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April 1974

National Security and Export Controls

Robert E. Klitgaard

A Report prepared for

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
AND
COUNCIL ON INTERNATIONAL ECONOMIC POLICY

Rand
SANTA MONICA, CA. 90406

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PREFACE

This study, one of a series of Rand reports on international technology exchange with communist countries, was sponsored by the Defense Advanced Research Projects Agency and the White House Council on International Economic Policy. It deals specifically with ways in which trade with a military competitor may be harmful to national security, using the case of computer sales to illustrate its theoretical propositions. Other Rand reports in the series are:

Leites, Nathan, *The New Economic Togetherness: American and Soviet Reactions*, R-1369-ARPA (forthcoming).

Stein, John Picard, *Estimating the Market for Computers in the Soviet Union and Eastern Europe*, R-1406-ARPA/CIEP, May 1974.

DeHaven, James C., *Technology Exchange--Import Possibilities from the USSR*, R-1414-ARPA, April 1974.

Wolf, Charles Jr., *U.S. Technology Exchange with the Soviet Union: A Summary Report*, R-1520/1-ARPA (forthcoming).

This report examines the logic of export controls--the rationale for restricting some goods but not others in the context of expanded East-West trade and current defense policy. It should be useful to policymakers charged with the derivation of control lists and the assessment of particular exception requests, especially those in the National Security Council and the Departments of Commerce, Defense, and State.

SUMMARY

Computers have an economic value recognized by the Soviet Chairman (who wants to import them) and the IBM Chairman (who wants to impart them). But some data processing equipment is also alleged to have military implications that warrant governmental restrictions on its sale to actual or potential adversaries. In a time of rapidly expanding East-West trade, should the West continue multilateral export controls? Does it make sense to ban the sale of certain commodities to communist countries while making a strenuous effort to expand and even to subsidize the sale of others? If it does, how should the list of restricted goods be derived?

The policy problem is to structure and to manage the tradeoff between our benefits from trade and the adverse implications of theirs: a problem briefly stated, yet difficult to specify. Complexities of international politics and technological assessment probably dominate the problem. But both policymakers and academics have frequently and incorrectly considered quite general propositions about the gains or losses from trade as conclusive arguments for or against East-West trade. The tradeoff between economic benefits, political effects, and national security risks has often been overlooked or oversimplified--both in the history of export controls and in the writings of economists.

This report proposes a reassessment of export control policy--and of trade with an adversary. There are three central issues:

1. What effects do our exports have on the adversary?
2. How do these effects in turn affect us, and what direct benefits do we obtain by exporting?
3. What can export controls do about questions 1 and 2--and what other ramifications do controls have besides restricting sales?

EFFECTS ON THE ADVERSARY

Suppose our exports can go to two different sectors of his economy (military or civilian) and can have two different kinds of effects in

either sector ("resource-freeing" or "capability-enhancing"). Only gains in his military sector create a negative "externality" for us. In addition to effects on *capabilities* in either sector, our exports may also change our adversary's *desire* to allocate resources to his military. The questions then are: (1) How do our exports free his resources, and how do such resources affect his military capabilities? (2) How might certain exports enhance capabilities in ways that increased resources cannot? (3) What about the "political" benefits from trade, where the fact that we export is alleged to reduce the adversary's desire to be militarily menacing?

It is difficult to justify a selective embargo solely on the logic of resource-freeing gains from trade. Some goods may enable the adversary to free more resources than others, but at present, COCOM export controls allow unlimited exports of most goods (and thus, in theory, unlimited resource savings) to whatever user in whatever country. In addition, if resources are fungible, neither the type of good we export (for example, military or civilian products) nor the end-user (for example, the army or the agricultural) really matter: The total *amount* of resources freed by our exports is the only important dimension for our policy. Possible decision rules under such circumstances are discussed, as are objections to the assumption of perfect fungibility of resources.

But certain exports may enhance an adversary's capabilities in ways that increased resources cannot. The logic of capability-enhancing gains from trade is discussed, and criteria are derived for assessing export restrictions along such grounds. These criteria are applied in a qualitative way to the case of large computers, one of the most controversial of the currently controlled commodities. This application is instructive but not definitive, since the case is fraught with technological and military complexity; in lieu of final answers, it provides an illustration of how particular export control questions should be approached. This case should provide a useful structure for further infusions of information.

Much has been made of the political benefits of trade--for example, the claim that commercial interactions may create a less hostile

atmosphere, leading to a reduction in the adversary's military strength or a diminished desire by him to use it. Skeptics on these matters also abound. This question is difficult to analyze in the abstract since it depends on detailed information about their policymakers and ours; and it is hard (and perhaps inappropriate) to generalize from past history. An agnostic conclusion is reached.

EFFECTS ON US

There may be various effects on the adversary, but what effect do our exports have on us? Two are paramount: military externalities and the economic benefits from increased sales.

Militarily, many treatments of export controls and technological gaps assume or imply a simplistic view of the effects of an adversary's gain on our security. There is, however, no simple "exchange rate" between his gains and our losses. The implication for export control policy is that we must forgo "gapmanship" and proceed to the details of particular cases; we must consider military importance, not just military or technological enhancement, when deriving control lists and allowing exceptions.

Economically, the restrictive effects of export controls are hard to assess empirically. Stein (1974) has provided the most interesting estimate to date, an upper bound on potential computer sales. His result carries the implication that the economic gains from looser export controls would not be large.

The important point for U.S. policy is that *neither the military externalities nor the economic benefit of exports have been correctly incorporated into list reviews or exception request decisions*. Precedents, rather than systematic analyses, predominate.

THE EFFECTS OF EXPORT CONTROLS

How can export controls be used as a policy instrument? Three issues arise here: Are controls *effective* in curtailing the flow of restricted commodities? Are they *efficient*, compared to alternative policies like export taxes or quotas? And what *other effects* do they have besides their intended ones?

The embargo is not effective in any absolute sense, although of course, it is difficult to measure the magnitude of illicit flows. It is clear that much "technology" is transferred through noncommercial channels. The most important technologies relative to possible military "breakthroughs" (basic science, classified research, and the "technology of the laboratory") are probably not those that export controls affect (the "technology of the factory"). The embargo may constrain the flow of restricted goods, but the degree to which it does and the degree to which the justification for an embargo depends on absolute effectiveness are almost impossible to assess accurately.

An embargo is not as efficient, in theory, as an export tax or quota, but for a variety of administrative reasons, it is probably preferable in practice.

As to other possible effects of the embargo besides restricting exports, there are many--and they may be important. The actual and potential uses of export control decisions as political signals, an insurance policy, or a bargaining chip may, in fact, dominate the export control issue as it is currently viewed.

IMPLICATIONS FOR U.S. POLICY

Section VI recommends a reconsideration of U.S. export control policy. Currently, it is considered sufficient reason to restrict a good if two questions can be answered affirmatively: (1) Does the good have military uses? (2) Is it not producible or obtainable in communist countries? These questions do not adequately assess the existence or the magnitude of possible security risks of Western exports, nor does the present export control process systematically incorporate economic and political considerations. The following three kinds of improvements are suggested:

- *Redefining the criteria.* Given the rest of current U.S. East-West trade policy, selective export controls that embargo some goods but allow others to flow in unlimited quantities must depend for their justification on the qualitative, capability-enhancing differences between the restricted and unrestricted

goods. The difference cannot be merely one of technological sophistication, for it is military enhancement that threatens the West. And not all military enhancements, especially in a multipolar world, increase security risks. To justify restrictions, the effect of our export must be militarily important, not just a military addition, given the rest of our trade policy. As a consequence, list reviews and exception requests must go beyond mere technological assessment. A set of appropriate questions to be answered for export control decisions is provided, along with recommendations about who in the U.S. government might help provide the answers.

- *Incorporating economic considerations*. The magnitude of potential sales of restricted goods should be included in the export control decision process, particularly during list reviews. Suggestions for estimating potential sales are given.
- *Considering the broader political uses of export controls*. The current export control process is carried out by middle-level officials spread across various departments. As a result, advocacy predominates, and the locus of concern is the narrow (if important) question of drawing the appropriate lines between permissible and restricted goods. But this process omits what could be the dominant considerations in export control policy: (1) the use of the embargo as a *bargaining chip* in the larger arena of East-West relations and (2) trade decisions as a *signalling device*. Both of these broad issues require high-level attention; both shift the policy focus dramatically from the present perspective. For example, the bargaining chip approach may imply a dramatic relaxation of export controls; the signalling approach may require retaining (or even lengthening) control lists and looking hard at improved and more extensive end-use safeguards.

ACKNOWLEDGMENTS

Interviews with officials of the Departments of Commerce, Defense, and State and the National Security Council in April, September, and November of 1973 and February of 1974 were invaluable sources of information; I am particularly indebted to Maurice Mountain of Defense for his expertise and encouragement. Discussions with Allen Barbour, Abraham Becker, Barry Boehm, Irving Cohen, Philip Dadant, John Despres, Edmund Dews, John Farquhar, Alvin Harman, Mario Juncosa, Donald Kosy, Donald Lewis, David McGarvey, Gary Mills, Jack Muckstadt, Nancy Nimitz, Theodore Parker, James Rosen, Hyman Shulman, Rein Turn, and Willis Ware, provided the basis for the assessment of the importance of better computers for the Soviet military. Charles Wolf, Jr., productively pummeled earlier drafts, leading to major improvements but perhaps not as many as he hoped. Arthur Alexander, Barry Boehm, John Despres, Victor Jackson, Ross Johnson, Mario Juncosa, Donald Kosy, Nathan Leites, Henry Rowen, Hyman Shulman, John Stein, Rein Turn, Willis Ware, and Albert Wohlstetter also provided useful comments. I must report that some of their objections have not been satisfied, and the usual caveat protecting these courteous people from further responsibility is, of course, in order.

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I. INTRODUCTION

Senator Claiborne Pell recently rebuked an Administration witness who had invoked the specter of communism to justify foreign aid. "That to my mind was a very valid *raison d'etre* for the AID program for maybe 20 years, but we are moving along," the Senator remarked. "Apparently communism is still an awful and lousy system, but we do not seem to be quite as concerned about it as we were."*

That Senator Pell argues from the fact that, rather than the reasons why, U.S. concern has seemed to lessen, is typical of situations where events and policy shifts outrace our ability to understand them. East-West economic relations have changed so rapidly that legislators, bureaucrats, and concerned citizens sometimes wonder what realities have changed to justify the high-level diplomatic initiatives; and long-standing feelings--as well as long-standing bureaucratic routines--against "trade with the enemy" and against support of "awful and lousy systems" are difficult to alter on a moment's notice. U.S. exports to the Soviet Union jumped about threefold in 1972, and through September 1973 the pace has been another three times higher, up to an annual rate of $1.3 billion. A U.S.-USSR Joint Commission on Scientific and Technical Cooperation has already approved over 25 action programs of cooperative R&D in six general areas, including computers and magnetohydrodynamics. The flow of U.S. trade with China for 1973 was $800 to $900 million, some ten times higher than 1972. Yet in the midst of all this change, the United States has been responsible for the maintenance of multilateral export controls, where many of the most commercially desirable goods, including some computers, magnetohydrodynamic equipment, telecommunications gear, and integrated circuits, are still restricted from export to the communist world.†

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*Senate Committee on Foreign Relations (1973, p. 139).

†Defined as Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, North Korea, North Vietnam, Outer Mongolia, People's Republic of China, Poland, Rumania, and the Soviet Union.

Multilateral trade controls have come under increasing attack from a number of quarters, not least the other countries who administer them. Our allies consistently badger for fewer restrictions, motivated in part by the greater role foreign trade plays and would play, if expanded, in their economies. Members have actually bolted the COCOM* structure more than once to make restricted sales, and some have occasionally threatened to withdraw if particular concessions were not made. Other countries have criticized U.S. sales that seemed inconsistent with earlier U.S. COCOM vetoes--for example, contracts for the Kama River truck plant in the Soviet Union and the satellite ground stations left behind after President Nixon's visit to China. In short, our allies often criticize trade controls as a cold war legacy that is inconsistent with détente and is merely a means of controlling European exporters until American firms can arrange the same transactions.

Many U.S. business firms have also attacked trade controls. The favorite target has been the U.S. unilateral Commodity Control List (CCL), traditionally lengthier than the COCOM list; but in May 1973, the CCL was drastically pared to near the COCOM level. The reduction was in response to strong Congressional pressure aimed at ensuring that the United States was not merely restricting items obtainable from other sources, in which case, it was argued, the only loser would be U.S. industry. But the COCOM list is still felt by businessmen to impair many potentially large sales items. In 1968, Hewlitt-Packard estimated that 44 percent of its worldwide sales were in products on the COCOM list.† Computer manufacturers feel that controls on larger, faster machines discriminate against U.S. firms, which enjoy a comparative advantage in such equipment. About 50 percent of commercially useful integrated circuits are banned under COCOM.

Finally, of course, the Soviets, Chinese, and Eastern Europeans have desired the removal of export controls, though they have not often expressed this in vociferous public critiques. The Soviets especially want advanced computer technology, feeling that large quantities of

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*COCOM stands for "Consultative Group-Coordinating Committee," the body that administers multilateral export controls.

†Wolf (1973b, p. 117).

sophisticated western equipment, including software, could aid in national planning and industrial management. The Soviet Union has given computers a high priority in recent years, and Western computer firms have been approached for direct assistance on fourth-generation computers,* for the construction of enroute and terminal systems for Kiev, Rostov, and Moscow airports (including radar and communications),† and for help in "using newest information systems for control purposes in industry, scientific research, and trade."‡ In 1972, China became the leading importer of embargoed goods (working through exception requests, where all COCOM nations agree that particular sales of restricted items are permissible). Even after the 1971-1972 COCOM list reduction, the number of exception requests still soared upwards; four out of five of the requests were in the electronics and precision instruments fields. The demand, and therefore the pressure for liberalization, is strong.

The principal result of these pressures has been significant reductions in both the CCL and the COCOM lists. The mood of much of the Commerce Department is sales expansion, and licenses have been granted in the past year for exports to the communist countries that would have been unthinkable even three years ago. The U.S. only vetoed 14 exception requests in COCOM in 1972, representing lost sales of less than $2 million, even though many of the over 1000 cases submitted included items that would certainly have been vetoed a few years back. The U.S. unilateral control list is virtually gone.**

Even these changes have not quieted the critics. The 1974-1975 COCOM list review, for which preliminary negotiations have already begun, promises to be a controversial one. Several European countries

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*_east-west_ (1973, p. 6).

†Specs were given to five U.S. firms--IBM, Raytheon, Sperry-Univac, Texas Instruments, and Lockheed Electronics-by the USSR Ministry of Civil Aviation, July 1973 (Harford and Grey, 1973).

‡_Socialist Industry_, cited in _Soviet Cybernetics Review_ (1973, p. 3), referring to cooperation with Arthur Andersen & Company.

**Only some 70 items in excess of the COCOM list remain; most of these have limited commercial importance. See U.S. Department of Commerce (1973).

have proposed "new criteria" for assessing the permissibility of exports; one country has even reportedly suggested selling military aircraft to Eastern Europe and China. While no one favors the complete elimination of multilateral export controls, it publicly will become more and more difficult to justify the embargo of certain commodities while others go unfettered. So much relaxation has taken place already that businessmen in the COCOM countries, as well as interested governments in the East and West, have lost their "case law" definitions of what a "strategic" good might be; and precedents are no longer enough. The whole logic of the embargo needs reexamination and restatement in light of recent events.

This report attempts to set forth some of the analytics of export controls in the context of current East-West trade relations. The central issue of export control policy concerns the tradeoff between economic benefits and national security risks. To make that tradeoff in a reasonably systematic way, one needs to answer several questions:

1. How do our exports affect the adversary's military capabilities?
2. How do our exports (and their effects on the adversary) affect us?
3. What can export controls do about those effects? And what other effects do export controls have, or could they have?

Sections II and III consider the first question. Section II summarizes the somewhat unsuccessful attempts by academics and export control policymakers to structure the economics/national security tradeoff in a useful and systematic way. Section III considers the effects of our exports on the adversary: in particular, their effects on his ability and desire to procure military capabilities.

Section IV considers the second question. *Militarily*, the adversary's gains may hurt us, but there is no simple metric, such as a "gap" in time or money or technological capabilities, that tells us how much. *Economically*, our gains are also hard to estimate, but they are probably relatively small.

Section V considers the third question: the *effectiveness* of an embargo in curtailing the flow of Western goods and technology and the *efficiency* of an embargo compared with alternative restrictive policies like taxes or quotas. Section V also examines the other effects, intended or accidental, that export controls have or could have. Some of these effects, frequently overlooked, may dominate the issues that currently receive the most attention in export control deliberations.

Finally, Section VI attempts to derive conclusions for U.S. policy.

II. THE TRADEOFF BETWEEN ECONOMICS AND NATIONAL SECURITY

Computers have an economic value recognized by the Soviet Chairman (who wants to procure them) and the IBM Chairman (who wants to provide them). But some data processing equipment is also alleged to have military implications that warrant governmental control over their sale to actual or potential adversaries. Export controls exist because of the belief that unrestricted private sales to communist countries may not be in the public interest. Private sellers pursuing profit will, from a national point of view, undervalue the security risks of their own transactions. Exports of some goods are thus argued to create an "externality" that justifies export controls by the state.

Trade with military competitors, while helping our economy, also helps them, and we may not want that. The policy problem is to structure and to manage the tradeoff between our benefits and the adverse implications of theirs: a problem briefly stated, yet difficult to specify. Export control policy is instructive precisely because its 25-year history of justifications and decisions sheds light on how policies involving both economics and national security have been analyzed--and misanalyzed.

