times OAR) (1 - SSKP_2 \times OAR)]$ for two dissimilar warheads. OAR is the overall system reliability.

This formula assumes that each of the warheads going to the same target is launched by a separate booster, which requires a criss-cross targetting of the MIRVs involved.

If the warheads going to the same target are launched by the same booster, the OAR of the system must be broken into two components: Launch Reliability (LR - the probability that the system will perform correctly through the successful separation of the warheads) and Flight Reliability (the probability that the warheads will perform successfully through penetration and detonation). TKP is given by the expression $LR \times [1-(1-SSKP_1 \times FR_1) (1-SSKP_2 \times FR_2)]$ which produces a lower value for TKP than in the case of independent warheads. It should be also noted that in this case most of the uncertainties considered in paragraph 175 cannot be overcome by using extra warheads, since failure could be due to a common cause affecting all of them.

25 Mr. L.S. Hagen and Dr. J.S. Finan, ORAE Project Report No. PR 242, ICBM Vulnerability and the Counterforce Problem: Issues and Capabilities, December 1983, p. 20.

26 M. Bunn and K. Tsipis, "The Uncertainties of a Preemptive Nuclear Attack", Scientific American, Vol. 249, Number 5 (November 1983), pp 38 - 47.

27 These scenarios are, in effect, an update of Examples 5 and 6 in ORAE Project Report No. PR242.

28 This implies that these 308 missiles would carry up to 682 warheads more than indicated in Table 5, Annex.

29 MX would replace 100 Minuteman 2 systems which carry a single warhead. The number of US launchers would stay the same but the number of warheads in the ICBM force would increase by 900.

30 ORAE Project Report No. PR242, pp 25-26.

CHAPTER 7

CANADA - THE LAND AND ITS PEOPLE

INTRODUCTION

188. In the next three chapters we look at some of Canada's links with the world. Human ties inherent in people's roots and economic links expressed in trade and capital investment will be delineated.

THE LAND

189. Canada is almost 10 million square kilometers in area. It is the second largest country in the world, covering nearly half of the North American continent. It lies between the two nuclear superpowers. Canada's only land neighbour is the United States. The Atlantic, Pacific, and Arctic oceans separate it from the rest of the world.

190. Canada has over 15 percent of the world's known freshwater volume. Fresh water forms over 7.6 percent of the total area of the country. In a finite world, fresh and clean water is an important long-term resource.

THE PEOPLE

191. Canada's population at the time of the official census (3 June 1981) was 24,084,000. It rose to 25,318,000 by 1 April 1985, the date of the most recent estimate available from the Statistics Canada. A detailed summary of 1981 Census data is given in Tables 6 and 6A of the Annex.

192. The composition of Canada's population reflects its history and influences its future.

193. Canada was first inhabited by Asian tribes believed by archaeologists to have migrated across the Bering Strait many thousands of years ago. Their descendents are today's Indians, Métis and Inuit, who comprise only 1.7 percent of the population.

194. The majority of Canadians have roots in the two founding peoples. French-speaking descendants of the original French colonists constitute almost 30 percent of the population. Over two-fifths of the Canadians are of British stock. The rest, more than a quarter, are of other origins.

195. Early immigration to Canada centered on Europe and was instrumental in settling the East and then the Prairies. More recently, Canada has opened its door to immigration from all parts of the globe. Since the mid-1970's more than half of the immigrants originated in Third World countries. Their presence has increased Canadians' awareness of, and sensitivity to, problems and opportunities in the developing world.

196. The third largest ethnic group in Canada are the Germans. Other large groups are the Italians, Ukrainians, Dutch and Poles.

197. The distribution of population's ethnic background by zones is displayed in Figure 33. It shows that about nine out of each ten Canadians have origins in Western Community countries. Close to five percent have roots in countries now in the Soviet Bloc, three percent in the Southern Hemisphere, and 1.2 percent are of Chinese origin.