Many government policies besides export controls are concerned explicitly or implicitly with the connection, and often the tradeoff, between economic benefits and national security risks. It might be argued that all defense policies must make the tradeoff, since weapons and their accompaniments are costly. Similarly, policies that increase economic strength also contribute to national security--by enabling the nation to afford military preparedness, to withstand the costs of potential war (and perhaps thereby to deter it), to decrease dependency on potentially hostile sources of critical economic inputs, to provide the industrial and technological base for qualitative improvements in weaponry. It is a truism that a nation's power is not measured solely in military terms, that its ability to coerce or threaten (or withstand either) may, especially in the absence of hot war, be more related to

economic strength than strength of arms. The recent use of petroleum sales by Arab countries is often cited as a case in point. And it is sometimes alleged that the ultimate motive for defense policies is economic: whether to protect the free enterprise system from its opponents or to insure the success of neo-imperialist business ventures abroad.

More specifically, one might imagine--and nations have*--a multitude of economic policies relating to "war and threats of war, international distrust, extortion, subversion, and defenses against them": including embargoes, boycotts, preclusive buying, dumping, counterfeiting, monetary agreements, even foreign aid grants designed to strengthen an ally's resistance to revolution or aggression.† And many military measures might have as a major objective the support or destruction of economic interests: for example, strategic bombing, protecting foreign investment, even deciding where to locate certain defense factories and industries.

The export control issue is not this broad. The current policy of controls on exports to communist countries deals with only one kind of economic measure (controlling international commercial transactions) pursued for one national security motive (in the words of the most recent version of the Export Administration Act," . . . to restrict the export of goods and technology which would make a significant contribution to the military potential of any other nation or nations which would prove detrimental to the national security of the United States.")‡ Export control policy confines itself to deciding, at a particular time, which commodities can and should be restricted from export to which buyers, to what degree, by which countries, and for how long.

Export control policy is, therefore, only one member of a larger set of questions involving both economics and national security. Still

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*See Yuan-li Wu (1952).

†Schelling (1958, pp. 487-488).

‡Export Administration Act of 1969, Sec. 3(1).

even this relatively narrow policy problem requires, for a comprehensive analysis of potential risks and benefits, answers to the most complex questions of international politics and technological assessment. The problems of estimation--the subjectivity of many key parameters, the detail needed to evaluate others--are awesome. *International politics* enters because security risks are a function of intentions as well as capabilities. Since others' intentions may depend partly on our own, and since mutual perceptions of reality are what matter, the recursive calculations of costs and benefits, of influence and resolve, cannot be separated from questions of broad value judgments and minute details about particular personalities. Subjective factors--ambience, will, appearance--may dominate; they can become the crux both of passive estimations of risk and active policies to reduce it.

Technological assessments enter because of the nature of most of the currently restricted commodities. Most are dual-use (i.e., military and civilian) goods representing the state of the art in particular technologies. There is a wide variety of restricted categories of goods (over 400); and several categories, so called "broad basket" items, contain thousands of individual product types (for example, restricted chemicals). To assess the security risks and economic benefits that would accrue from free trade in each commodity clearly requires extensive scientific and economic knowledge.

This complexity clearly limits what one study can contribute to the export control discussion. This report is certainly not a conclusive treatment of the gains and losses. Often, however, analyses or explanations of export control policy have considered quite general arguments to be conclusive. "Never mind details about intentions or technologies," one might caricature these treatments, "the point is that the adversary gains (or we gain, or we both gain), and therefore free trade should be restricted in certain ways (or allowed to proceed untrammelled)." The crux of many disagreements stems from different ways of conceiving of the gains and losses from trade, not from detailed assessments of the relevant political and technological factors.

The first task seems to be to unpack some of these different conceptions, in order to discover how we and our adversary are affected

by our exports to him. Then we can attempt to deal with the complex pros and cons of current export control policy more clearly.

GENERAL APPROACHES TO GAINS FROM TRADE

One approach to assessing gains from trade might be called the *macro* approach. Borrowing from the theory of international trade, the macro approach sets up the problem as one of *nations* trading with one another according to the principle of comparative advantage. The protrade version of this approach cites the fact that trade leads to gains for oneself. Often this is seen as a sufficient justification; sometimes the further knowledge that, under certain conditions, universal free trade maximizes world welfare is adduced as an additional comforting fact.

The antitrade position points out that trade implies dependency. If demand is inelastic, and especially if the good imported is important to one's economy, then dependency may imply a vulnerability to threats of cutting off the supply. As a further argument, it is sometimes noted that the free trader's conditions for a world optimum are not fulfilled in reality, that therefore deviations from *laissez faire* may be nationally and universally desirable. What is for the protrade position an economic benefit is for the antitrade view a potential tool for extortion or destruction.*

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*Sometimes pros and cons reduce to debates over who the most able traders are. The protrade side claims that our side would never willingly give away more than we received. Harold Stassen, then Director of the Foreign Operations Administration, told the Senate Foreign Relations Committee in 1954 that

> Whatever is shipped in, it is agreed that the free world insists on getting something out. So their economy has to send something out the free world wants, has to mine it or produce it and ship it out in order to get something back in. Consequently, the net advantage, if the free world nations are able traders, which I believe they are, will be with the free world.

The antitrade side sees things just the other way. In 1955, economist Jacob Viner testified as follows:

A second approach, the *micro* perspective, focuses on the actual firms and organizations that carry out international trade. It admits that analyses of comparative costs have their place, but avers that the major determinant of a nation's gains is the way that transnational and subnational interests created by trade enhance or inhibit national autonomy and welfare.

The protrade micro view sees trade to be beneficial in at least five ways: (1) by promoting "contacts" that in turn imply better communication, mutual esteem, and more effective "penetration" of the adversary's system; (2) by providing mutually beneficial interaction whose aura is likely to improve relations in the more conflictive domains of politics and security; (3) by fostering the adversary's convergence to our own economic practices; (4) by creating transnational linkages, thereby spinning a stabilizing "web of vested interests"; and (5) by speeding the adversary's development, thus reducing his hostility and need for expansionary policies.*

The antitrade micro version denies these benefits, or even turns the causal arrow the other way. Trade enables the adversary to penetrate our system and induces our own convergence to alien economics--both presumably undesirable. The alleged mutually beneficial ties actually restrict national sovereignty; stabilizing webs turn out to be constraining webs; and anyway, the ability of microcontacts to prevent macroconflicts is historically disconfirmed.†

Thus, gains from trade have not only been analyzed in different ways, but within each approach there are arguments for favoring and

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> Whatever East-West trade does occur, I am sure has been scrutinized by the Russians in a cynical, realistic, and probably able manner. . . [The Russians] are in a position to make clear-cut cold-war decisions. They are adequately security-conscious, or aggression-conscious, and if they permit any trade to occur, it must be because they have concluded that it is to their military advantage.

Both quotations are cited by Osgood (1957, p. 104).

*See Leites (1974).

†Before World War I, France and Germany were each other's chief trading partners; the U.S. was Japan's before Pearl Harbor.

opposing trade with adversaries. Nathan Leites (1974) describes five stages through which U.S. views about trade with the enemy have advanced:

> *Phase 1 (High cold war)*: As soon as a transaction would procure economic gain to communists--and which would not?--it's a transaction--one should abstain from it.
> *Phase 2 (Low cold war)*: If our economic gain were to exceed theirs, we may engage in a transaction with them.
> *Phase 3 (Low détente)*: Never mind how small our economic gain and how large theirs; as soon as there is political gain (but determined by whom?) from a transaction, it should be undertaken.
> *Phase 4 (High détente)*: Never mind how large (within limits) our economic loss and how big their economic gain, as long as there is a political gain--or an avoidance of political loss, which might be substantial.
> *Phase 5 (Normalcy achieved)*: Never mind our or their political gains or their economic gains; as soon as there is economic gain for us we should do it; and the greater their economic gain, the greater the future political gain for us.

Serious analyses and formal models of these divergent approaches with regard to trade with an adversary are rare. Nonetheless, there are several relevant studies by economists. Also, one can consider the pattern of justification and actions on the part of U.S. export control policymakers as constituting a *de facto* analysis of gains from trade. First, let us look at the way export control decisions are currently made and the implicit criteria used; then, we shall examine some simple economic models of trade with an adversary.

THE ECONOMICS/NATIONAL SECURITY TRADEOFF AS STRUCTURED BY EXPORT CONTROL POLICYMAKERS

Students of export control policy, as well as many of the policymakers themselves, agree that systematic thinking about the costs and benefits of East-West trade restrictions have been rare. A coherent and complete justification for restricting some exports but not others does not exist.* In part, this lack may reflect the diffuse

*The lengthiest study of export control policy (Adler-Karlsson, 1968) concludes "But nowhere in the discussions, or in the scant

organizational responsibility for export control decisionmaking in the United States. Commerce, State, and Defense are the major departments involved. Commerce is in charge of the U.S. CCL, State runs the U.S. side of COCOM, but in both cases, interagency committees make the decisions. Each agency plays an advocacy role, emphasizing the economic, political, and security aspects respectively. The interagency committees,

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literature dealing with these actions, is it possible to find a consistent and rational argument attempting to show what the embargo should, or, with some degree of probability, could accomplish." (p. 31; see also p. 111). Wolf (1973b) also reviewed U.S. views and summarized his findings in this sentence:

> The basic conclusion which emerged from our analysis of U.S. East-West trade policies is that in the beginning they were in part based on some erroneous assumptions, that once these policies were established, however, the problem of "what is an optimum policy" was largely ignored, and that it has been only recently, in response to emerging economic pressures as well as to growing East-West détente, that major steps have been taken to bring these trade policies into line with present international economic and political realities, and to begin to move towards something that could be loosely called an "optimum" set of policies. (pp. xix-xx)

It is not surprising that academics despair at a lack of systematization; they do, often irrelevantly, in many areas of governmental decisionmaking. In the case of export controls, however, the officials themselves have often complained, especially recently, about the lack of a coherent U.S. rationale for restriction and permission. I have examined many government working documents and position papers dating back to the inception of COCOM. In the early days there were some partial attempts at developing systematic considerations of costs and benefits; for example, calling for elaborate input-output models of the Soviet economy to decide which goods the USSR needed most. But in recent years--especially with the loosening that has taken place under the Nixon Administration--one finds predictable advocacy by particular agencies alongside increasing mention of the need for a coherent policy. According to one Defense Department official, the White House has often been asked, without success, to give "the precise criteria U.S. departments and agencies should use in implementing the Export Administration Act of 1969" (interview, September 1973). Malcolm Currie, Director of Defense Research and Engineering, recently said, "I believe this is an issue of national importance. We need clarification of our national policy, and I will work toward that end." (Currie, 1974, p. 9) Such sentiments are not surprising when precedents break down and change makes previous informal understandings seem outdated.

made up of middle-level officials, compose what is in effect the court of first instance for CCL and COCOM decisions. Only occasionally do decisions escalate to higher, more neutral levels: the National Security Council makes rulings when the three departments cannot agree to an answer. In lieu of a systematic logical framework for assessing the tradeoffs involved in East-West trade, a quasi-judicial system has grown up around export controls, where precedent and tradition serve to temper and direct departmental advocacy toward mutually acceptable solutions.

But as these precedents have broken down with recent expansions and high-level policy shifts, the export control system has been left without a coherent rationale for restricting some goods and allowing others. What rationale was implicit before, in the pattern of permissible and restricted exports? What sorts of questions are asked by the export control decisionmaking process? Even if the old dividing lines are no longer accepted, was there an implicit logic behind them that can be reconstructed, perhaps to provide a first step toward deciding what policy should be in the present period of flux?

The History of COCOM

There has not been one, but many control lists over the last 25 years--and many implicit ways of trading off economics and national security. Multilateral export controls were officially established in 1949 under COCOM, which is made up of representatives from Japan and the NATO countries except Iceland. The United States was the instigator. Worried over the military and industrial growth of the communist bloc, the United States induced its allies, first with persuasion and later with explicit threats to withdraw Marshall program aid, to embargo a wide variety of goods from the communists. The arrangement had all the trappings of the Cold War: all negotiations and much documentation about the control list were (and are) classified, no treaty was ever ratified to legitimize or enforce COCOM, and several publicly neutral countries apparently participated "voluntarily." Until 1954--during the lifetime of Stalin and the course of the Korean War--the embargo included military goods and many basic industrial exports (capital goods, raw materials like rubber and copper, and so forth), on the theory that

the latter would build the economic base of the communist war machine. Even an array of civilian consumption goods were restricted--plastic combs, for example--because the availability of such items was thought to stifle the will to revolt.*

By 1952, however, the word "economic warfare" had been replaced by "economic defense," and by 1954, there was great pressure, especially by the Europeans, for fewer controls. Our COCOM allies were (and are) much more dependent on foreign trade for economic growth; their preembargo levels of sales to the East were much higher and the embargo, therefore, represented a proportionally greater sacrifice for them. Stalin's death, the end of the Marshall program, and a growing feeling that the embargo had not worked (the Soviet atomic program was apparently progressing well) all led to the dramatic downward revision in 1954.† Policy thereby shifted from one concerned with the communists' economy, as well as their military, to a "strategic" embargo.‡

A further downward revision occurred in 1958, perhaps deleting or narrowing as many as half the previously restricted goods. Some Europeans now called the remaining controls an insignificant barrier to trade.

But despite further reductions at three year intervals from 1958 to the present, by the late 1960s the commodities that remained embargoed had grown in commercial importance. International List I includes some of the goods most important to modern economies--large computers, integrated circuitry, telecommunications equipment, among others. Many European countries and the Japanese now do consider the COCOM controls a significant barrier--and so do many U.S. companies.

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*Presumably for this reason, sugar-frosted breakfast cereals were embargoed until 1966--although there may have been fear about the military consequences of strategic brands like Sugar Jets and Sugar Pops.

†Apparently 200 of the 450 categories of items "of strategic significance" were "downgraded or otherwise decontrolled." (Adler-Karlsson, 1968, p. 92)

‡The 1954 revision was summarized in the *Financial Times* in this way: "What is important is that the decisions that have been reached establish the principle that the strategic controls are strategic and not an economic blockade." (July 27, 1954; cited in Osgood, 1957, p. 67)

The "Technology Gap" and Export Controls

What is the reasoning behind the existing export controls? We can confine our attention to U.S. views and decisions, since COCOM operates on a veto system and the United States is invariably the spokesman for tighter controls.* Inside the U.S. government there is a diversity of opinion about the communist military threat, the effectiveness of an embargo, and what items should be controlled. But there seems to be substantial agreement on the purposes of export restrictions, though the argument is seldom made systematically.

Current controls are based on the importance of advanced technology in military forces and the existence, partly due to government-sponsored R&D and partly due to differences in industrial capabilities, of a "technology gap" between the United States and the Soviet Union. There is, especially in the Department of Defense, a "strong conviction that it is essential for the U.S. to have a technological base which is superior to that of potential adversaries." (Richardson, 1973). An argument used by the Defense Department to justify export controls runs like this: U.S. defense policy places primary emphasis on deterrence; the success of deterrence rests on a margin of military or technological advantage (thus, for example, the United States spends over $8 billion annually on military R&D); the United States should not, therefore, supply its adversaries through the channels of trade with the wherewithal to reduce that margin. Of course, superior military technology has importance in tactical as well as strategic contexts; the gap is not solely important for deterrence.

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*The veto does not imply absolute control. COCOM does have an override provision where countries may make a sale despite a veto, if they deem the transaction essential for national welfare. This has occurred several times in COCOM history. Despite the U.S. veto power, European complaints and recommendations often carry great weight, as top-level U.S. policymakers wish to avoid spending too much political capital on this narrow issue. Nonetheless, the United States calls the COCOM tune: all requests for list tightening and most resistance to list loosening come from the United States, and on all the exceptions requests in COCOM history that were not allowed, the United States voted yes only once.

The existence of a gap in our favor also is seen as a means of minimizing the risks of technological surprise. "Strategic breakthroughs in weaponry that could negate the strongest defense posture are possible,"* advise the authors of *The Soviet Military Technological Challenge*, in a section headed "The Gravest Danger, Technological Surprise." The potentially destabilizing impact of such advances has long been recognized and feared.† In 1973, the President, the Secretary of Defense, and the Director of Defense Research and Engineering all stressed the importance and unsolved nature of technological breakthroughs (especially, of course, by the other side.)‡ Technological surprise is seen as the worst of the worst cases, with visions of unknown analogues to the atomic monopoly, this time under enemy ownership. Several export control officials said in interviews that the fear of a Soviet technological breakthrough was the major reason for the continued existence of trade controls.

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*The Center for Strategic Studies (1967, p. 11). The quotation continues: "Such breakthroughs could occur in fields apparently without military application where no U.S. requirements for military systems have been established. One of the major war-prevention tasks of technology, then, is to forestall technological surprise."

†Witness Henry Kissinger in 1957:

> There has been a great deal of discussion about the possible consequences of technological breakthroughs which may be achieved by either side, and, given the current rate of technological change, this factor presents a real problem . . . [a]n adverse technological breakthrough is always possible (1957, pp. 118, 128).

In the same year, Jerome Wiesner confessed that

> . . . one of the frightening things to me, and a source of real danger to us, is that some inconceivable development, some new idea, some new scientific insight might give the discoverer a decisive advantage if he chooses to exploit it . . . (cited in The Center for Strategic Studies, 1967, p. 12).

‡Nixon (1973, p. 196); Richardson (1973, p. 27) justified the push for U.S. technological superiority in part as "a hedge against technological surprise;" Foster (1973, *passim*).

The purpose of export controls is to *delay* the communist acquisition of military technology. The goal, as stated in numerous government documents, is not to *deny* that technology forever, since that is impossible; nor is it to increase the monetary *cost* of technological capability, since other East-West trade, now greatly expanded, enables large cost savings by the communist countries. The notion is that certain goods, if exported freely, would provide the communists with technologies unobtainable by them at any price over some relevant time horizon, and this delay in communist procurement makes the U.S. deterrent more credible, insures the superiority of U.S. military forces, and reduces the possibility of technological surprise.