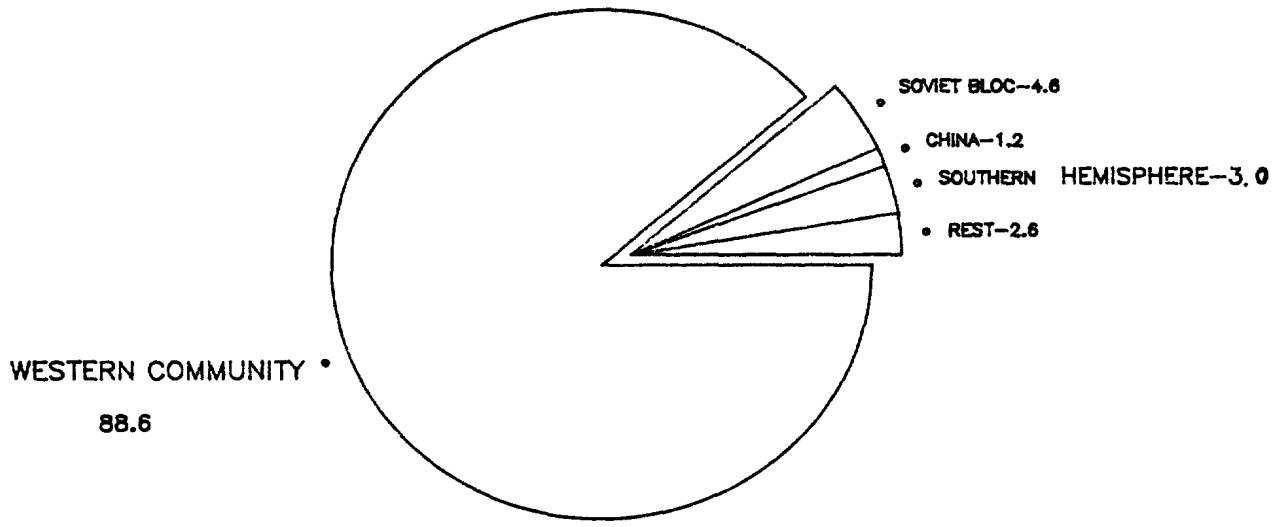
198. The 1981 census was the first to allow more than one ethnic origin response. As noted in technical comments in the Annex this accounts for 2.6 percent of the population being placed in the remaining category. Some of the people in this category have 'dual' roots than can be determined unambiguously (e.g. 0.48 percent have ethnic background with ties to both the Western Community and the Soviet Bloc), while for others data cannot be disaggregated further.

199. These minor uncertainties do not affect significantly the ranking pattern just described. That is, Canada is predominately a Western Community country with an admixture of representatives from all the corners of the world.

FIGURE 33

ETHNIC ORIGINS OF CANADIANS

(1981 CENSUS)



CHAPTER 8

CANADIAN TRADE

INTRODUCTION

200. Canada is a trading nation. In the 1980-82 period it ranked ninth among the world traders,[1] a decline from the fourth position in the not too distant past. Recovery of post-war European and Japanese economies is the major reason for our relative decline but lagging productivity gains in Canada have also been a factor.

TRADE AND DOMESTIC ECONOMY

201. International trade has been an increasingly important component of our domestic economy despite our relative decline in global competitiveness. The twenty-year pattern of exports (Figure 34)[2] clearly shows this. In the last five year period 1979-83 our exports averaged approximately 25 percent of gross national product. More than 3 million jobs now depend on exports.[3] International trade performance affects directly and indirectly almost every Canadian.

MAJOR TRADING PARTNERS

202. The top ten trading partners of Canada for the 15-year period 1969-83 are listed in Table 30. The United States, Japan, and United Kingdom top both lists. West

Germany, France, and Italy also figure on both lists while the other countries disclose differences in the structure of our exports and imports. The Soviet Union and China are important as export markets for Canadian grain. Venezuela and Saudi Arabia rank high as import sources due to oil. Detailed import and export statistics for the fifteen year period 1969-83 are included in the Annex, Tables 7C to 7F.