"Technology" is a term of many uses, and it is often left undefined in discussions of export control policy, despite its central role. The basic idea seems to be that technology refers to "qualitative" advances in capability that occur as a function of time and R&D expenditures, among other things. Technology also has aspects of a secret, where the possession of a single exemplar may enable one to extract its technology. Export control officials, interestingly, separate two kinds of technology. What they call the "technology of the laboratory" tends toward pure science; the Soviet Union is considered our equal in most such technologies and our superior in some; and flows of this technology can not easily be affected by government policies, since they occur by way of publications, academic interchanges, and so forth. The "technology of the factory," on the other hand, comprises the practical know-how, machinery, and processes that transform laboratory techniques into industrial production. The Soviets are felt to lag badly in this area, and it is believed that controls on exports, commercial technology transfers, and turn-key plants are effective and feasible governmental steps to impede Soviet progress. Export controls, then, are aimed at preserving the Western lead in the technology of the factory, not at stopping Soviet scientific advances of a less applied sort.

Export Control Decisions

This fundamental objective gets translated into a number of criteria for two sorts of export control decisions: (1) deriving the

lists of restricted items and (2) deciding under what conditions exceptions will be allowed.

List reviews occur every three years, and they last almost two. The arduous process of decisionmaking within and then between governments contains a basic logic of how the goods to be embargoed are identified. Before the international review begins, an interagency committee made up primarily of representatives from the Departments of Commerce, Defense, and State requests certain information from their technological arms and the intelligence services. Basically, two questions are asked: What new technologies (or new applications of existing technologies) have been developed over the last three years that have military uses in the West? How have the technological capabilities of the Soviet Union and its East European allies* grown over the last three years in the technological goods now restricted?

Given this information, the interagency committee and its technical staffs identify goods that (1) are used by the U.S. military† and (2) the communist countries are not capable of producing. It recommends restricting exports that are roughly equal to or above the top of current communist capabilities in these goods.

Exception requests are submitted throughout the year at the weekly meetings of COCOM delegates in Paris. Country representatives request that certain transactions proposed by firms in their countries be allowed, even though they involve restricted commodities. The delegates try to prove that the customer is in the civilian sector and that end-use guarantees have been provided. Over 1000 such requests were made in 1972, representing about $180 million in potential sales. Four out of five requests dealt with electronics and precision instruments; about one in five involved large computers, representing potential sales of over $65 million. Clearly, exception requests are big business.

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*Information about Chinese capabilities is not pursued as vigorously, because the data are felt to be of poorer quality and because China trails the Soviets in every area of technology.

†Often this is described by the percentage of a good's sales within the United States that were to military customers.

Decisions in the U.S. government about exception requests proceed like a miniature legal system, with "case law," "precedents," and "higher courts" to which one can appeal. The adversaries are usually the Department of State (allow) and the Department of Defense (prohibit), with the Department of Commerce generally in favor of exports but often vacillating. The court of first instance is composed of middle-level officials from all three departments, all experts on export controls. "Appeals" are possible to the Assistant Secretary, Secretary, and President levels. The basic question is: Can civilian end-use of the technology be guaranteed? Extraordinary political circumstances sometimes enter, especially when the case escalates to the "higher courts." If end-use safeguards are sufficient and the good has legitimate civilian uses, requests are often allowed.*

The criteria for both list reviews and exception requests have suffered internal breakdown over the past three years. List reviews have resulted in such dramatic changes that no one is quite sure what the current criteria are or should be.† Sales are occurring routinely today that were unmentioned a few years ago. Exception requests have frequently been motivated by high-level diplomatic and political considerations; because of the legalistic nature of COCOM decisionmaking, these exceptional decisions have stood as standards for future decisions. "Case law" has eroded. The results are a growing dissatisfaction among export control officials with the implied purposes and criteria behind current decisions, and recognition of the need for reexamination.

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*End-use safeguards are often byzantine in complexity, sometimes involving actual presence of Western personnel on site. Many goods, however, cannot by their nature have effective end-use controls--for example, integrated circuit production machinery, where the distribution of the products cannot be monitored. Communist countries differ in the degree to which they allow elaborate end-use safeguards. As a result of these facts, exception requests often involve laborious negotiations and lengthy debates about details of the product and the end-user.

†The U.S. CCL included 2700 "items" in 1970; after an item-by-item review in 1971, the number dropped to 1700; in 1972 it fell to 963, and after last May's revision, the number was near 560 (the CCL includes the COCOM list). The COCOM list was reduced by 40 percent in 1968-69 list review, then by another 30 percent in 1971-72.

At the same time as it suffers internal breakdown, the implicit logic of the export control process has come under increasing fire from our COCOM allies. Listening to high-level U.S. lauding of détente and watching the soaring American sales, our allies wonder what the threat is and whether a few computers would help the Soviet Union more than last year's tripling of U.S. exports. Since the Soviets have permitted the most detailed end-use safeguards at their Western-supplied computer facility at Dubna, critics say the same procedure could be followed for many other sales.

The basic problem with current export control logic, however, is not just internal erosion and external critiques. One fears that by concentrating only on Soviet technological gains from trade, we may be overlooking other gains that are more important, or be assuming automatically and incorrectly that every gain in their technology has important military implications. That a good might be used by their defense sector does not mean it will create a military externality (though, of course, it may); that another item can be used only in the civilian sector does not mean it is without military implications. And export control policy has largely continued to treat all communist nations alike--implying, for example, that the military threat to the United States from China is the same as the threat from the Soviet Union.

Moreover, the export control process does not systematically incorporate economic and political aspects of trade into its decisions. It is considered sufficient for restriction that a security risk exist--even if the risk is small and the potential sales large. The tradeoff between economics and national security is not made in any structured way.* Even the law that currently governs export controls considers the problem unidimensionally. The object is

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*In an indirect way, the amounts of pressure for the relaxation of different goods that come from private firms and from other governments reflect their estimation of foregone sales. And in exception requests, of course, the economic value of the proposed sale is known, and it sometimes plays a part in decisionmaking. But within the U.S. government, the economic dimensions of list review and exception request decisions are not traded off with the security and political effects in any structured fashion.

> . . . to restrict the export of goods and technology which would make a significant contribution to the military potential of any other nation or nations which would prove detrimental to the national security of the United States.*

The tradeoff that is central to the problem, then, is not considered explicitly.†

To examine these shortcomings systematically, one needs a framework within which to investigate the different kinds of costs and benefits. The following sections take some simple economic models as first steps toward structuring the tradeoff between economics and national security in a more satisfactory way.

THE ECONOMICS/NATIONAL SECURITY TRADEOFF IN SOME ECONOMIC MODELS

A First Model: His Gains Are Our Losses

The simplest representation of trade with an adversary assumes there is only one enemy and only one dimension of interest: relative economic wealth. (Security and economic considerations are collapsed to a single variable.) Furthermore, the situation is zero-sum. If we trade with him, he gains according to the principle of comparative costs. If he gains, it must mean we lose, as in chess or in situations where the objective is to maximize the difference between our wealth and his.‡ However, we also increase our wealth by trading with him.

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*Export Administration Act of 1969 (Sec. 3(1)).

†Other policymakers in the U.S. government clearly do have the economic aspects of East-West trade in mind. These remarks apply to the export control decision process alone.

‡Bishop (1960) has each duopolist maximize the difference between his rival's profit, and a zero-sum game of economic warfare ensues. Osgood (1957) makes relative economic power the maximand in his model of East-West trade. Gift (1969) considers different relative economic objectives, such as maximizing the absolute difference or the ratio between our wealth and his. Wolf (1973b), in his most comprehensive model of East-West trade to date, includes variables indicating that relative advantage along a military and an economic metric are to be maximized.

If our gain is larger than his, we should trade; if not, we should forego trade.*

Some variants of this simple approach consider other economic policies besides trade. The objective function may be different: to drive the adversary below some threshold of survival.† This is economic warfare for keeps, perhaps employing such measures as dumping, preclusive buying, state trading, counterfeiting, industrial espionage and sabotage, blockades, and others. In such a case, our desire is to drive him toward autarky and to disrupt his economy. The optimal strategy for us involves buying everything third countries wish to sell and selling everything third countries want to buy (and hoping, as Wan assumes, that they will not state their desires to sell and buy insincerely). This is the best way to drive an adversary into bankruptcy, but it is not guaranteed to succeed; and it may be prohibitively costly for us to try.

A Second Model: The Search for Optimal Tariffs

Short of all-out economic wars of survival, and more realistic than single-variable models, there are more sophisticated formulations based on the theory of optimal tariffs.‡ There is still only one adversary, and we have a zero-sum relationship with him militarily. The difference is that all his gains from trade are not necessarily our losses; neither his military gains nor our losses can be equated with comparative cost calculations. Rather, it is assumed that certain types of trade--for example, sales of military goods--create a negative value to the exporting nation in addition to the positive economic gain

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*We are country Y, he is country H. The variable of interest is X, the wealth of each country. In this model, the utility functions of Y and H are $U_Y = X_Y - X_H$, $U_H = X_H - X_Y$. It is often implicitly assumed that the goal of relative advantage is ours alone, that U_H is only a function of X_H. (Otherwise, trade would not occur, since neither side would trade if the other received net advantage.)

†For example, Wan (1961).

‡Osgood (1957); Wolf (1973b).

from the sale. A "national security externality" is generated. Our analytic problem is to incorporate this externality into our derivation of taxes and tariffs.

Usually, it is assumed that some simple functional relationship exists between the dollar volume of trade (in certain goods) and the externality generated. The solution to our analytic problem, under certain restrictive assumptions about the production and welfare functions of every country, is to levy certain export tariffs on the goods that create the externality. If transshipment can be controlled and if other suppliers of the injurious goods can be shut off, then we should behave as a discriminating monopolist/monopsonist with regard to adversaries and friends.*

This optimal tariff approach is interesting because it formalizes the tradeoff between national security costs and economic benefit. However, it falls short of practical usefulness on three counts. Its assumptions are extremely restrictive, and if they are not met, the computed optimal tariff may be quite nonoptimal.† Second, even if the assumptions were acceptable, the information required in order to set tariffs (a complete knowledge of all countries' offer loci, cross-elasticities of demand at all levels of trade, and welfare functions)

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*In this model's barest bones, $U_Y = U_Y(X_Y, M_H)$--where M_H is his military power and assuming ours is fixed--and $U_H = U_H(X_H)$. Retaliation by him is specifically ruled out (as in most optimal tariff models). If $U_H = U_H(X_H, M_Y)$, an arms race can be generated using plausible reaction functions (Boulding, 1962; Conolly, 1970), but bargaining enters, too, and the optimal tariff formulation breaks down.

†Wolf reminds us that "should any one or more of our innumerable optimal conditions [i.e., the "assumptions" above] be constrained to nonsatisfaction, we cannot in general suppose that satisfaction of some or all of the remaining conditions [e.g., an optimal tariff] will move us any closer to the optimum position." (1973b, p. 41)

is unobtainable.* Third, it is unrealistic to ignore the prospect of retaliating policies, even by threats, by the adversary.†

A Third Model: Guns, Butter, and Bargaining

Suppose the adversary's capabilities can be divided into two types, military and civilian. Assume further that it is his military capability alone that creates an externality for us. His civilian capabilities do not bother us, except if such capabilities lead to present or future increases in his military.

Our adversary procures military and civilian capabilities depending on their relative costs (the "marginal rate of product transformation"), his income, and his preferences (the "marginal rate of substitution"). Figure 1 provides a graphical representation of the static situation. The adversary allocates his budget according to the point of tangency of his budget line (in heavy ink, indicating relative costs and income) with his indifference curves (the curved lines, indicating relative preferences).

Trade may affect the adversary's procurement in a number of ways.

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*Even in an idealized world, the derivation of the optimal tariff requires an enormous amount of information. The optimal tariff depends on:

> various elasticities and cross-elasticities of supply and demand for these products, as well as reflecting the relative volume of trade in these various goods. Because of the latter fact, but also because elasticities are in general a function of the volume of trade, our tax rates will also differ, in general, for each level of trade. (Wolf, 1973b, p. 17)

The need for precise estimates is not just a matter of decimal places. Even the sign of the effect of many strategies is often quite sensitive to small parameter shifts. Furthermore, even theoretically "it is possible that prices in both markets became indeterminable." (Wan, 1961, p. 80)

†The assumptions of nonretaliation and absence of threats are essential for the optimal tariff formulation. See Wan (1961, p. 17); Wolf (1973b, pp. 15, 44).

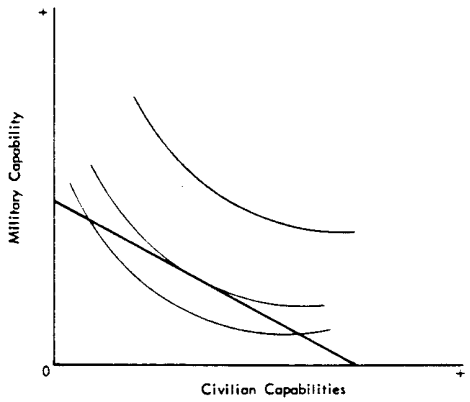

Fig. 1 — The adversary's resource allocation decision

1. It may affect the slope of his budget line by changing comparative costs.
2. It may affect the shape of the budget line, which may be flat at some point if the adversary faces a technological or other constraint.*
3. Trading with us may affect his indifference curves, i.e., as a result of trading with us, he may feel less inclined to procure military capabilities. To rephrase the porter in *Macbeth* about the effects of alcohol on lovemaking, our exports may increase the performance but take away the desire.
4. We may be able to bargain with the adversary, making certain sales to him only if he can guarantee that his military capabilities will not be increased.

The first and second effects pertain to what the adversary is *able* to do, the third and fourth to what he *wants* to do.

This model is still too simple to represent the situation of East-West trade fully. However, it is fruitful as a baseline from which to

*If we have a monopoly on a factor of production, the possession of which would enable the adversary to attain a capability that at present no amount of his resources can procure, comparative costs become misleading. This point will be discussed further below.

consider opposing arguments about some effects of Western exports. In the next sections, I will discuss the first three effects of exports outlined above. Then, in the following section, I will consider how our trade policy should weigh our economic gains against our negative feelings about his military advances. Finally, I will consider some broader aspects of export controls, including how they might be used as a bargaining chip.

III. THE EFFECTS OF OUR EXPORTS ON THE ADVERSARY

CHANGING HIS COMPARATIVE COSTS

When the adversary imports our goods, he does so because we can produce them more cheaply than he can. Our exports increase the purchasing power of his dollar (or ruble or yuan). Suppose we only export goods that lower the relative price to him of civilian capabilities. In Fig. 1, the budget line becomes flatter, reflecting the new, lower costs of civilian capabilities with respect to military ones.

The degree to which the lower costs will lead to increased spending on civilian capabilities depends on a number of factors. The lower civilian-sector costs resulting from our purely civilian exports could even lead to larger *military* procurements.

If resources are transferable across sectors, the effect of lower civilian-sector prices on his procurement depends on the magnitude of the "substitution effect" and the sign and magnitude of the "income effect." There may be increased consumption in the civilian sector. If his demand for military capability is great, however, our adversary may wish to retain his former level of civilian capabilities and allocate the resources he has saved by buying from us to his military procurements. (He would not *substitute* consumer expenditures for military capability at all, but would use the increase in *income* for military procurements.)

If we feared that the adversary would allocate all resource savings from trade to his military, we would be concerned solely about the magnitude of his savings, rather than about the type of goods we sold him.* (More generally, if his allocation of the gains from trade depended only on the income effect, we would worry only about the size

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*Gift (1969, p. 42n) says:

> Were it not for technical time lags in the utilization of the resource-releasing gains from trade . . . the content of the trade-list would not be crucial to a rational decision on trade; the resource-releasing effects, and *only* the resource-releasing effects, would fully exhaust the relevant considerations.

of the increase in his income.) For example, suppose the adversary wished to purchase a given dollar amount of rifles or wheat. We might first suppose that the rifles should be restricted, since we care about his military capability but not about his civilian nourishment. If, however, he produced rifles quite efficiently but wheat quite inefficiently (compared to us), the wheat sales would free more resources for eventual military use.*

We might have a number of decision rules under these conditions, including the following:

- If we wished to restrict all possible military gains by the adversary, we should export nothing to him and try to persuade other countries to do the same.
- If we were constrained by our allies or our own domestic needs to export a given volume of goods to him, we should order goods according to their comparative costs, assign each good an expected volume of exports based on calculations of the adversary's demand and the supply schedules of ourselves and other nations, and move down the list until our given volume of exports is reached.
- In a still different situation, if we could estimate the magnitude of the substitution effect in the adversary's

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*Interestingly, this logic has been used both for and against increased exports of civilian goods to the Soviet Union. The Special Committee on U.S. Trade Relations with East European Countries and the Soviet Union (1965, p. 9) argued that ". . . the USSR accords overriding priority to military expenditures. Any change in total resource availability in the USSR would, under present policies, affect its civilian economy, not its military budget." Schelling, however, has pointed out that

> Wheat shipments may have the same effect on military programs as jet engine sales. Wheat shipments may permit the Soviets to keep chemical industries oriented toward munitions rather than fertilizers; jet engine sales may permit the Soviets to allocate engineering resources to consumer goods rather than jet engines.

Cited in Holzman (1973, p. 665); also see Harvey (1966, p. 13). Further discussion of these points is provided below.

> economy for different types and levels of trade, we should take it into account in estimating the potential increase in his military capabilities that different kinds and volumes of exports would occasion.

This discussion is highly stylized, of course. So far, it has assumed that only comparative costs are important, and it has further posited that resources are transferable across sectors. Later, we shall consider other effects of trade besides lowering the adversary's costs. Now we can ask, are resources really fungible in bureaucratized communist economies?

On the one hand, many scholars have cited fungibility as a major advantage of centrally planned systems. In communist economies, it is argued, a central authority makes allocation and production decisions, and monopolistic control of foreign trade serves, theoretically, to collect trade surpluses for allocation to sectors of greatest priority.* Most academic treatments of international trade assume internal transferability of resources. And several early U.S. policy papers on export controls also emphasized fungibility in their advocacy of near total embargoes and, later, of the restriction on the export of capital goods.

But to what extent is fungibility a reality? Clearly an assumption of perfectly mobile and convertible resources is inconsistent with what is known about the impact of organizational self-interest and inertia on the budgetary process--a fact that does not escape some communist planners.† Budgets resist change. Insofar as many institutions compete for inevitably scarce resources, it will be difficult to allocate surpluses generated by trade to just one of them, or even to do budget allocation efficiently.‡ Resources in some sectors of the

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*See, for example, Campbell (1966, p. 103); Feisel (1972, p. 9); Grossman (1967, p. 20); Sherman (1969, pp. 188ff); Smith (1973, pp. 12-14). See also Kuzmichev (1967, pp. 104-106) and Bartenev (1973, p. 5).

†See, for example, Csikós-Nagy (1973, Part II, Chap. 2).

‡Shortcomings in the efficiency of the Soviet allocation process, often attributed to deviations from perfect fungibility due to organizational rigidities, are stressed by many authors; for example, Bergson (1964, p. 203 and *passim*).

economy are more difficult to transfer than those in other sectors. In the short run especially, resources may look fixed. And Soviet trade policy has generally not been a device for resource allocation.* Fungibility is limited in the short run, even in centrally planned economies, by both the feasibility and desirability of resource reallocation.

The stylized discussion of comparative costs and gains from trade does, then, admit to an exception, if the adversary's resources are nonfungible in a certain way, and especially if our time frame is the very short run.

There is, in addition, a quite different argument against considering comparative costs when deciding what to sell the adversary: to assert that the total volume of such savings is too small to matter militarily. There are several versions of this argument, some of which seem accepted by U.S. decisionmakers or implied by current policies.

First, it seems that the United States does not think increased Soviet resources are threatening. Economic warfare--minimizing Soviet resource gains from trade with the West--is explicitly not the U.S. aim. Their level of resources and our security have been radically divorced in U.S. policy. As of the Export Administration Act of 1969, it was no longer law to restrict trade that would make a "significant contribution to the . . . *economic* potential of such nation or nations which would prove detrimental to the United States";† but as we saw above, the *military* potential of the enemy does matter (implying that the two potentials are now thought to be different). Henry Kissinger (1973, p. 2) has recently argued that a "fact of the contemporary situation which is quite different from any previous period is that there is no necessary relationship between economic strength and military strength."‡ The dissociation of security and economics was highlighted in official comments about the 1972 U.S.-Soviet trade negotiations. Then Secretary of Commerce Peter Peterson (1972, p. 17) noted that

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*See Smith (1973, Chap. 1). Some evidence is given in Berliner (1959, pp. 41-42).

†This was the previous wording in the 1962 legislation (cited by Holzman, 1973, p. 661); emphasis added

‡Schultze (1973, p. 523) has recently made the same point.

"the firm position taken by the United States is that U.S. export controls are a national security matter and not subject to negotiation;" while Secretary of Agriculture Earl Butz stated that one purpose of the wheat exports was to show the USSR that the United States could aid its economy in times of trouble: "We also wanted to prove to the Russians that we can help supply their farm-product needs, even when large";* a position seeming quite distant from ruble/dollar calculations.†

Second, *we now permit unlimited sales of many sorts of goods, even to military end-users*. Most small- and medium-sized computers are allowed to be exported in any quantities. Several U.S. suppliers contribute to the Kama River truck factory which produces, among other items, military transport vehicles. And the huge U.S. sales of corn and wheat can be used to feed soldiers as well as civilians. I estimate that 90 percent of current U.S. exports to the Soviet Union have potential military end-use; and one must remember that under current export controls such sales are *unrestricted in amount* and end-user.

One might say, of course, that these current views and policies are simply mistaken. Clearly, some enormous level of resource gains by the adversary would be alarming. The argument, however, contends that the adversary already places substantial priority on his military sector, meaning that military needs are met first and that additional resources gained from trade will have low military productivity;

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*Quoted in Frank (1972, p. 1806).

†Contrast the sentiments of then Secretary of Agriculture Orville Freeman in 1964 as he argued against agricultural exports to the USSR:

> Making our peaceful technology available would have the effect of releasing their scientists, engineers, and technicians for work on other and perhaps less peaceful projects. It would materially shorten the time needed for research and development, and could substantially increase their economic potential. It could hasten the time when the communists could more effectively infiltrate and influence the developing and uncommitted countries through aid programs. It could enhance their ability to provide aid to such countries as Cuba without also imposing unacceptable deprivations on their own people in the Soviet Union.

Cited in Adler-Karlsson (1968, p. 118).

that, in the current military situation, greater quantities of military resources do not change the balance of power significantly; and, most importantly, that the resources freed by East-West trade, even when expanded many times over, are insignificant in volume compared to the adversary's national product. Export controls restrict some goods entirely while letting others go in unlimited amounts. It is difficult to justify such a policy from the point of view of comparative costs and resource savings.

CHANGING THE SHAPE OF THE ADVERSARY'S BUDGET LINE

What, then, could justify U.S. East-West trade policies, which combine free trade in some goods with an embargo on others? To put the question another way: How might some goods help an adversary's military potential besides in a resource-saving way?

One answer might be that the West possesses a monopoly on some factor of production, without which certain levels of military capability are not obtainable. The factor could be a rare metal, a military secret, or perhaps an advanced technology that the Soviets do not possess. In such a case, "comparative costs" are misleading, and the appropriate way to look at trade in such factors is to think of capability enhancement rather than resource savings.

Means of production A is more efficient than means B if either (a) a given amount of performance is produced with less resources or (b) a given amount of resources yields greater performance. These two statements are equivalent for linear production functions, but not when there is some upper bound on inputs or some (technological) frontier that limits the output attainable. In Fig. 2, AB is the production function relating resources to performance, and AB is bounded by CD. If, at some interesting point, gains in performance from additional resources can be considered negligible, a *resource-freeing* gain in efficiency (type a) is not equivalent to a *capability-enhancing* gain in efficiency (type b).* If upper bounds do exist on technologies in

*Note that below resource level E (approximately), the resource-freeing gain (a) is also capability-enhancing, while the capability-enhancing gain actually involves an efficiency *loss* (more resources

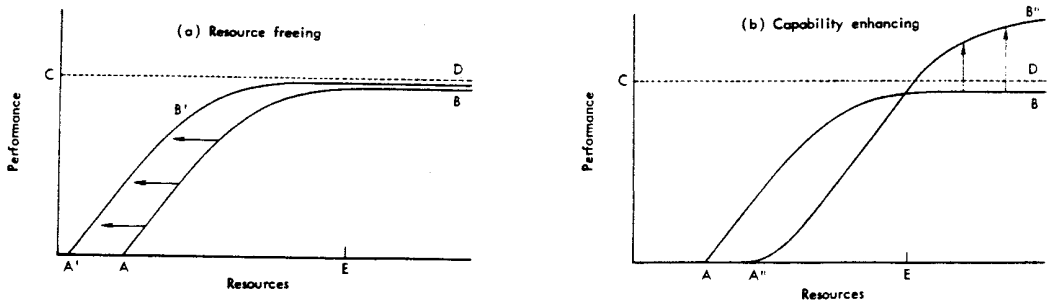

Fig. 2 — Comparison of resource-freeing and capability-enhancing increases in efficiency

communist countries that do not in the West, then trade may enable them to make capability-enhancing gains above the CD constraint, moving them from production function AB to one like A″B″.

It is this "qualitative," capability-enhancing aspect of restricted items, rather than the "quantitative," resource-freeing gains, that forms the basis of current export control policy.

Three different kinds of capability-enhancing differences among commodities may be relevant.

First, a certain good may represent a *state-of-the-art* technology that the communist nations cannot produce or obtain from other sources. Gains from trade in other commodities cannot be converted by communist countries into an Illiac 4 computer, for example; only by buying one from the West can they obtain it, at least over some pertinent time horizon. The communists simply do not have this advanced computer technology yet--there is a "gap" between what they have and what the West has. In this way many "high technology" goods are not like wheat.

A second, related qualitative difference can result from communist *production constraints*. The Soviet Union, for example, may only be able to produce a limited number of high-grade integrated circuits.

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for the same level of performance). However, above E, capabilities cannot be enhanced in (a) but are in (b). An example of (b) might be the use of a very large computer: on small problems (i.e., at low levels of performance), it may be less efficient than a small computer, but it has capabilities that surpass those of the small computer, even one with large amounts of resources devoted to it.

They "have" the good--which distinguishes this case from the first--but at some interesting point the price of additional units becomes very large (where "very large" makes what might be called a qualitative difference in further availability of the good). Such a situation of constrained production is often thought to characterize communist computer industries.*

Third, a commodity might not just affect the level of another nation's resources or technology, but also the *rate of change* of those resources. A good may embody much more than its concrete uses: It may disclose a technology (knowledge, a "secret") that is extractable and imitable. Thus, a jet engine may have not only its individual characteristics, but may also embody a production technology that assists the Soviets to be more efficient in their own engine design and production, or knowledge that increases Soviet military capabilities, or a militarily-relevant "secret" about Western technology and about the range of options open to Western military forces.† No such embodiment occurs with goods like wheat, even though highly sophisticated technology may have been employed in producing them.‡ Some technological

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*Reporting on a trade mission to the Soviet Union and Poland, Sodolski (1972) concludes:

> The technology for the conception and design of equipment at least as advanced as that which exists in the United States is available in both countries. There do seem, however, to be difficulties in bringing prototype design into production in Russia and Poland [p. 1, section on USSR]. . . Again, as with the Soviet Union, there is no lack of technology of prototype units. The difficulty is in the production techniques and producing enough equipment to satisfy the demand [p. 2, section on Poland].

†Thus, for example, the unilateral U.S. Commodity Control List, drastically reduced in May 1973, still includes "nonmilitary jet, turboprop, turbo-shaft, and gas turbine aircraft engines" because "the premature decontrol of civilian-use aircraft engines could reveal to the communist countries technological advancements in the U.S. military engines." (U.S. Department of Commerce, 1973, p. 16.)

‡Even if such technological embodiment does occur, why should it evoke governmental concern? Apparently the fear is that the price of a technological good will not reflect the true Soviet gains, perhaps because private firms will be willing to sell too cheaply from a national point of view.

goods may therefore be qualitatively different in their ability to affect the recipient's rate of growth of resources or technology.

All three kinds of differences have this in common: Increases in communist resources cannot currently obtain certain capabilities that might be procured by trade.* And this difference justifies restricting the commodities with these characteristics, even while allowing other goods to be traded in unlimited quantities.

AN EXAMPLE OF GAINS FROM TRADE: THE CASE OF EXPORTS OF LARGE COMPUTERS TO THE USSR

The most controversial single commodity in COCOM is large computers. Several things are clear. First, current controls restrict many of the big machines that are most desirable commercially and scientifically. Second, computers have wide applicability in the U.S. military, particularly in the Air Force, and they are expected to become more important

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*The distinction between capability-enhancing and resource-freeing gains from trade--and in part the distinction between technological and other goods--can be crudely characterized as a distinction between quality and quantity, with the assumption that quality is not purchasable by quantity over some relevant time period. Intuitively, the distinction of kind that is made between *goods* (i.e., restricted or permitted) should correspond to some distinction of kind between the *effects* of goods, since COCOM controls permit unlimited export of many goods that potentially save Soviet military resources (e.g., trucks, small computers, food, and so on).

In practice, an absolute distinction between quality and quantity breaks down, since additional resources can be used to accelerate technological advance. The Soviets, for example, can invest resources gained from trade into military R&D, thereby enabling them to "catch up" faster even in embargoed technologies. Does this investment lead to the same technological results as importing the technology would, were it available? The important variables determining the answer are (1) how U.S. security varies with the size of a U.S. temporal lead in the technology and (2) the return from further Soviet investment in military R&D. If the Soviets already place priority on military research and development, additional ruble investment may have a minimal impact. It is argued that they do not need more R&D funds, but Western hardware, know-how, and the technology itself. At any rate, the point is that embargoed goods must either provide a technological capability unobtainable by the communists over the relevant time period or must save the communists an amount of resources more significant than the resource savings made possible by the other exports that currently flow untrammeled.

in the future. Third, as Fig. 3 displays, the Soviets are making a decided effort to accelerate their domestic production of data processing equipment. (The Soviets claim this effort is motivated by a desire to improve macro- and micro-level economic planning and management.) But despite the Soviet push, as Fig. 4 reveals, the United States enjoys a sizable lead in the technology of large computers, as measured along certain important hardware parameters. Experts believe the U.S. lead in computer software, which is not restricted under COCOM controls, is even larger.

As we have seen, it has been enough to cite the military *usefulness* of computers and the Western *lead* as sufficient reasons for current restrictions. The question we must now ask is, Would the enhanced *technological* capabilities resulting from free trade in big Western computers imply enhanced *military* capabilities? If computers merely would enable the same military capabilities to be procured at decreased cost, trading them would not be different from trading other commodities that free Soviet resources.*

There is an important if elementary logical point here. Even if a large computer would enhance the Soviet Union's *computing* capabilities along various technological dimensions, it would not necessarily enhance their *military* capabilities (in a way different from grain exports that feed Soviet soldiers or smaller computers that can be exported that do the job). It is not that such machines would have no military applications, nor that they do not enable the United States to achieve greater capabilities: but the Soviets may be able to substitute other resources for computers, or may need computers less given their tactical and strategic situation, thereby obtaining qualitatively equivalent results.

Of course large computers may make a tremendous difference to the Soviets. The point is simply that it is not *necessarily* true that possessing a more advanced technology, even a militarily-relevant one, leads to military capabilities that were not possible before.

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*If one believes in nonfungibility, add "dual-use" before "commodities."

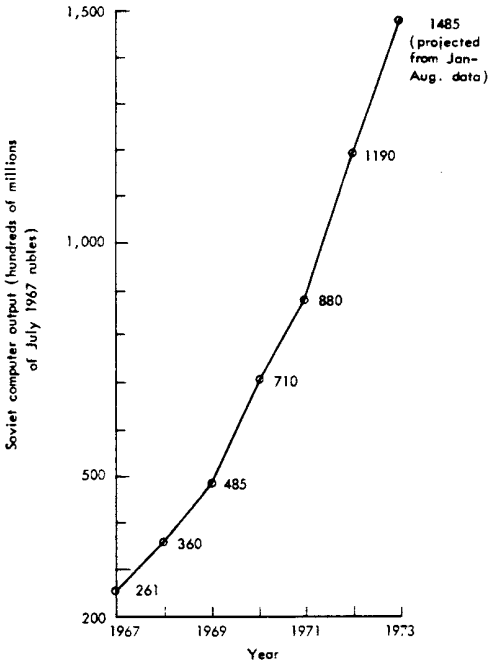

Fig. 3 — Soviet computer output per year, including spare parts (SOURCE: A.E. Nimitz, The Rand Corporation)

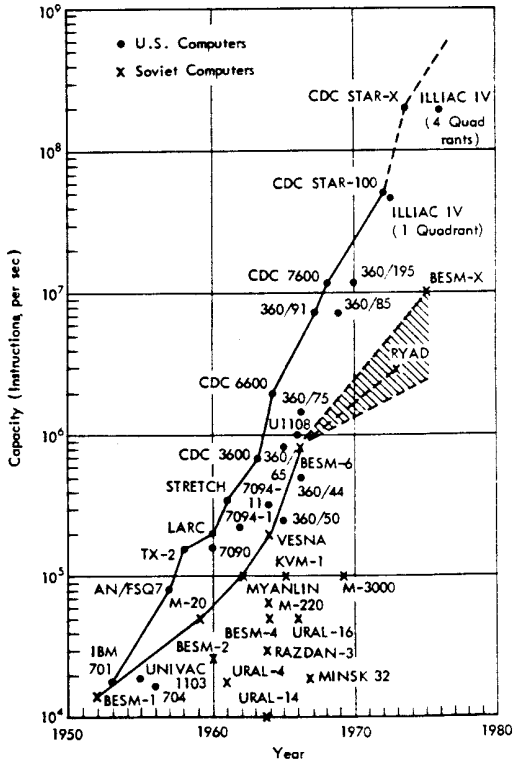

Fig. 4 — Comparison of U.S. and Soviet high-performance computers

Visualize big computers as one of a number of "factors of production" (including manpower, military hardware, time, money, and so forth) used in various "production processes" (alternative weapon systems, organizations, and doctrines) to yield "military capability." It is possible that the Soviets presently substitute both factors and processes* for large computers in such a way that (1) they attain the same capality as the more computer-intensive Western military production choice and (2) the addition of computers would not enable significantly greater results. In theory, data processing equipment might make a large difference to the United States, given its factor costs, defense budget constraints, and military situation, but might not to the Soviet Union.

The relevant question about large computer exports, then, is:

> *What capability-enhancing military difference would big Western computers make to the Soviet Union, given (1) the current level of Soviet computers; (2) possibilities for substitution of other factors of production; and (3) Soviet strategic and tactical needs, systems, and organizations?*

This question has seldom been asked in the export control decision process.†

To answer such a question definitively is of course beyond the scope of this study. It would require expertise in the applications of large computers over a wide range of military activities. It would also require large amounts of information about the Soviet military: its needs and desires, its ability to absorb sophisticated computers and software, its opportunities for substitution.

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*"Actually, much substitution in production . . . arises through shifts in the extent to which alternative discrete processes are used, rather than through continuous variation in factor combinations within the individual process." (Koopmans, 1951, p. 458)

†I have reviewed much of the copious literature pertaining to the military use of large computers, including studies done for list reviews. Most concentrate purely on technical comparisons in Soviet and U.S. hardware, without raising the question of military importance; others talk about military applications in the United States from a narrow cost-effectiveness (resource-saving) point of view. None that have come to my attention has dealt in detail with the question posed above. One recent example is Possony (1973).