FIGURE 34

EXPORTS AS PROPORTION OF GNP

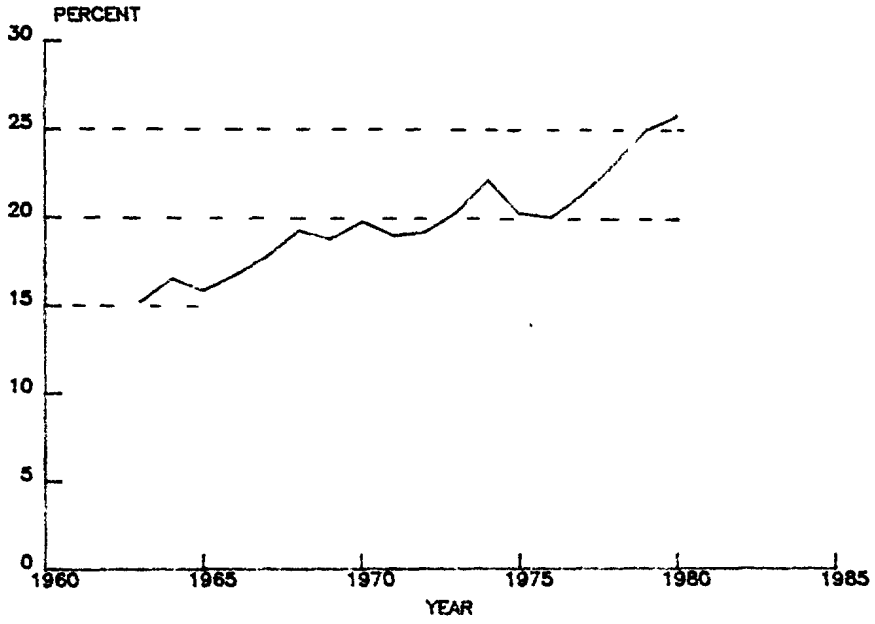


Table 30

Canada's Major Trading Partners, 1969-83

Rank	Exports	Imports
1	USA	USA
2	Japan	Japan
3	Britain	Britain
4	Germany, Fed. Rep.	Venezuela
5	USSR	Germany, Fed. Rep.
6	Netherlands	Saudi Arabia
7	China	France
8	Italy	Italy
9	Belgium - Luxembourg	Taiwan
10	France	Australia

1983 TRADE

203. The pattern of 1983 exports and imports (Figure 35)[4] highlights a number of points. First, the overwhelming importance to Canada of the United States market is clear. Our exports to the US were fourteen times our exports to the second market in importance, Japan.

204. Second, the five largest export markets (US, Japan, UK, USSR, and China) accounted for 84.6 percent of all our exports.

205. Third, our trade with the Pacific Rim[5] countries exceeded the volume of trade with Western Europe (10.2 percent versus 9.2 percent). Pacific trade is likely to continue to increase, inasmuch as some of the newest and fastest growing markets are in Asia.

FIGURE 35

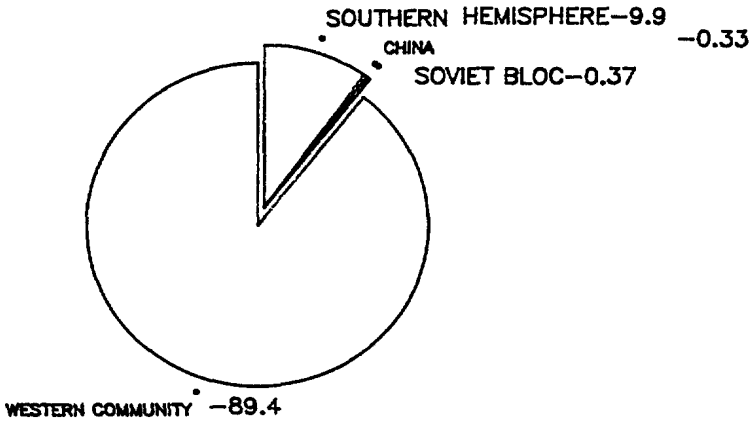
CANADIAN TRADE, 1983

(PERCENTAGE SHARE BY ZONE AND TOP FIVE MARKETS)

IMPORTS

($75.6 BILLION CDN)

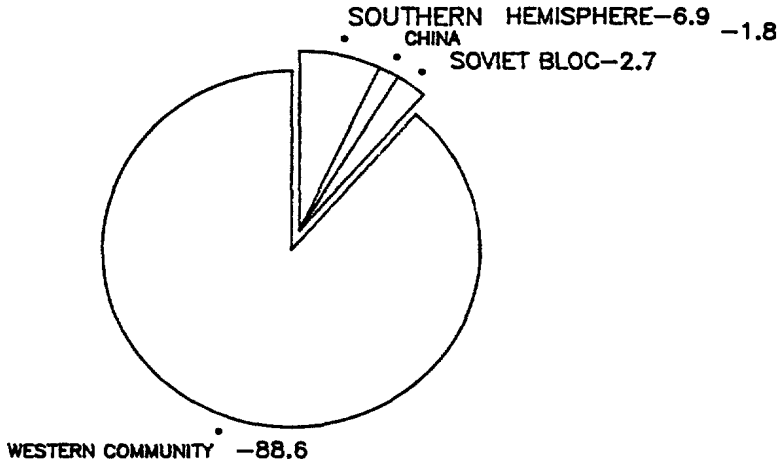
US–71.6
JAPAN–5.8
UK–2.4
GERMANY,FR–2.1
MEXICO–1.4



EXPORTS

($91.8 BILLION CDN)