Nonetheless, it was thought to be useful to pose a simpler version of the question to a loosely-organized sample of specialists in computer technology, various military areas, and Soviet affairs.* The questions were simplified by assuming perfect absorption of technology by the Soviets and supposing that the publicly available BESM-6 computer, first released in 1965, defined the current level of Soviet computing power.† It was assumed that all controls on large computers were removed. With these conditions understood, the specialists were asked in informal interviews what capability-enhancing differences large Western computers would make to the Soviet military in the areas of command and control, logistics, military research and development, intelligence, missile guidance, antiballistic missile systems, and avionics.‡ They were asked to keep in mind various substitution possibilities that are available to the Soviet Union--substituting smaller, available computers, time, increased resources, and manpower for the large machines. They were also requested, when appropriate, to consider the situation of the Soviet Union--militarily, organizationally, and so forth--as they responded.

What follows is an attempt to organize judgments of these specialists. The results are, I think, surprising. In view of its tentative nature, however, this survey should not be taken as a final answer. It has not been checked by other panels of experts nor by independent calculations. Its goal is primarily to indicate, by example, the sorts of questions that should be asked about export controls and to provide a framework for further infusions of information.

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*See the Acknowledgments for a list of the interviewees.

†Since absorption would not be perfect and since it is often said that the Soviet military may possess machines much more advanced than the BESM-6, these assumptions impart an upward bias to the estimated impact of U.S. computers.

‡This list does not exhaust the military areas where computers have been and will be important--for example, anti-submarine warfare, fleet defense, and so forth. However, what is sought here is not a comprehensive, definitive assessment of the role of large computers in defense, but an illustration of the questions that should be asked instead of those that currently are.

Command and Control (C^3)

Large computers are widely employed in U.S. command and control to solve problems of airspace control and allocation of sorties. The main function of the computer is data storage, rather than computation. In the United States, the desired computer characteristics are increasing mobility, modularization, and resistance to hostile environments (dust, heat, jarring, etc.); at the tactical C^3 level, U.S. computers do not strive for size or extraordinary speed. The constraint facing U.S. C^3 is apparently not computers, but organizational problems and communications technology (troposcatter, switching, communication nets, and so forth).

Computers may present more of a problem in the future. The U.S. tendency is toward increasing *centralization* of strategic C^3 to reap the expected economies of scale from grand optimization of the allocation problem, and centralization may imply a need for larger computers. The Air Force's World Wide Military Command and Control System employs a Honeywell 6070 computer system that is more sophisticated than publicly available Soviet computers. Furthermore, the anticipated *automated battlefield*--new technologies in precision-guided munitions, sensors, and remotely-piloted vehicles--could raise C^3 problems by an order of magnitude. The future target acquisition software task may be impossible; sensors could imply needs for immense data storage capability; and the allocation problem will grow in difficulty. However, the binding constraints on the implementation of the automated battlefield will probably be three other factors: institutional resistance and implementation costs; communication technology; and defensive counters that nullify these seeming advances in offense (e.g., dispersion and jamming).

Both centralization and automation are policy variables. Short of completely centralized C^3 and total reliance on new battlefield technologies, it is quite possible that there will be little loss in efficiency even with present computer capabilities. Computers may be a constraint at *some* levels of centralization and automation, but those levels may not be different enough militarily from feasible lower ones to matter.

Furthermore, the Soviet C^3 problem has traditionally been less computer-intensive than ours. Instead of pursuing grand optimization schemes over many commands, areas, types of military operations, and alternative uses of the same forces, the Soviet military has tended to suboptimize. The Soviets link their air armies with their ground armies, a practice the Allies followed in World War II but have since discarded. This doctrine in effect ties their air units to specific geographical areas. The Soviet Union possesses less versatile airplanes, restricting the range of alternatives that have (or can) be considered. The Soviet air force is considered to be defensively oriented, with heavy emphasis on interception but not on deep penetration; this orientation, different from the United States', also reduces the scope of allocation problems. Consequently, the Soviets have a much simpler C^3 problem than our military posture and strategy has implied for us, and given their strategy, increased computing power may make little difference to their C^3. One expert believes that the Moscow civilian airspace control system employs as complicated a computer as their military could desire for command and control.

Conclusion: Large computers do not appear to be a constraint on U.S. or Soviet command and control. The automated battlefield of the future may make computers more important, but the best guess is that other factors will be much more important than large computers that are currently beyond Soviet capabilities.

Logistics

Data processing equipment is widely used in the U.S. armed forces to alleviate logistics problems. Many of the problems resemble those in business, although often with special features requiring custom-designed software: work scheduling, reorder, evaluation, forecasting, inventory control, payroll, record-keeping, and so on. U.S. logistics emphasizes computer characteristics like data storage and remote access. Speed is increasingly important: many of the current expensive changes in the Air Force Logistics Command involve an attempt to give commanders real-time access to the data base, instead of "canned" reports. The U.S. Air Force has been working for seven years on a new logistics

command system, employing 1200 skilled workers and 400 supervisors, using a third-generation CDC 6600 computer, and eventually retraining 50,000 people to handle the system. The software work on this system is said to push forward the state of the art. The system is not expected to be completed until 1976.

The need for this sophistication stems from the very high cost of parts and the reduced number of aircraft, each being more versatile and expensive. Spare parts consequently have a greatly increased time/place utility; work scheduling becomes more critical; inventory mistakes can be disastrous. Computers are also more widely used because manpower is in short supply; computers are being substituted for enlisted men and women. As sophistication, expense of spare parts, labor costs, and versatility of weapons rise, so does the need for better logistics.

The Russians are not nearly so sophisticated; one specialist called their computer applications in related civilian management problems "primitive." The similarity of many of these civilian problems, for which the Soviets have expressed great interest in acquiring Western data processing equipment, to military logistics problems has led to concern over the ease with which computer sales to the civilian sector might be redirected. However, logistics sophistication that does push the state of the art--as our Air Force Logistics Command does--is anything but an effortless application of civilian hardware and software, despite the apparent resemblance of the problems. It implies great expenses in software, skilled personnel, and time.

Furthermore, the Soviet logistics problem is considerably more constrained than ours. As in command and control, different weapon systems, needs, and doctrines imply different computer needs. The Soviets have not opted for weapon systems as sophisticated as the American choices. Individual airplanes are not as expensive, and there are more of them; spare parts and work scheduling are consequently not as critical. Labor is plentiful and cheap. In effect, the Soviets have substituted greater quantities of arms and manpower for computers; given their choice, enhanced computer capabilities would probably save some resources (although not in the short run), but would not make a capability-enhancing difference to their military strength.

Conclusion: Like command and control, logistics "pays the price" of the increased sophistication in military forces. The U.S. has emphasized computers as a substitute for other forms of capital equipment and for labor; the Soviets achieve similar results by doing the opposite. Greater availability of data processing equipment would enable the Soviets to save some resources, but it would not enhance their military capabilities.

Research and Development

The main function of the large computer in research is affectionately called "number crunching" by military R&D specialists: large-scale computations in problems of weapon effects; exploration of outer space; ocean current and atmospheric modeling; and the design of boat-hulls, jet engines, and airframes. At first glance, there seems to be a clear discontinuity between U.S. and Soviet computer capabilities that has important military implications.

However, experts on military R&D are quick to point out that, even without the big Western machines, the Soviets have been able to solve all the major R&D problems on which the U.S. employs its most sophisticated machines. Their solutions to various design problems have proved equal to the West's; they have achieved moon landings and other space ventures; and their nuclear weapons are sophisticated. The Soviets may lag in atmospheric and oceanic modeling, but data shortages and the feeling that such modeling is not important may account for this lag rather than computational constraints.

In short, the Soviets are very good at military R&D. This may be because some of their secret computers are more sophisticated than those generally available. It is probably, however, the result of a willingness to take longer and spend more to obtain answers; as one expert said, "They may substitute time and thinking for computer power."

Conclusion: Very sophisticated computers are utilized in many U.S. military R&D problems, often providing savings in time and cost over smaller, Russian-level machines. But the Soviets have been able to handle the same problems well (atmospheric and oceanic modeling may be exceptions). The computer gap does not seem to result in a substantial difference between U.S. and Soviet military R&D results.

Intelligence

The use of large computers in military intelligence ranges from cryptanalysis to the storage and selection of information. Some tasks emphasize "number-crunching" (cryptanalysis); others require speed (handling large, continuous streams of satellite data); while others involve sizable data storage (maintaining the enemy order of battle). Some cryptanalysis tasks apparently involve the very largest available machines. Many of these problems, however, can also be solved using smaller computers, but at larger manpower and time costs. Our knowledge of Soviet intelligence capabilities and objectives is shrouded in uncertainty and secrecy, but one cannot readily show, using publicly available information, that access to large U.S. computers would make an important difference to Soviet intelligence capabilities.*

Guidance

The U.S. employs both ground and on-board computer systems to improve missile guidance. Ground computers are used for the extensive modeling needed for planning the four stages of missile flight: boost, cutoff and separation, geoid and gravity, and reentry. Often the computations are sizable. In the boost stage alone, over one hundred different parameters are modeled in some U.S. missile systems. On-board computers must handle models with over two hundred parameters and use them to transform incoming data into guidance instructions.

For a number of reasons, large computer technology has not constrained Soviet missile accuracy. The detailed modeling necessary for on-board guidance is well within the capability of the Soviet BESM-6 computer. It is true that many of the ground computer calculations can be handled faster and more easily on large, sophisticated machines, but smaller Soviet-type computers are also capable of performing them. Furthermore, guidance accuracy has been limited by instrumentation, imperfect surveying, imperfect knowledge of the geoid, and engine technology, rather than by a need for larger computers.

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*Many computer applications in U.S. intelligence and cryptanalysis are highly classified. I have not had access to such material, and it may affect the conclusion drawn here.

Even with MIRV, large computer hardware beyond that which the Soviets presently possess does not seem essential. The limiting technologies in MIRV pertain to engine stopping and starting, separation, and possibly inertial instruments, but not data processing.

Conclusion: The Soviets have substituted engine technology for on-board computer guidance in the past. As they now begin to use on-board computers, they are probably not constrained by large computer technology--in part because of their larger boosters and willingness to substitute time and manpower for hardware. If there is a computer constraint, it is not a lack of large commercial-type machines, but small, special-design, on-board computers.

ABM Systems

The role of computers in the development of ABM systems is a very controversial subject. Some experts feel that extremely large computers would be essential; others believe that networks of small, fast machines would be sufficient. The software problem was called insoluble by some, difficult but tractable by others.

The disagreements in part are a result of different definitions of "antiballistic missile system." The important parameters of ABM systems are the area protected, the amount of leakage allowable, the altitude of interception, the sophistication of the expected attack, and the size of warheads. Depending on which parameters are chosen, the computer task ranges from "not overwhelming" to "probably impossible."

From one point of view, the SALT 1 agreements restricting ABM deployments make the potential impact of computers on Soviet ABM potential a moot question. Others, however, might contend that treaties are not forever; that deployment might be difficult to detect if carried out under the guise of improvements in the existing air defense radar net; and that increased computer strength might enable the Soviets to violate SALT restrictions or threaten to.

Conclusion: The importance of the largest computers for ABM is a major uncertainty. Experts do not agree about whether U.S. computers would enable the Soviet Union to build an ABM system more resistant to a U.S. second-strike than an ABM system using their own best machines; nor do they agree that SALT 1 eliminates ABM as an area of concern.

Avionics

The U.S. Air Force has developed and utilized a series of increasingly sophisticated computers in avionics. These machines are part of the on-board equipment of modern warplanes; the new B-1 bomber, for example, will contain over 30 separate computers. Such machines emphasize size, light weight, and lower power requirements--combined, of course, with adequate data processing ability.

In the U.S. Air Force, the driving force behind the increasing avionics sophistication has been the desire for more and more accurate air-to-ground placement, whether of munitions or of supply materiel. Although data on Soviet avionics is not readily accessible, it is believed that the Soviets cannot match the highly integrated digital subsystems, sophisticated inertial navigators, and elaborate controls and displays of U.S. avionics systems like the FB-111A's Mark II.

The Soviets, however, may not need or desire such elaborate systems in their aircraft. Sophisticated avionics is increasingly necessary in long-range, multiple purpose, air-to-ground warplanes; the Soviets have stressed short-range, single-purpose, air-to-air capabilities. The Soviets also tend to use the same basic avionics system in different aircraft with minor modifications, as opposed to the U.S. practice of developing different systems for different planes. Many U.S. technological advances would be inappropriate and perhaps irrelevant, given Soviet military and R&D policies.

More importantly, small general-purpose computers with potential avionics uses are not restricted under current COCOM controls. The large, restricted machines would not affect Soviet avionics capabilities.

Summing up the Military Impact of Computers

Perhaps surprisingly, the Soviet military seems able to substitute time, labor, other military resources, and doctrine for large computers, producing achievments comparable to those of the West's more computer-intensive defense policy. The U.S. military seldom uses large computers more sophisticated that the Soviet BESM-6; when it does, there is little evidence of a substantial difference in capabilities from those the

Soviets obtain or would desire, given their defense policies.* Possible exceptions are ABM applications and atmospheric and oceanic modeling, but even here the importance of a computer advantage is not clear. Our fears about the impact of large computers on Soviet ABM capabilities should be lessened by the successful agreement of SALT 1, and end-use restrictions could easily ensure that an exported large machine would not be used in an on-line ABM system. Atmospheric and oceanic modeling is of less than central military importance.

If the Soviets obtain militarily equivalent outcomes without large computers, lack of those machines does not represent a technological bottleneck. Would this result, if confirmed in more detailed studies, imply that big computers should be freely traded?

Before this conclusion would be legitimate, two more questions would need to be answered. *First*, suppose the Soviets are equal without the computers: Would they not obtain superiority by having them? *Second*, if the Soviets are presently equal, is it merely because the United States has failed to exploit its lead in large computers? Could a revised U.S. defense strategy make the gap in large computers something it is apparently not today, namely an item of importance to U.S. security?

On the first question, straightforward economic reasoning suggests that if computers have a positive productivity, the Soviets' having them

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*Of course, large computers might well provide the Soviets with cost savings in these areas. Ronald Finkler of the Institute for Defense Analysis cites the unclassified results of several 1969 case studies of the use of large computers in the U.S. military. Large computers (above COCOM allowable levels) were examined in one design application (an IBM 7094-UNIVAC 1108 configuration used to design the Lockheed C-5A), one real-time communication application (two UNIVAC 494 computers used in NASA'S NASCOM system), and two air defense systems (the NIKE-X ABM system and the SAGE defense system against manned bombers). In every case, networks of smaller computers could have been used to achieve identical capabilities, though at higher cost (33 percent for the Lockheed C-5A case, substituting five exportable UNIVAC 418 II computers; 20 percent for the NASCOM situation, substituting five CDC-3300 computers). Both the NIKE-X and SAGE systems were judged feasible with linkages of smaller computers. The point is that Soviet military capabilities would not be enhanced through the availability of large computers, making their export similar to other allowed sales of the resource-freeing kind.

would raise Soviet military capability; and if without them the Soviets are equal, with computers they should go ahead. However, the specialists interviewed expressed doubts on this score. They cited the large investments of capital and organization that have already been made in a less computer-intensive defense posture. Given the rest of the Soviet military apparatus, to utilize computers as the United States does would involve far-reaching, costly, and time-consuming changes. Even if the Soviets wanted to make such changes, their "primitive" software, especially the severe shortage of trained personnel, would probably be a binding constraint over the short and medium run. To the extent that large computers and relatively simple military systems, large computers and cheap manpower, and large computers and defense doctrine are *substitutes* and not complements, the benefits of such computers to the Soviet military would be small; and the costs of adopting big Western computers American-style would probably be too large to be worthwhile.

The second question is more difficult to answer. Currently, a study is underway at Rand to investigate the possibility that the U.S. could exploit the computer gap more effectively in the U.S. defense posture. There are areas hypothesized in which large computers might enable the U.S. to do things the Soviets could not. Two important dimensions must be considered, apart from purely technological considerations: (1) the *importance* of the unrealized advantage and (2) the *cost* of its procurement. The first is affected not so much by whether the Soviets could duplicate U.S. technology but whether they could *counter* it. The second, of course, is necessary to decide whether the flame is worth the candle. We must withhold judgment on this question until further research can be completed.

While short of answering these two important questions definitively, one nonetheless can conclude with the following three propositions:

1. Insofar as the logic of restrictions on the export of large computers depends on the existence of a bottleneck in the Soviet military that Western machines would relieve, the case seems weak. ABM and oceanic and atmospheric modeling applications may be exceptions. In other areas, although the import of large computers might result in resource-savings, they would apparently not imply capability-enhancing

gains, and therefore, they are not separable from other types of (dual-use) exports currently sold without restriction.

2. The Soviet Union is weak in software and applications. Their constraints on skilled personnel apparently are tight, even with the small number of computers they now possess. If the West allowed more large computer exports to the Soviet civilian sector (perhaps with end-use safeguards), the Soviets might allocate their scarce software resources there instead of to the military sector, thereby benefiting Western security. In effect, our export of general purpose computers with end-use guarantees would raise the opportunity cost of military computer systems.

3. Although large computers might not enhance Soviet military capabilities, there were some indications that small, special-purpose machines and specially-designed military software would lead to military results not presently obtainable by the Soviets. Major and rapid improvements in mini- and microcomputers are likely to have a wide range of capability-enhancing military applications, especially in the 1980s and beyond.

*Mini*computers--basically small versions of familiar machines--will have increasingly important uses in avionics and missile guidance, as well as in tactical command and control. The key technology of military relevance has to do with "ruggedization," rather than with logical structure or electronics: with how equipment can be protected from the hostile environments associated with military operations. For export control purposes, if further analysis confirms that minicomputers should be restricted, study should go into the question of which measurable parameters would effectively distinguish minicomputers that would enhance military capabilities from those that would not.*

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*Currently, there are several operational criteria for restricting small machines: for example, restricting the export of computers that can operate below a certain temperature range. However, such a criterion may not restrict minicomputers that *are not* currently used under such ranges in the United States, but which *could* operate below the temperature with fairly trivial packaging adjustments. *Computer* technology per se may not be the place to look for export control parameters in this case: rather, in the technologies of hermetically sealed containers, latching mechanisms, hygroscopic treatments, and so forth.

*Micro*computers--under various guises and names (computer-on-a-card, microprocessor, chip calculator, and others)--have reached the state of sophistication that their large-scale incorporation into all sorts of production, instrumentation, and signal-processing systems is a reality. Many of these uses may enhance capabilities in military areas--for example, ground-to-air communications, radar, "smart" weapons, "smart" sensors, and the operational security of communications in general.

The key technology for microcomputers is the production of large-scale integration (LSI) chips. Such production equipment is currently controlled by COCOM, although whether at the right level is a matter for concern. A problem in attempting to control the international transfer of microcomputers, however, is that they will be widely available in the West and easy to smuggle. (Thousands fit in a single suitcase.) Therefore, even if sales of integrated circuit production machinery can be effectively restricted, microcomputers still will be difficult to keep out of communist hands.

Mini- and microcomputers should probably receive proportionally much greater export control attention than the large machines that currently dominate COCOM concern. Special attention should be paid to technical parameters along which feasible and effective control can be exercised.*

CHANGING THE ADVERSARY'S INDIFFERENCE CURVES

Suppose our exports to the adversary improved his military *capabilities*. We would not, other things being equal, like that. But

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*The export of *large* computers to communist buyers would have only marginal impact on their ability to design and produce *mini*- and *micro*-computers. The technological advances embodied in the giant number-crunchers have little to do with the technologies that are most important for mini- and microcomputers. (Integrated circuits are basic to all three, but no one would buy a large machine for its chips.) The design process of small machines often involves the use of bigger computers, but not machines above the BESM-6 level, and gains from using larger machines would be of the (moderate) resource-freeing variety.

One exception may be the use of very large computers to simulate environments for checking out and improving avionics computers. Such a use of giant computers involves months of continuous computer time and close contact with other equipment and personnel in avionics facilities. Like ABM, this sort of use of large machines could easily be deterred with minimal end-use controls.

other things may not be equal: It is widely believed that increased trade with potential enemies may reduce or inhibit his *hostility* toward us.

One version sees trade as a substitute for military rivalry. Secretary of Commerce Dent (1973, pp. 19-20) voiced this popular view, as follows:

> It should be apparent that there could be dangers abroad in the world today which could destroy all of us if we remain paralyzed by their complexity and magnitude. But men of initiative see in these very perils great opportunity for policies of action designed to allay fear and reduce hostility and tension. Simply put, they see the possibility of replacing military competition with commercial competition. No one has grasped the value of this simple axiom more strongly than President Nixon.

No one has put this idea quite as starkly as Lewis Richardson (1960), who used trade flows as a measure of international friendship and arms expenditures as a measure of bellicosity. The Soviets do not seem as taken with this point of view (Leites, 1974), although a recent series of important articles by G. A. Arbatov, the Director of the Institute for the Study of the U.S.A., contains a number of propositions resembling Secretary Dent's:

> The movement which is currently taking place away from cold war . . . is leading to a shift of the center of gravity of this struggle into nonmilitary spheres. . . . This must mean a transition to a form of economic competition which would not only not exclude but would avance broad international cooperation on the basic principles of advantage and cooperation, strengthening peaceful relations among states.*

A second version posits that trade creates stabilizing transnational ties among countries, thereby inhibiting hostile initiatives by the central governments. Some of the arguments on this score have been summarized above (p. 10). It is worth noting here than one of the leading proponents of this view is Secretary of State Kissinger:

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*Arbatov, 1973b, p. B4, B11; also see Arbatov 1973a.

> We hoped that the Soviet Union would acquire a stake in a wide spectrum of negotiations and that it would become convinced that its interests would be best served if the entire process unfolded. We have sought, in short, to create a vested interest in mutual restraint.*

Skeptics point out that trade may engender conflict, not reduce it, or that transnational ties are infringements on sovereignty.

The appearance of a contradiction on these points depends in part on one's definition of "conflict" (wars may decrease, other harmful interactions may increase) and on one's predilection for single-variable correlation (pessimists cite the higher mutual trade flows among combatants like France, Germany, and England just before World War I compared to those between these countries and noncombatants like Brazil, Japan, or China, as if other relevant factors were held constant). Important research remains to be done in this area, and the need for professional judgment and awareness of the context of each event probably dominates the application of historical generalities.†

Other political effects are often mentioned, though they do not directly fit the metaphor of changing the adversary's indifference curves. One has to do with making communist nations more capitalistic. Our trading with them is sometimes averred to carry the merits of free enterprise with it. Not only might Soviet imports from the West have an effect, but increased Soviet exports to Western markets would force Soviet industries to be more competitive on Western standards, with allegedly important internal repercussions. (Usually, however, this ideological penetration is not explicitly defended as a good thing; and the possibility of reverse penetration is left unexamined.) However, the *a priori* nature of most such arguments does not yield a clear answer when applied to specific cases. For example, some experts believe that increased availability of Western commercial computers would

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*Cited in Hardt and Holliday (1973, p. 13).

†Cooper (1972, p. 173) concludes that "the impact on political leadership may possibly lead to the most important effect of [economic] interdependence on foreign policy, but it is too subtle and uncertain in direction to be analyzed with any confidence."

promote a decentralization of the Soviet economy; others contend that such exports would stimulate more diligent efforts at centralization and grand optimization.

Another political effect of increased trade, if exports were selective, is thought to be a further breakdown of the communist bloc. "The trouble with the embargo," wrote Nicolas Spulber in 1952, "is simply that the more efficacious it becomes with respect to the small countries of the Soviet orbit, the greater becomes the bargaining position of the USSR in its intra-bloc trade relations."* But whether increased Western trade could ever have helped split the bloc is debatable; that relaxing current controls would contribute significantly to doing so is unlikely.

It does seem reasonable that, short of bloc splitting, different East European countries could be given incentives or rewards for favorable behavior in the form of a differential embargo, perhaps by using exception requests in a more political fashion. More importantly, in the case of China and the Soviet Union, differential policies could better take account of the nonidentity between them and the possibility that U.S. trade could alter Sino-Soviet relations in a way beneficial to the West.†

To summarize the political effects of increased trade: much is asserted, but little is proved. Indeed, it is difficult to imagine appropriate evidence from the past that could guide policymakers in the present on this question. It seems fairly clear that increases in trade with an adversary does foster some short-run climate of cooperation. What is not at all clear is that the loosening of export controls would

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*Spulber (1952, p. 126). See also Spulber's evidence eight years later (Spulber, 1960).

†These possibilities are discussed further on pp. 58ff.

affect the desire of military competitors to procure military capabilities, especially in the long run.*

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*Specific instances could have large political repercussions, but the effects are hard to estimate in the abstract. To name two such possibilities:

1. A dramatic reduction of export controls, with appropriate atmospherics about "the end of a cold war vestige."
2. A particular sale of a capability-enhancing military technology--say, to China--that enhances the stability of the military situation along the Sino-Soviet border.

Both cases are presented as hypothetical examples, not as recommendations. In either eventuality, the "political effects" would not primarily be sought in some general shifting of "indifference curves," but in tangible quid pro quo arrangements. (More on this dimension of export controls appears on pp. 76ff, 85ff.

IV. THE EFFECTS OF OUR EXPORTS ON US

The preceding discussion concentrated on how our exports might affect the adversary's military procurement. The important consideration for our policy is how those exports affect us. We are affected in two ways: (1) adversely, if it enables him to increase his military capabilities, and (2) beneficially, by his payments for our goods. How much do increases in his military capabilities matter to us? And how could we gauge our own economic benefits?

HIS MILITARY GAINS AND OUR SECURITY

At present COCOM restricts all military exports and all dual-use technologies thought to enhance communist military capabilities. As argued in the previous section, enhanced *military* capabilities are not equivalent to enhanced *technological* capabilities. The mere use of an advanced technology by an adversary's military does not imply an increase in capabilities beyond those increases made possible by the allowed exports in unlimited quantities and without regard to end use of most commodities. The conclusion was that one must go beyond such simple criteria for restriction as (1) the item has military uses and (2) it contains a technology unavailable to the adversary.

In this section, a similar argument is made. Export control policy implies that it is a sufficient reason for embargoing a good that the good would enhance an adversary's military capability. Furthermore, export controls are often justified in terms of the preservation of a technological gap between the West and the communist nations. In this section, I wish simply to point out that such a criterion and such a justification are again too gross. We might well export some goods that enhance an adversary's military capabilities. Again, we must go beyond a simple criterion and consider the *importance*, and not just the *existence*, of whatever military enhancement might occur.

How much do particular military gains by an adversary matter for our security--or, indeed, do certain gains matter at all? What is the "exchange rate" between his gains and our losses? Under some models,

these questions are not difficult at all. Most treatments of trade with an adversary presume, for simplicity, a bipolar world with a zero-sum military relationship.* "Relative military advantage" is the quantity to be maximized; under such conditions, the adversary's gain is our loss, measurable in principle along some single national security metric. And if the arithmetic difference between our national security score and theirs is to be maximized, it means that all gains by them or losses by us of equal magnitude are equivalent, no matter what level of national security either of us had beforehand.

This formulation is in some ultimate sense tautologically true. *If* one had a grand metric of national security that *were* a function of the difference between our security score and the adversary's, there would indeed be a zero-sum, bipolar situation. The problem is that we have no such metric--and, from all evidence, such a grand metric would correlate quite poorly with scales like the relative number of missiles or quantity of fighters or, to be more germane, the size of various "technological gaps" with military relevance.

There are a number of reasons why such simple metrics are faulty.

1. *Nonlinearity*. Even in duels, the archetypal zero-sum situation, the advantage we reap from a certain lead over the adversary often depends on what level each of us has, as well as on the type of lead. Having a one-rifle lead would be all important if we had one and he none; it might be of almost no consequence if we had fifty and he forty-nine. An advantage on land may be linear to proportional superiority in troops; some argue that the advantage at sea or in the air is, qualifications aside, quadratic to proportional superiority in ships or planes.†

2. *Non-zero-sum considerations*. As soon as the power to hurt becomes important, conflict becomes non-zero-sum. "Deterrence," "accidental war," "brinkmanship," "alliances," "arms race," "arms control," and even "threats"--all central concerns of defense policy--have no

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*See, for example, Osgood (1957), Wan (1961), Gift (1969), and Wolf (1973b).

†Hoag (1961, p. 510).

meaning in a zero-sum context.* Even if we have the superiority to defeat an adversary, we may not want to, if he can hurt us to an unacceptable degree in the process. And even if he could defeat us in the end, we may be able to credibly *threaten* an unacceptable loss to him and thereby coerce his acquiescence.† In such circumstances, as Henry Kissinger has written, "to seek safety in numerical superiority, or even in superior destructiveness, may come close to a Maginot-line mentality--to seek in numbers a substitute for conception."‡

The clearest examples of non-zero-sum aspects occur when one considers the stability of peace and the role of arms in deterring unfavorable actions, both "strategic" and "tactical," by the adversary. In the simplest case, our superiority in a military area may be destabilizing and therefore undesirable, perhaps by giving the adversary an incentive to strike first in order to disarm us, for fear that we may utilize our advantage; or by leading to a spiral of arms spending, as first he, then we, strive to catch up and get ahead. In such cases, what matters is not captured by our relative numerical advantage along some dimension like number of missiles or airplanes. Thomas Schelling has argued as follows:

> As to criteria, the first thing to emphasize is that it takes a good deal of strategic analysis to decide whether a particular limitation or augmentation of weapons or facilities is a good one or a bad one. . . . One has to ask whether the technological and economic consequences of a particular scheme are or are not conducive to military stability; and the answer is very unlikely to be closely correlated with whether more weapons or fewer weapons are involved, bigger weapons or smaller ones, or even whether notions of "more" and "less," "bigger" and "smaller," can be applied.**

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*Schelling (1967).

†See, in general, Schelling (1966).

‡Kissinger (1957, p. 61).

**Schelling (1961, p. 171). Schelling (1967) concludes that *no* simple "exchange rate" can be devised to translate the adversary's costs and benefits to our own, precisely because of the non-zero-sum nature of military relationships.

These are stark examples. But much of U.S. defense policy, in its broadest public formulations, pays particular attention to the non-zero-sum aspects of both the strategic and tactical* military situation. President Nixon has recently gone so far as to note that:

> In the nuclear era, both the United States and the Soviet Union have found that an increment of military power does not necessarily represent an increment of usable political strength.†

Henry Kissinger (1973, p. 2) voices a similar view:

> In the past, it would have been inconceivable to any statesman that he could ever have too much power, and any increment of power was politically useful. In the contemporary period, we are in a situation. . . where additional increments do not necessarily have either military or political significance.

3. *Multipolarity*. In the early days of export controls, the communists were homogeneous and the threat was thought to be near-term; now the communists are divided, even militarily, and U.S. defense planning takes a long-term perspective. Yet much of the logic and the procedures of export restrictions have remained the same. Unlike the early 1950s, the military world is now multipolar. Most importantly, this fact means that treating China and the Soviet Union in export control policy as if they posed identical military threats is a mistake. It is quite possible that exports to either country would have more

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*Non-zero-sum considerations do not apply to so-called "strategic" areas alone, but also to "tactical" situations. Zero-sum models are sometimes useful to model tactical interactions, but only when there are fixed resources and no intention of influencing the enemy's intentions (Schelling, 1967). Schelling (1966) offers several examples of the non-zero-sum aspects of limited warfare, European conventional conflict, and passive and active defenses against nonnuclear attacks (e.g., pp. 79, 107f, 112). He also offers numerous historical examples of deterrence and other non-zero-sum aspects of "arms and influence" that greatly antedate the introduction of strategic nuclear weapons (Chapter 1).

†Nixon (1973, p. 194).

effect on Sino-Soviet relations than on U.S.-Soviet or U.S.-Chinese interactions; that, to be purely hypothetical, exporting tactical air defense systems to China might *enhance* U.S. security overall.* Similarly, differential treatment of the different countries of Eastern Europe might reinforce desirable behavior. Actions that might affect Sino-Soviet relations in a way beneficial to the United States, or improve relations with particular bloc countries, would often be rejected from the point of view of bipolarity--one world, two sides, them and us. This is true in export policy and elsewhere.

IMPLICATIONS FOR EXPORT CONTROL POLICY

The point of citing these considerations is certainly *not* that all military leads are unimportant. Military gains by an adversary may entail a decisive loss for us. The point is that simple functions that attempt to relate communist military gains to U.S. losses are misleading; searching for simple rules of thumb to relate the two is not merely inaccurate but may do violence to what we really mean by national security. And the point of all these "maybes" is to counter simple arguments that *assume* the opposite: arguments that are often used to justify export controls, to define restricted items, and to measure the benefits of present policies.

A syllogism often used to defend export controls looks like this:

1. The U.S. invests in military R&D to produce a technological advantage.
2. Trading technology gives the gap away.
3. Therefore, restrict such trade.

Indeed, the worth of export controls is often described by government officials as equal to the amount of money necessary to produce the technological gap.

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*Exporting some military technologies even in a bipolar world might be desirable, were they stabilizing: for example, a more error-free early warning system that would reduce the chance of false nuclear alarm. For other suggestions, see Schelling (1961).

But the notion of a gap, in use if not in theory, is basically zero-sum: his gain is our loss, and we want to maximize our relative advantage. Despite recognition in high-level defense policy of the non-zero-sum nature of competition in military technology,* not to mention competition in bombers, missiles, and multiple warheads, many defense advocates return again and again to metrics like gaps, to metaphors of "ahead" and "behind," to goals like "superiority."† Discussions of the technology gap and its importance for national security often must struggle to be consistent with the rest of U.S. defense policy. For example, the need for technological *superiority* is sometimes derived from (or equated to) the quite non-zero-sum concept of *sufficiency* in the area of strategic deterrence.‡

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*For example, Nixon (1973, p. 203): "If competition in technology proceeds without restraint, forces capable of destroying the retaliatory forces of the other side could be developed; or the thrust of technology could produce such a result without deliberate decisions."

†Bazell (1971, p. 707) attributes a selfish motivation to this tendency: "Research and development has thus appeared as the latest generation in the family of gaps that the Defense Department presents. . . as rationale for increased funds." One need not be so cynical. Gaps are measurable (at least in theory); "ahead" and "behind" are clearly understood. In contrast, pleas for non-zero-sum subtleties, inevitably complicated, result in a lack of global metrics and, sometimes, the abandonment of habitual modes of thought.

‡Two examples are "sufficient." First, author Hanson Baldwin performs definitional prestidigitation:

> Since deterrence is a knife-edge formula--easily upset, easily changed--and since the political and psychological results of inferiority would be highly dangerous to the United States and destablizing for the world, "sufficiency," in this context, must mean a clear-cut and visible U.S. qualitative and quantitative superiority.

"Equivocation on this issue," he adds forebodingly, "risks the life of the nation." (Baldwin, 1970, p. 295.)

Second, in his 1973 statement to Congress, Director of Defense Research and Engineering John Foster, Jr., defines his directorate's mission as "sufficiency" in a quite straightforward way:

> The objective of our strategic R&D program is to insure that we have *adequate* strategic forces of *sufficient* quality to deter any nuclear attack, or coercion by the threat of nuclear attack, on the United States or its allies. (1973, p. 5-1, emphasis added)

The point is that simple-minded gapmanship is no longer a credible or sufficient argument--for export controls or for any other defense policy. The desire to maximize the gap, or to use it as a measure of national security, prompts one to overlook the fact that (1) a military lead may not be an advantage, (2) a technological lead does not necessarily imply a military lead, (3) the technology traded often has little to do with the specialized technology produced by military R&D, (4) the cost of having attained a lead usually will not be equal to the value of having it (some costs were incurred not to produce a lead but to get certain absolute levels of performance; the lead may be incidental; it could be caused by uncontrollable private sector differences), and (5) the various measures used to gauge the gap (time, performance characteristics, dollar costs for us to get it or for them to overcome it) have no direct connection with the gap's security importance.*

But then sufficiency is first said to imply that the U.S. needs "to avoid technological inferiority" (p. 1-2) and second, that since the Soviets want technological superiority, so should we. After all, he argues,

> . . . the Soviet Union has long felt that, in the struggle between the two social systems, science and technology will be the most important field of competition and that whoever wins this race will end up being the predominant power (p. 2-2);

and the Soviets are making a

> determined effort to wrest military technological superiority from us (p. 1-2);

therefore,

> it will remain our policy to maintain technological superiority in specific areas essential to our military strength (p. 1-2).