US–72.9
JAPAN–5.2
UK–2.8
USSR–1.9
CHINA–1.8

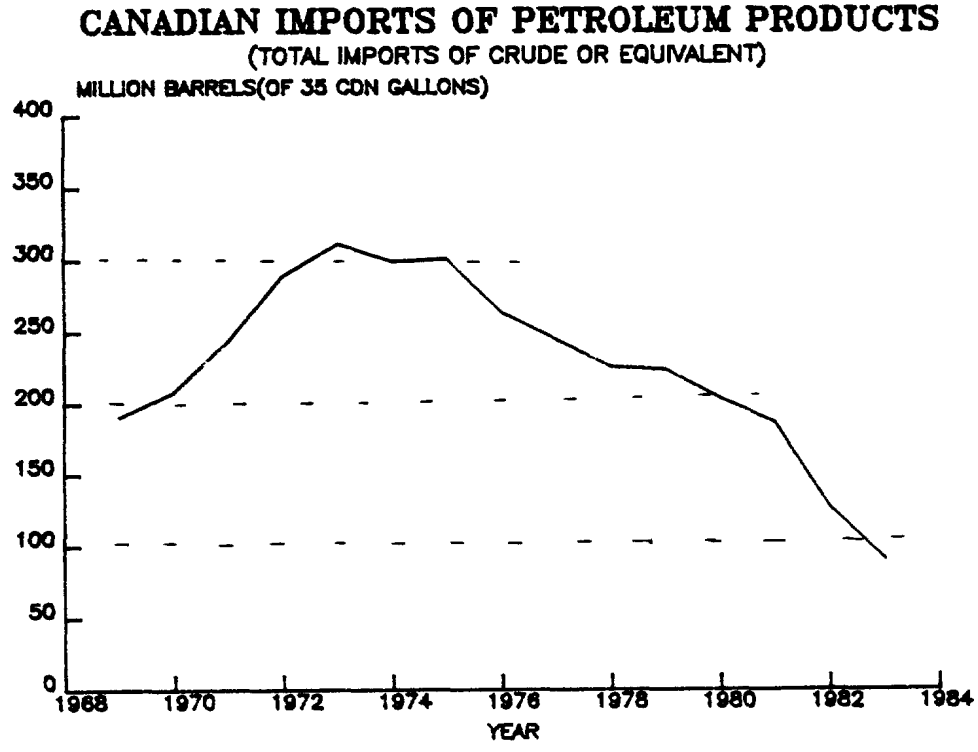


206. Finally, looking at trade patterns in terms of zones shows that our trade with the Western Community is 89 percent of the total, some eight times as much as the trade with the rest of the world. Southern Hemisphere countries are second in terms of trade volume (8.3 percent). Soviet Bloc (1.6 percent) and China (1.1 percent) complete the picture. The trade with the last two is small in relation to other zones but in absolute terms it is still very significant to the Canadian economy (over $4 billion of exports in 1983).

OIL IMPORTS

207. Energy sufficiency has been a major concern of the Canadian government since the 1973 oil shock. Some statistics germane to the problem are included for this reason. Figure 36 portrays the history of Canadian dependence on petroleum imports during the past 15 years.[6]

FIGURE 36



208. Oil imports have decreased steadily from 1975 (300.6 million barrels) to 1983 (90.3 million barrels). Drop in demand due to economic slowdown played a part in this decrease, as did national energy policies. Canada has also decreased its dependence on the Middle East oil by importing substantially more oil from the American sources (Mexico, US, etc.) in the past few years.