(There is no mention of the obvious symmetry, consequently there is no anticipation of a Russian counterpart to Foster citing him and saying, "Since the U.S. wants technological superiority . . ."). Foster concludes that "sufficiency" entails "superiority": ". . . the United States must take actions that are necessary to maintain a *sufficient* technological *lead* to preserve an adequate strategic posture." (p. 5-2, emphasis added)

*A technological lead *may* be important for security reasons; this paragraph merely lists the logical steps often left out by gap advocates.

The objective of this discussion has been to dispel the use of simple justifications and one-dimensional metrics in export control policy. We should not automatically restrict military exports or other sales, even if they would be likely to enhance military capabilities. The implication is that we must proceed to the details of particular cases and consider military importance, not just military enhancement, when we make export control decisions. Suggestions on how current export control procedures could be refined to do this are found in the last section.

OUR ECONOMIC GAINS FROM EXPORTS TO THE ADVERSARY

Despite the persistent claims by business interests that trade controls imply large sales losses, estimating the foregone export volume accurately is a formidable problem. Export restrictions are only one of a large number of impediments to increased East-West trade. The amount of Soviet imports may be constrained by a policy of trade balance or by limited hard currency, meaning that the hypothetical increased sales of controlled goods might only substitute for present exports. Trade depends heavily on political decisions and national economic policies; since many of these are presently in flux, inferences from analyses of past trade data can be misleading. For these reasons, estimates of the restrictive effects of export controls must be highly speculative.*

These steps are often missing in the logic of military procurement and R&D in general, not just in export control discussions. A number of recent studies find that many U.S. defense expenditures do not seem founded on a convincing demonstration of the strategic or tactical importance of the new products thus procured. Instead, one finds (1) the desire to avoid military inferiority, fueled by uncertainty about enemy capabilities and long procurement horizons, which, in turn, fuels the arms race, and (2) pressures from within the Defense Department and from defense suppliers for the best and the latest. See, for example, Allison and Morris (1974); Kurth (1971, 1972); Halperin (1972); and York (1970).

*Wolf (1973b) examines the past impact of U.S. *unilateral* controls, obtaining a figure of $215-$300 million of foregone sales in 1968; but since the U.S. list was drastically shortened to near the COCOM level in May 1973, Wolf's estimate is only of academic interest. Similar remarks apply to his "The Quantitative Impact of Liberalization of United States Unilateral Restrictions on Trade with the Socialist

John Picard Stein (1974), however, takes the interesting approach of attempting to gauge an *upper limit* for potential exports. Even when estimates of averages are completely unreliable, estimates of bounds may be robust. He uses the specific case of computer sales to Eastern Europe and the Soviet Union (EESU) to develop a multiple regression methodology for the estimation of potential demand.

To assess an upper bound, Stein posits the most favorable environment for computer exports: the removal of export controls, no limits on communist payment potential, and compatibility of Western machines with Eastern needs and infrastructure. He assumes that, with certain economic and "structural" features held constant, EESU will demand as many computers per capita as the Western European countries. This is an optimistic approach, for at present, EESU use far fewer data processing machines than the West; but for purposes of estimating an upper bound, Stein (1974) properly adopts the view that current differences in computer demand, after controlling for the other features, are due to export controls and other East-West trade impediments.

Estimates of the upper bounds of the EESU *demand* for computers, thus generated, can then be compared with the planned *supply* from EESU producers. Stein assumes a conservatively low production schedule--that EESU will produce only 40 percent of the expansion targeted through 1985. Then, by subtracting this conservatively low estimate of EESU supply from the optimistically high estimate of demand, he obtains an upper limit for EESU computer imports from the West.

Countries of Eastern Europe," (1971) and Chapter 8 of his *U.S. East-West Trade Policy* (1973b). Various estimates of aggregate Soviet-Western trade in 1980 are made by Kaser (1973, pp. 7-8), but he does not estimate the restrictive effects of COCOM controls. The volume of foregone trade is not the only economic dimension of interest. One should also consider balance of payments effects and distributional equity. Furthermore, transfers of technology may spawn communist economic competitors. However, both the possibility of this occurrence and its desirability are open to dispute, with little hope for empirical resolution of the disagreement given the present state of knowledge: Whether withholding trade creates or avoids creating foreign competition depends on whether one considers their firms to resemble Japanese-style imitators or infant industries needing protection; whether foreign competition is desirable depends in part on whether one is a mercantilist or a free-trader.

The result is that, through 1985, Western nations would at most provide a cumulative total of $4.6 billion in data processing equipment to EESU. (This averages $386 million annually.) If U.S. firms would get as much as 75 percent of this figure, the total would be $289 million a year, or 4 percent of overall U.S. sales.

Do trade controls also imply foregone technological *imports* from communist countries? There is probably no relationship, since COCOM restrictions do not apply to imports, and there is no evidence of comparable export controls in the USSR.* Still, there may be some way that loosening Western controls would improve U.S. access to certain areas of communist technological superiority, perhaps via some exchange mechanism.†

In summary: The economic benefits that would accrue from changes in export control policy are difficult to assess. Stein's methodology offers a way to bound Western trade gains. Even this upper limit of future computer sales is considerably lower than many members of the U.S. business community have projected.

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*"It is interesting to note that the USSR allows us to import, on a regular basis, a sizable list of strategic commodities despite the Vietnam War: platinum, iridium, palladium, rhodium, nickel, magnesium, titanium, cadmium, chrome ore, molybdenum, and aluminum scrap." (Holzman, 1973, p. 664n)

†For a discussion of technological *quid pro quos*, see DeHaven (1974).

V. THE USES OF EXPORT CONTROLS

After considering the impact of our exports on the adversary and on ourselves, we may decide we wish to restrict certain sales. There are a number of techniques we could employ to do so. One of them is an embargo on selected goods, which has been the choice of the COCOM allies. We might have more than one purpose in mind when we restrict sales, besides the consideration of an adversary's possible military gains;* and, whether we wish it or not, our restrictions may have other effects and uses besides diminishing exports.

This section treats various aspects of the use of export controls as a policy instrument. It considers three questions:

1. How *effective* is an embargo in achieving its objective of curtailing the transfer of goods and technologies?
2. How *efficient* is an embargo compared to alternative policies of export restriction, such as taxes and quotas?
3. What other *purposes* might export restrictions serve, intentionally or unintentionally, aside from diminishing certain foreign sales with military implications?

THE EFFECTIVENESS OF AN EMBARGO

Embargoes are notoriously leaky. Cipolla (1965) provides an informative and often amusing account of attempts to embargo the transfer of cannon technology in the sixteenth and seventeenth centuries. There are several interesting lessons regarding the effectiveness in those times of export restrictions.

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*U.S. legislation allows exports to be restricted for three purposes: (1) to control sales with security implications (the purpose behind COCOM and CCL controls); (2) to prohibit exports of goods in "short supply" domestically (for example, the quantitative restrictions imposed in the summer of 1973 on U.S. sales of soybeans abroad), and (3) for other "national purposes" (a rationale never actually used, but one discussed recently in the Senate as possible justification for retaliatory economic sanctions against the Arab petroleum embargo).

First, there were important political pressures to embargo this militarily important technology, even though it was of great commercial value, and the resulting regulations were an administrative nightmare.*

Second, despite the imposition of embargoes and other export restrictions, the transfer of technicians, tools, "know-how," and hardware was constant and large, even to "enemies."†

Third, even though technology transfers took place, the recipients were usually unable to take advantage of them, due to basic industrial and cultural differences. Technology transfer is hardly automatic.‡

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*The British attained a significant lead in the technology of cast-iron cannons in the sixteenth century. "English guns were, in the words of Sir Walter Raleigh, 'a jewel of great value'; why, argued the politicians, should the English place such 'a jewel' in the hands of potential enemies?" (p. 44-45) As a result of such pressures, in 1574 Queen Elizabeth restricted cannon exports. "From that time onward the export of guns was a point of contention between gun founders anxious to sell as large a number of guns as possible whether at home or abroad and politicans no less eager to prohibit this export altogether. The natural result was a succession of petitions, proposals, arguments and counter-arguments, Acts of Parliament and regulations of licenses on a scale sufficient to delight the heart of any Dr. Parkinson of those days." (p. 45) The Dutch developed their own industry and were prominent exporters, even of entire plants for the production of cannons. There were similar pressures for embargo. For example, in 1645 the chief of the Dutch factory in Nagasaki wrote that "'these mortars are great jewels and one may well ask whether it had not been wiser never to have taught this proud and haughty nation about them . . . (as to the request by the Japanese authorities for the loan of a gun-founder) we ought to be rather evasive and fob them off with polite nothings.'" (p. 112)

†Cipolla gives many examples, among them Spain and Turkey; but two interesting ones concern the Russians and the Chinese. The Dutch established a gun foundry in Russia in the 1630's. China used Western technicians to develop their cannon industries, and usually these technicians were Jesuit priests, a fact that led Historian M. Chiang to write, "While Buddha came to China on white elephants, Christ was borne on cannon balls." (Cipolla, 1965, pp. 115-116).

‡Most transfers to the Spaniards and Turks were unsuccessful. And "the products of the Russian foundries could be offered at a very low price in Amsterdam, but their quality was extremely poor, and still at the end of the seventeenth century Russian production was not considered very important. . . . [T]he cannon produced at the Russian factories (only up to 24-pounders) 'were exported via Archangel to Holland where they generally blew up at their testing'." (Cipolla,

It is also true today that commercial sales and transfers of hardware and technology are difficult to restrict. Illegal trade, smuggling, espionage, and theft are used to obtain embargoed goods.* Export control officials mention "widespread" illegal transactions in China; the Commerce Department's quarterly report *Export Controls* cites discovered violators and their punishments; and U.S. publications lament that other COCOM countries do not devote sufficient resources to enforcement of the embargo.† Furthermore, modern technologies are often transferred through noncommercial channels. Publications, exchanges of scholars and students, trade fairs, and even the process of negotiating possible sales--all can be important conduits of knowledge and "know-how." It is very hard, and sometimes illegal, to try to control these flows.

As a result of this inevitable leakiness, an embargo cannot be expected to restrict *absolutely* the access by adversaries to unclassified, commercial technology. It is widely admitted by export control officials that the communist nations "can get one of any good they want." And even limited leakiness can have important consequences. If a particular technology is embodied in the good (as, I am told, in the case of miniaturized rockets) or if the good gives away a militarily relevant "secret" (as may be the case with certain civilian-use jet engines),‡ one exemplar in the hands of an adversary can cause a loss in national security. An embargo would be ill-advised if its justification demanded absolute unavailability to the adversary.

This fact, however, does not imply that export controls are futile. The "extractability" of the technologies embodied in currently restricted commodities is, according to export control officials, seldom an issue.

1965, p. 60) As to the Chinese failure despite "the technical assistance of the Jesuits, a good supply of raw materials, native wit and ingenuity," Cipolla says, "I would be inclined to remark that what was at issue was not only technical skill, but also taste, cultural pride and institutions." (p. 117)

*Adler-Karlsson (1968, pp. 196-197) offers an educated guess that such illegal activities accounted for $25 to $50 million of communist acquisitions during the 1950s.

†See, for example, U.S. Department of Commerce (1973).

‡See p. 34, note (†).

Communist possession of a single exemplar is not considered a significant help in their possessing or mastering its technological secrets.* For example, most advances in computer technology are not embodied in the machinery. The Soviets may possess the West's most advanced computer disks and marvel at how closely to the disk the air bearing floats; but observing the disk contributes little to their ability to produce it. The Soviet Union is lacking in capabilities for large-scale production of certain computers and components, and possession of a few Western exemplars will not be a significant step toward overcoming these problems.

But the flows of knowledge and information from West to East pose a different problem. Perhaps in recognition of the fact that such flows are difficult to curtail, advocates of export controls point out that the embargo is not designed to restrict the "technology of the laboratory" but rather "the technology of the factory." The target is the practical use of technology that communist imports above leaky levels (and the concomitant technical assistance from exporters) may assist; this technology is all that the embargo can stop and, it is maintained, all it was intended to stop.†

This admission has an interesting implication for another major motivation of export controls and of technological competition with the

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*Interviews with officials from the Departments of Defense and State, January 1974. Nonetheless, end-use safeguards frequently include measures that are designed to inhibit the use of exports as prototypes for study and imitation.

†It is ironic that many experts believe that it is precisely "the technology of the factory" that cannot be *shared*, never mind stopped. For example, in a study of the U.S.-European technology gap, the Hornig Report argued that the Europeans were not effectively *utilizing* the technology that had been transferred to them and created by them, and that therein lay the cause of the gap (Interdepartmental Committee on the Technology Gap, 1967). Much of the literature on attempts to subsidize the transfer of industrial technology to developing countries makes the same point. And many Sovietologists "suggest that the problem with technology arises not so much from lack of know-how, although this may contribute, but rather from problems of organization [and]. . .the poor incentive-motivational system." (Holzman, 1973, pp. 667-668). Judy (1970) documents the pattern of Soviet acquisition of computer technology since 1950. In his long list of barriers to such transfers, export controls are not mentioned: rather, social and economic differences of the broadest sort.

Soviets in general: the fear of a technological surprise. Insofar as such breakthroughs are understood, they proceed from research in fundamental science, rather than from the "technology of the factory."* Even if it is *not* true that

> . . . [T]he USSR has focused more on continuous evolutionary growth of capability in numerous small steps, whereas the U.S. has been inclined to reach for larger step improvements less frequently.†

but rather pursues "leapfrog techniques [that] create dangers of technological surprise,"‡ it is not clear what Western trade embargoes can do about the possibility of a breakthrough. Apparently, the Soviets are the equals of the West in many areas of basic scientific theory and research; fundamental scientific information flows freely through publication channels, at least from West to East; and export controls admittedly cannot affect "the technology of the laboratory." If trade restrictions must ultimately base themselves on the desire to avoid big Soviet breakthroughs, the case is a difficult one to make.**

Dynamic Effectiveness of an Embargo

On a different note, although still relating to the effectiveness of trade controls, many writers have argued that withholding certain technologies serves to *promote* communist self-sufficiency and competence

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*See Wiesner (cited in The Center for Strategic Studies, 1967, p. 12): ". . . [T]he more fundamental investigations scientists do, the more likely such a discovery is." The Center For Strategic Studies (p. vii) draws the following "policy implication" from the study:

> Accelerate fundamental research especially in those border areas of science that produce technological breakthroughs. All the quantum jumps in military technology have come from the fusion of two or more sciences.

†Elliot Richardson (1973, p. 30); Bazell (1971, p. 708) states that "virtually every major innovation of the arms race has been the product of U.S. technology."

‡The Center for Strategic Studies (1967, pp. vi, 18).

**Large computers may be an exception, since many important uses of the biggest restricted machines are in basic scientific research.

in precisely those areas. The Committee for Economic Development (1972, p. 27) says about trade restrictions that

> In some cases their effect on security may actually be negative. By withholding important products or technology from countries such as the USSR and China, we may encourage them to develop the needed technology and productive capability, thus strengthening their capacity for future conflict.

"In C. P. Kindleberger's general formulation, in the case of a denial of trade, 'The loss from less efficient allocation of resources . . . may be offset by . . . advantages in undertaking the production of new goods;' and 'if the most probable time of military conflict is remote, the static benefit [to the one who denies trade] may well be less than the dynamic loss.'"* Thus, by forcing the Soviet military to be self-sufficient, "there may be long-run gains [for them] and development of greater independence."†

The argument is interesting, but it is not compelling without empirical evidence.‡ Examples from Japan and Europe can be invoked to demonstrate how technological trade can lead to greater (not less) long-run productive capacity and autonomy. Soviet trade strategy is apparently geared to import only those items not producible at home, precisely in order to maximize self-sufficiency.** Insofar as technology can be imported and then imitated, trade would not necessarily impair

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*Leites (1974).

†Holzman (1973, p. 667).

‡Wilczynski (1969, p. 286) offers an example:

> As a result of the sudden West German ban on the export of large-diameter welded pipes to the USSR in 1963, the Soviets constructed necessary plants at Cheliabinsk, Novomoskovsk, and Shadnovsk in a few months. The Soviet Union now claims to be the world's leading producer (600,000 tons annually), and a plan has been announced to build another factory at Volgograd.

**It is likely that the Soviet policy of importing only that which it considered necessary and limiting exports to those needed to pay for imports will be continued, since import needs far exceed capabilities. (Smith, 1973, p. 285)

self-sufficiency; it could enable autarky to flourish more rapidly. The answer is not clear *a priori*.

To summarize these general considerations of the effectiveness of an embargo:

1. The embargo is leaky; the communists can get one of any restricted commodity they want. To the extent that the justification for restricting a particular good depends on its being absolutely unavailable to the adversary, an embargo is probably ill-advised.
2. "Technological surprises" are not impeded by export controls, to the extent that (a) the former depend on breakthroughs in basic science and (b) flows of information and technology relevant to basic science are not affected by the latter. The availability of large computers may be an exception, since such machines have important scientific applications.
3. Not trading with an adversary might force him to become more self-sufficient than one might like; but trading with him might enable quicker and more productive autarky. Either is possible; neither is obvious.

THE EFFICIENCY OF AN EMBARGO

Given a desire to restrict exports of certain goods to certain countries, is a selective embargo the most efficient choice? Several theoretical considerations suggest not. An embargo is a crude tool. By absolutely restricting trade in a particular product, we not only imply that its export creates certain undesirable externalities. This sanction also means that no price is sufficient to compensate for those externalities. But in theory, there is surely some price at which we would be willing to sell even the most advanced computer technology--and, pushing the logic to its culmination, even the most important military good. In theory, instead of an embargo, a more efficient choice would be an export tax, its amount chosen to compensate for the externality that the export creates.