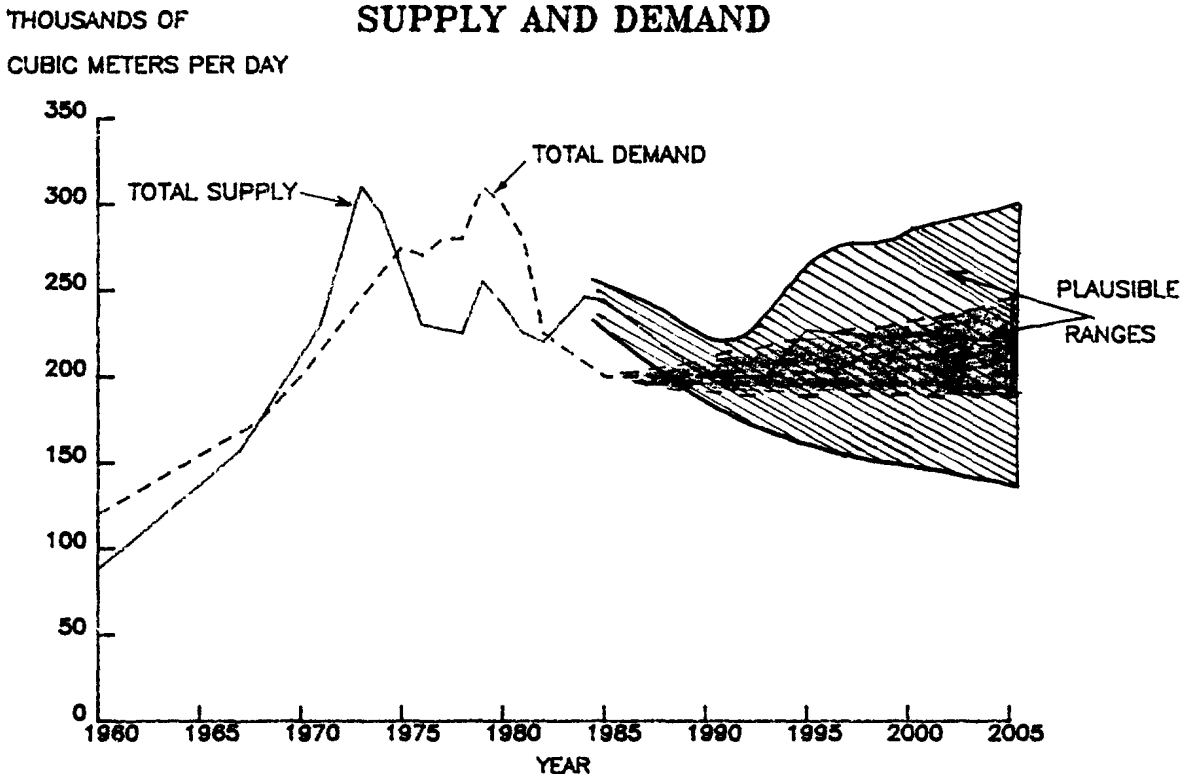
209. The National Energy Board (NEB) has analysed a likely evolution of supply and demand for all forms of energy for the years, 1983-2005. Their projections, like all projections, depend on a number of assumptions about the key variables, uncertain future world oil price included.

210. A plausible range for both supply and demand for total crude oil is shown in Figure 37. NEB report concludes:

> In general, it is indicated that there are reasonable prospects for Canada to be self-sufficient in oil on a total basis. This will depend mainly on the availability of frontier supplies and the extent of oil sands development. The balance depends to a somewhat lesser extent on variations in demand.[7]

FIGURE 37

PLAUSIBLE RANGES FOR CRUDE OIL SUPPLY AND DEMAND



BILATERAL CANADA - US TRADE

211. The bilateral trade with the United States is critical to the Canadian economy. 73 percent of our 1983 exports went to the US. They amounted to 20.2 percent of America's imports, well ahead of Japan's 15.9 percent share.[8] The bilateral trade with Canada is thus also very important to the United States, particularly in specific industrial areas and regions of the country.

212. The recent history of Canadian trade with the United States is portrayed in Figures 38 and 39[9]. It shows our exports to the US as percentage of total exports and balance of payments position which shows large Canadian surpluses in recent years.

FIGURE 38

EXPORTS TO US AS PROPORTION OF TOTAL EXPORTS

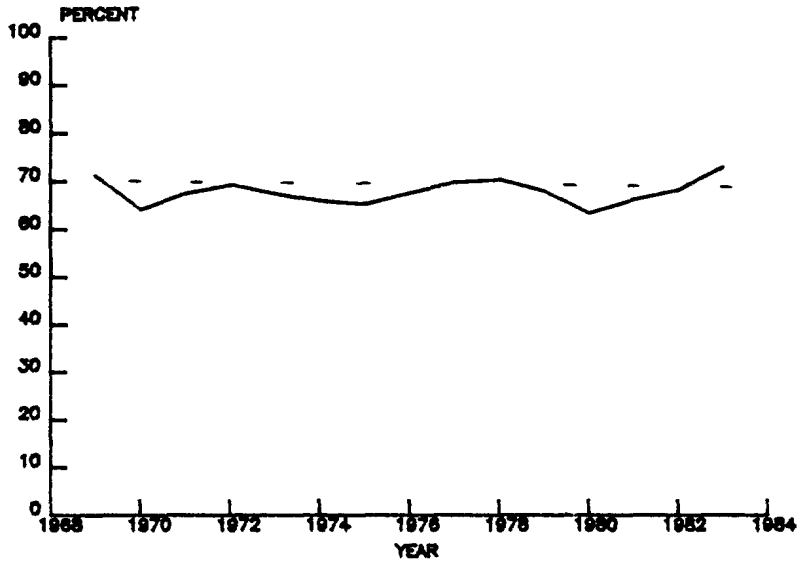
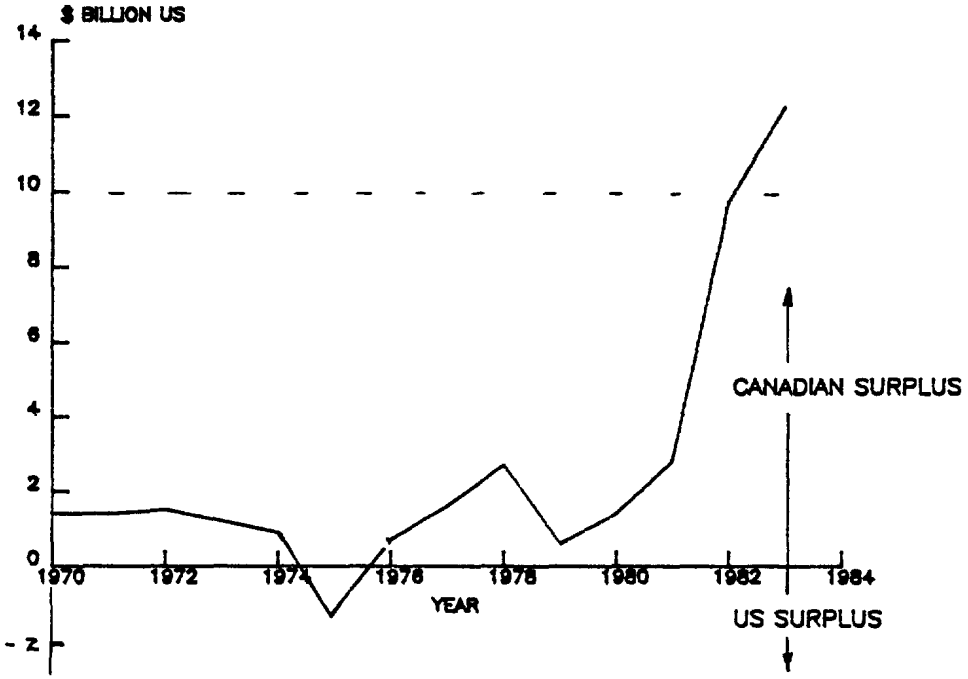


FIGURE 39

CANADA–US BALANCE OF PAYMENTS



FOOTNOTES

1. Monthly Bulletin of Statistics. New York, Dept. of International Economic and Social Affairs, Statistical Office, United Nations, Vol. 38, No. 1, January 1984.

2. Based on Table 7A, Annex.

3. How to Survive and Enhance Canadian Access to Export Markets, Government of Canada Discussion Paper 1985, p. 1.

4. Based on Table 7, Annex.

5. This group includes Japan, South Korea, China, Northeast Asia and Southeast Asia. See Table 7, Annex.

6. Detailed statistics are in Tables 7G, 7H of the Annex. A deeper study of self-sufficiency would have to examine net imports as well as total imports, total production, total energy consumption and total resources.

7. Canadian Energy, Supply and Demand 1983-2005, National Energy Board, September, 1984, Figure 7-10, p. 85.

8. See Figure 16, this report.

9. Based on Tables 7A and 7B, Annex, respectively.

CHAPTER 9

CANADIAN INVESTMENT ABROAD

INTRODUCTION

213. Canadians are active participants in international investment. This chapter delineates the extent of Canada's long-term investment in other countries.

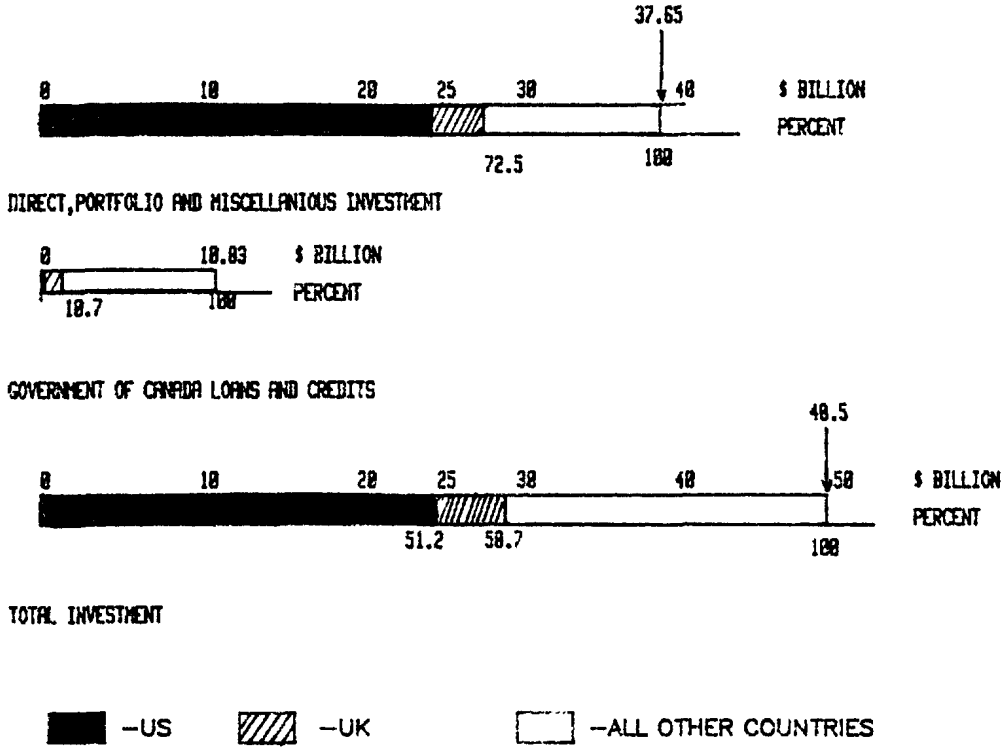
LONG-TERM INVESTMENT ABROAD

214. Canadian long-term investment abroad was valued at 48.5 billion Canadian dollars in 1980,1 some 16.3 percent of the size of the annual GNP. Direct investment at $25.8 billion comprised 53 percent of this total, portfolio and miscellaneous investments contributed another 25 percent, while the balance was made up of Government of Canada loans to developing countries, export credits, and subscriptions to international financial agencies.

215. The composition of Canadian long-term investment by type of investment and location is displayed in Figure 40. Direct, portfolio and miscellaneous investments were heavily concentrated in the US and UK (72.5 per cent). Government of Canada credits, loans and subscriptions exhibit, not unexpectedly, an opposite pattern with almost 90 percent going to countries other than the US and UK.

FIGURE 40

CANADIAN LONG-TERM INVESTMENT ABROAD



DIRECT INVESTMENT

216. A foreign direct investment is any foreign investment in which the investor holds anywhere from 51 percent to 100 percent of the equity.[2] Direct investment implies management responsibility. This power to make or to influence economic

decisions and priorities can be a source of friction between multi-national enterprises and host governments. Under some circumstances such as political instability, foreign exchange crisis, or coming to power of a government motivated by a socialist philosophy, foreign direct investment may become vulnerable to nationalization.

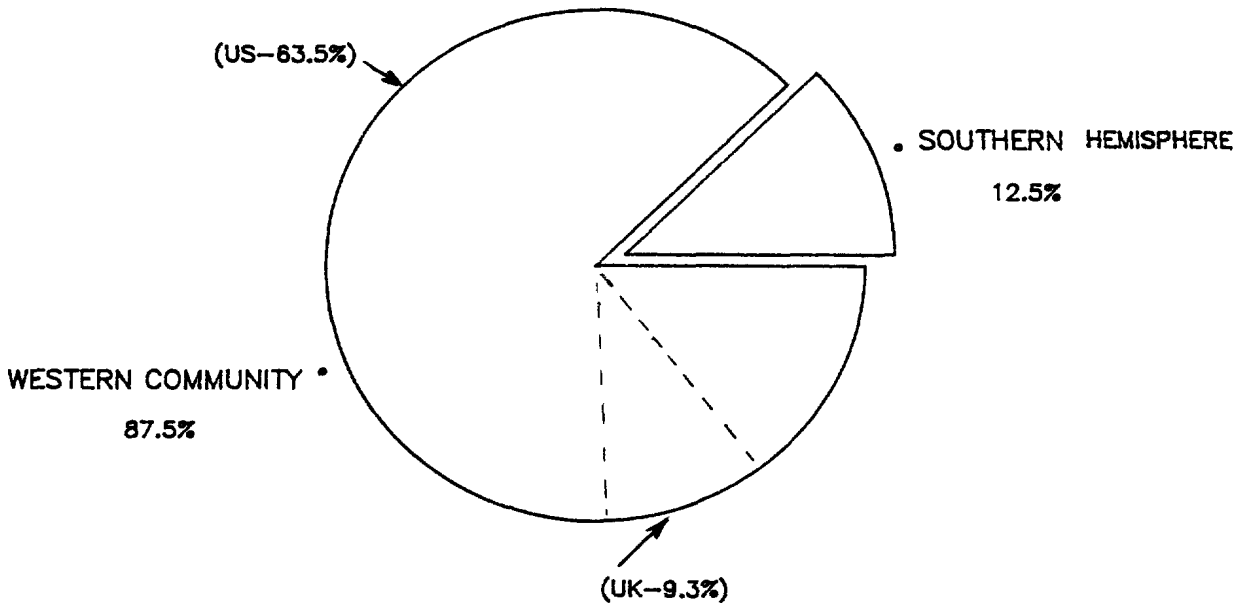
217. The distribution of Canadian direct investment abroad in 1980 is portrayed in Figure 41 below. Canadians invested almost nine times as much in the Western Community countries as in the Southern Hemisphere. The United States was the prime location for investment accounting for $16,395 million or 64 percent of total direct investment. The United Kingdom at $2,405 million was the second largest host country. Next in order of importance were Bermuda ($993 million), Australia ($675 million), Brazil ($585 million) and Indonesia ($570 million). These six countries accounted for eighty-four percent of total Canadian direct investment.3

218. Investment in developing countries was 17 percent of total direct investment abroad. Of the total $4,267 million invested in developing countries at the end of 1980, more than 40 percent was invested in the Caribbean ($1,764 million). Investment in South and Central America amounted to $1,034 million while developing countries in Asia stood at $982 million.

219. Direct investment statistics for 1981 show a sharp increase in investment abroad, from $25.8 billion at the end of 1980 to $32.7 billion at the end of 1981. Three quarters of this increase ($5.2 billion out of $6.9 billion) is accounted for by the investment in the US, increasing further that country's share of Canadian investment capital (66 percent in 1981 vice 64 percent in 1980), and explains proportional decrease in shares of investment in other locations.

FIGURE 41

CANADIAN DIRECT INVESTMENT ABROAD



1980–$25.8 BILLION(CDN)

FOOTNOTES

1. 1980 is the latest year for which complete and final statistics on long-term investment are published. For direct investment only, detailed statistics are available for 1981 and will be used. See Tables 8, 8A, Annex.

2. Portfolio investment is any foreign investment where the investor holds less than 51 percent of the equity.

3. For the 15 year period (1967-1981) top ten investment locations were: US, UK, Brazil, Australia, Bermuda, Bahamas, France, West Germany, Indonesia, and Jamaica.

CHAPTER 10

CONCLUSION

220. This report has dealt with some of the major measurable dimensions of the global strategic environment. It has aimed to show the world in figures and to portray patterns of relations among those power variables whose influence is critical and long-term.

221. The picture of the world presented here is not complete. The reasons for this lie at the very root of the global strategic environment. The world and the world of power are complex phenomena, they belie simple characterization and reduction to numbers. Power is relative, dynamic, and the product of many interacting factors. Power is potential as well as actual. Its human dimension is pre-eminent, yet least quantifiable.

222. Nevertheless, the powerful influence of people, geography, economics, technology and military forces on political fortunes and aspirations of nations is undeniable. Delineation of quantitative components of the global strategic environment matters, for these factors must be taken into account and used by those who try to shape the future. Karl Marx summed up best the role of factors and forces such as these in his famous aphorism: "Men make their own history, but they do not make it just as they please."

223. The long and bitter history of mankind shows that men cannot interact without quarrelling. But, as Cicero wisely observed long ago,

> There are two ways of settling disputed questions; one by discussion, the other by force. The first being characteristic of man, the second of brutes, we should have recourse to the latter only if the former fails.[1]

Since men are both rational and animal, they can make peace or war. To reduce the threat of nuclear war and to secure peace with freedom and justice will require all of the reason, vision, and goodwill that men can muster.

224. This combination of realism, creativity, and idealism has not been particularly abundant in history. It is needed now, more than ever before. Time must be gained to bridge the enormous gap between the destructive capabilities of existing weapons and the political institutions that must control them. It is a task in which man must not fail. The Earth might then continue as a Living Planet on its infinite journey through the stars.

FOOTNOTE

1. Mortimer J. Adler, How to Think about War and Peace, (New York: Simon and Shuster, 1944), pp. 67, 68.

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