International trade theory creates a rich literature on optimal

restrictions of free trade. If certain exacting conditions are met,* tariffs, quotas, embargoes, state trade monopolies, subsidies, and other departures from *laissez-faire* practice are not rational. But in a world where these conditions are clearly not satisfied, such as when national security externalities are involved, "second-best" measures can become preferred policies.† If the resources of other nations matter to a government and a transaction affects those resources in a way it values negatively, some optimal tariff ought to exist as compensation.‡ Unless the negative value is infinitely large, economic theory indicates that an embargo is inefficient. If the externality only occurs after some quantity of a certain good is sold, an export quota might also be preferred to an embargo.

But theoretical efficiency does not entail administrative usefulness. Some of the problems with optimal tariff approaches to the export control problem have already been cited. The conceptual advantages of a (continuous) tax schedule on exports rather than a (discontinuous) embargo probably evaporate when the following practical points are considered:

1. There is no readily-available "security metric" to assign negative utility to communist military gains (see above, pp. 55-62). In practice, the precise magnitude of the disbenefits from communist possession of various technological developments can be estimated, if at all, only in a complicated, case-by-case fashion.

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*"These conditions are, roughly speaking, competition, indifference of factors with respect to the industry in which they are employed, and absence of external economies and diseconomies." (Haberler, 1950, reprinted in Caves and Johnson, 1968, p. 214)

†A recent article that brings together much of the enormous literature on distortions and optimal policy under a general analytical framework is Bhagwati (1971). Distortions are necessary but not sufficient conditions for deviations from free trade policies.

‡Since tariffs also affect domestic incomes and prices as well as enemy consumption, the tariff will not be equal to the dollar value of the externality created but will be devised to make the government indifferent between the sale occurring and not. For the algebra, given a national security externality, see Osgood (1957) and Wolf (1973b).

2. Determining the correct tariff depends on the specification of relevant demand schedules, offer curves, market imperfections, and so on--an impossibly complicated task.
3. The 15 COCOM nations would find it very difficult to agree on the appropriate tariff for each sale, especially depending on which member country were making the deal and what particular security externality might be involved. The already encumbered negotiations that surround COCOM list reviews and exception requests would be further complicated by at least an order of magnitude.
4. The political impact of such tariffs would probably be unfavorable, both in the communist countries and in many domestic interest groups. The present embargo, which can be interpreted as saying that national security is not to be sold at any price, provides a comfortable refuge from potential criticisms that the price is wrong or that the policy is antagonistic. Absolute prohibition, which even if unjustified is the status quo and understood by all, may cause less political resistance than a tariff whose magnitude can only be justified by tortuous argument and perhaps not precisely even then.
5. Getting Western governments into the export tariff business may set a bad precedent. It may even be illegal under Article I, Section 9, of the U.S. Constitution for the government to assess such taxes on exports.
6. The administrative costs of enforcing the appropriate tariffs would be large.

To summarize on the efficiency of an embargo: If one ignores practical problems, an embargo is less efficient than an export tax; but problems of tax determination and collection far exceed those of embargo supervision. Some system of "second-best" export taxes--relatively simple, somewhat arbitrary, and less than prohibitive--may be possible for goods that are currently controlled. But the political, legal, and administrative aspects of such a scheme should first be carefully appraised.

OTHER PURPOSES OF EXPORT RESTRICTIONS

Restrictive national economic policies like export controls might be imposed for many reasons. To aim only at an enemy's military capability, as current COCOM controls do, is a special case; it may also be a special case to worry about an "enemy." If the success of the Middle Eastern oil embargo has fueled a new interest in economic measures as coercive devices against adversaries, it is also true that economic competition from allies (or its alleged lack, as in Servant-Schreiber and the complaints of less developed countries) has stirred an interest in economic policies that might curtail "give-aways" (or prevent economic dependency). And U.S. fears of food shortages have led to the imposition of "short supply" export controls on some agricultural goods, where foreign buyers are not allowed to outbid artificially controlled domestic prices. Even in cases where only national economic welfare is the concern, export controls and other economic policies may become relevant. When considering security export controls, then, one should not be misled into thereby passing judgment on controls with economic motives. They are a separate concern.

Even within the framework of militarily motivated export controls, it is worth mentioning that many important security risks may not involve the communist nations. Certain significant military goods--miniaturized rockets, infantry weapons, biological matter, antiaircraft missiles--might be less harmful to U.S. security if sold to Russia or China than in the hands of guerrillas or Arabs or Jews. This may also be true of some dual-use technologies, although no good example comes directly to mind. World order may be less threatened by sophisticated military aircraft sold to the governments of China or Czechoslovakia than by much tamer commodities in the hands of violent subnational groups or noncommunist governments in dispute.*

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*It is worth raising, in this context, the issue of exporting strictly military goods to communist nations. The current COCOM ban on all military exports is not based on their uniform, qualitatively-significant potential contribution to the communist technological frontier nor on some rationale of administrative feasibility. The ban is straightforwardly political: no U.S. administration wishes to pose the issue of arms exports to the communists. There have been few pressures for such sales (no munitions makers would dare suggest it, the Soviets appear to desire military self-sufficiency dogmatically). When an

Signaling

Particular export decisions that favor particular countries may be useful (or inadvertent) signals of national intentions or desires. In an international environment where words are cheap, trade can be an important currency of communication; but only if trade is not completely unrestricted. Otherwise, nations do not communicate, only firms.

There is evidence that COCOM has sometimes been used as a signaling device. Certain exception requests approved by the United States for China in the early 1970s were probably intended as signals, rather than being motivated by economic desires or by consistency with COCOM precedents. COCOM lists have systematically favored Poland and Romania; the U.S. CCL favors Romania.

The legalistic nature of COCOM, however, limits the degree to which exceptions for signaling purposes are feasible, since precedents are quickly seized upon.

"Signaling"--and other, more direct forms of communication--also occurs in COCOM with respect to allies. In early days, COCOM debates apparently served as means of expressing broader displeasures, especially by the Europeans. Currently, many U.S. officials believe a chief benefit of COCOM to American allies is the chance it offers for industrial intelligence. The other members are said to learn in detail

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issue is undiscussed, the answer implicitly accepted may be conveniently relegated to the class of truths not requiring empirical argument. "There is, in fact, no neat dividing line between arms at one end of the spectrum and consumer goods at the other," admits Philip E. Uren (1966, p. 115), "but, since *a priori* arms exports are politically and strategically undesirable, a line must be drawn." No mention of price here (permitting no arms exports to the communists implies that no sum would be enough, which seems clearly false); no mention of fungibility; no mention of the theoretical possibility that for the United States to supply some Czech or Chinese arms might be stablizing, dependency-inducing, and helpful both to their *civilian* sector and our own. Since there is thought to be no chance that the United States or COCOM will soon allow arms exports to the communists, many advocates of increased East-West trade kowtow to this "obvious" restriction, even as they cite principles that belie it. The ban is not directly related to U.S. security risks or Soviet gains from trade, but is symbolic and political; and the reasoning may not withstand scrutiny if and when it receives it.

about new U.S. products;* they also have the chance to study U.S.-Eastern trade contacts, with hopes of duplication.†

Insurance

COCOM can also be seen as an (expensive) insurance policy. Even if export controls were currently unwise and inefficient, it might be contended that their worth resides in their role should hostilities break out. If war occurred and something like COCOM were not already in existence, export controls would be difficult to implement quickly and effectively. The value of such insurance depends on one's assessment of the potential importance of export restrictions in the future as well as the cost of the premium.

Bargaining Chip

Even if export restrictions were irrational from the perspective of their avowed purpose, they do exist. They are part of the status quo. If their removal could be used as a bargaining chip to obtain some reciprocal benefits--from the Soviet Union or China, from Eastern European countries, even from our COCOM allies--it would be foolish to relax them freely.‡

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*Ironically, in 1954, when the British published the hitherto classified COCOM list for the first time in the *Board of Trade Journal*, the U.S. complained that it gave the communists direct information about which goods Western experts considered most important militarily--that these "trade secrets," now available for a shilling, were in themselves strategic. (Adler-Karlsson, 1968, p. 93)

†Also ironically, the Europeans reverse the logic, claiming that the same benefit for the United States is the true motivation behind the American continuation of COCOM.

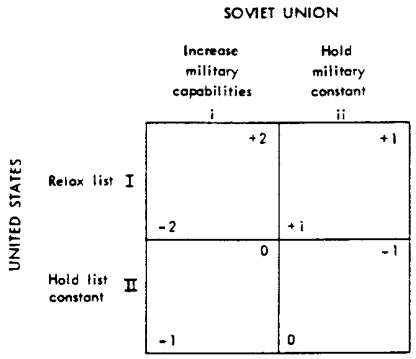
‡Vernon (1974, pp. 249-250) has recently made a similar point in stronger terms:

> During the two decades of the cold war, the economic contacts between the United States and the USSR were reduced to a bare minimum. . . . The United States was busy imposing an Orwellian mesh of bureaucratic controls to choke off any initiatives that its own businessmen happened to offer . . . At times the U.S. bureaucracy seemed to be screening all transactions by one simple criterion: How would an ignorant, though well-meaning, patriotic Congress-

This general point validly represents the simple bargaining logic of export controls. Imagine the two-person version described in Fig. 5.

If the Soviets can promise "ii if I"--that is, to keep their military capabilities at some constant level if the U.S. relaxes export controls--then the desirable upper right hand cell is reached. (The same effect could be had if the Soviets could be forced to move first: They would choose II knowing that the United States would choose i.) Otherwise, by the arbitrary but illustrative way that I have assigned the payoff numbers, the Soviets choose i and the United States chooses II, and both sides are worse off.

Even if the true U.S. payoff from (i, I) were the same as the U.S. payoff from (i, II)--that is, even if export controls were ineffective--the United States might want to *pretend* that (i, II) were higher. Such a stance would enable the U.S. to threaten credibly "II if i," and then the Soviets should be willing to settle on (ii, I). The United States would be foolish merely to announce "I," for the Soviets would then choose i.



(NOTE: Pay-off numbers in the lower left of each cell symbolize U.S. "utility;" those in the upper right, Soviet "utility.")

Fig. 5— Export controls in a hypothetical bargaining situation

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man react? Accordingly, exports were prohibited and imports discouraged even when the effect on U.S. security seemed remote . . . Though restrictions of the cold-war period did not serve U.S. interest well, it does not follow that the simple removal of such restrictions will serve our interests much better."

Such bargaining logic has its limits. There is something perverse about keeping bad policies because they might make good bargaining chips. If both sides follow such tactics, something akin to a tariff war occurs, and everyone is worse off. There is another consideration: To concede or to resist in one bargaining situation may inadvertantly affect the appearance of firmness or sincerity in another.

Nonetheless, to view export controls as part of a bargaining game--and therefore as part of a broader set of East-West relations--puts things in quite a different light than the usual bureaucratic perspective. Instead of COCOM line-drawing, where the question is "Which particular commodities should be restricted?", the issue shifts to diplomatic bargaining, where the question is "What quid pro quos could be obtained from what sorts of policy changes?" And it would not be surprising if two such different questions should have quite different answers.

VI. IMPLICATIONS FOR U.S. POLICY

Much of this report has been skeptical of the conventional wisdom on East-West trade. Doubts have been raised about many popular but insufficiently established beliefs about the political, economic, and national security effects of expanded East-West commercial and technological interaction. Facile presumptions of large *political* benefits seem unjustified. Estimates by Stein (1974) show that the potential *economic* benefits, in the case of computers, are not nearly so large as many have proclaimed, even under the most favorable assumptions. And many of the criteria used to decide when a "*security risk*" occurs have been criticized as insufficient and misleading. In the case of large computers, the security risks of increased exports are probably not as great as heretofore feared; at least the existence of those risks has been insufficiently established.

But this report's most important lessons for U.S. export control policy do not reside in recommendations for particular changes in the COCOM control lists nor in definitive estimates of the security, economic, or political effects. Rather, the report carries implications for *improving the way the U.S. government derives and thinks about export controls*: the questions that should be asked and how they should be answered.

The recommendations are grouped into three areas: (1) redefining national security risks, (2) incorporating economic considerations, and (3) considering export controls in a broader context of international politics.

REDEFINING THE NATIONAL SECURITY RISKS

Our exports can create security risks by giving an adversary more resources, and sometimes qualitatively different resources, that can be used to enhance his military capability. *Given* the rest of current U.S. trade policy, selective export controls that embargo some goods but allow others to flow in unlimited quantities must depend for their justification on the qualitative, capability-enhancing differences

between the restricted and unrestricted goods.* The difference cannot be merely technological, for it is the military enhancement that threatens us. And not all military enhancements create security risks: The effect must be militarily *important*, not just a military addition. As a consequence, list reviews and exception requests must go beyond mere technological assessment.

Ideally, one would like the following questions answered:

1. What *military capabilities* of ours and the adversary's are important? (In what areas? Vis-a-vis what adversary? In what situations? *How* important, as a function of what the adversary(ies) possess?)
2. What *technologies* lead to these military capabilities? (To what degree? With what possibilities for substituting other, perhaps nontechnological resources to obtain the same capabilities?)
3. How do the *adversaries* stand in these technologies (sophistication, production capabilities)? How are they likely to progress? How do we stand and how are we likely to progress?
4. If we "turn the dial" that allows more *trade* and *technology transfer* in these technologies, what is likely to happen (over what time frame) to different adversaries' levels of technology, given their (1) needs and priorities, (2) ability to absorb the technology, and (3) substitution possibilities?
5. If the dial were turned, could capability-enhancing, militarily harmful applications be deterred by end-use safeguards? (What kinds of safeguards? Is the technology "extractable"?)

This is a useful list; but in practice, conclusive answers to such questions would be very difficult to obtain. Granted this point, it must be remembered that at present only two basic questions are considered during list reviews: Does the good have a military use in the

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*Of course, one might object that the rest of U.S. trade policy toward communist nations is itself mistaken, in which case this statement is not necessarily true.

United States? Does it contain a technology not possessed by the communist countries? If the answer to both is "yes," the good is restricted.* Even if exhaustive answers to all the relevant questions prove infeasible to obtain, surely we can avoid confining ourselves to two such simple criteria.

Two sorts of *improvements* are recommended: (1) to involve additional information sources and interests in the present list review process, and (2) to commission special studies.

Additional Information Sources

Currently, COCOM *list reviews* are handled by Working Group 1, an interdepartmental committee chaired by the State Department. Working Group 1 receives technical advice on several major commodity areas from groups of government experts that parallel the Technical Task Groups that assist the Commerce Department in decisions about U.S. unilateral controls.† During both COCOM and CCL list reviews, three basic sources of information are relied upon:

1. The Office of Economic Research of the Central Intelligence Agency, which provides information about the Soviet (and Chinese and Eastern European) "state of the art" in the particular technological areas covered by the COCOM list.
2. The Defense Directorate of Research and Engineering (DDR&E), which provides the loosely structured auspices for a number of Defense Department experts to advise on the use of COCOM-restricted and other technologies in the U.S. military.
3. The Technical Advisory Groups, composed of 10 to 25 members mostly from the business world, that meet quarterly and give

*Furthermore, all strictly military goods are automatically restricted.

†The U.S. unilateral CCL is administered by the Operating Committee. Like Working Group 1, it is composed of middle-level officials from several agencies, only it is administered by Commerce. Since the CCL is now functionally equivalent to the COCOM list, and since it does not matter exactly which department chairs these administrative committees, the Operating Committee and Working Group 1 might profitably be merged, as could their (already overlapping) technical advisory bodies.

some ancillary advice on the parameters that define particular technologies.

The important point to note is that nowhere in this system is there an attempt to link the existence of the technological gap in COCOM-controlled areas with the enhancement of an adversary's military capabilities.

Other organizations have both expertise and information that seems highly relevant to assessing this crucial link between technology and the enhancement of important military capabilities. For example:

(1) Policy Planning and Evaluation staff, Office of the Secretary of Defense.
(2) Staff of the Joint Chiefs.
(3) Office of Strategic Research, Central Intelligence Agency.
(4) Arms Control and Disarmament Agency.

These groups should be drawn into the list review process.

In addition, DDR&E could become much more centrally involved, perhaps via a coordinated effort in the Director's office. Currently, DDR&E's role is limited to suggesting knowledgeable individuals from various defense institutions throughout the country who might provide technical guidance to Working Group 1. Instead, one might imagine a *directed effort* at forming DDR&E's own committees to specify exactly *which technologies matter, how much*, and to *which military capabilities*. Such committees would fit well with DDR&E's mission of assessing U.S. technological needs for defense. It would only be necessary to shift the perspective somewhat: to gauge how what we have would affect us if *adversaries* had it through trade.

There may even be an argument for transferring responsibility within the Defense Department for export control policy from the Assistant Secretary for International Security Affairs to DDR&E.

Special Studies

To incorporate systematically the additional information sources in the current export control process might be expensive, both in

dollars and bureaucratic resistance. The five questions on p. 80 could be investigated in a different fashion: by commissioning special studies.

For example, several of the most debated COCOM commodities (computers, computer peripherals, integrated circuit production machinery, telecommunications equipment, numerically-controlled machine tools, test equipment) might be selected for outside analysis--a study of whether and to what degree their export would enhance communist military capabilities.*

Special studies might also investigate plausible cases of *military* sales to communist countries (fighters to China, for example), which currently are banned outright.

These studies might be performed by outside research organizations, but could also be structured within the government. The key would be to insure that appropriate inputs beyond merely technological ones would be included.

INCORPORATING ECONOMIC CONSIDERATIONS

Current list review decisions do not systematically consider the potential economic results of changes in export controls. In an indirect way, the amounts of pressure for the relaxation of different goods that comes from private firms and other governments reflect their estimations of foregone sales. But within the U.S. government, the economic dimensions are not traded off with the security and political effects of increased exports in any structured fashion.†

The questions one would ideally want answered are the following:

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*Special studies have been performed on some of these commodities, but to my knowledge they confine themselves to descriptions of military *uses* in the United States and of communist technological *inferiority*. The questions listed on p. 80 are not addressed.

†In exception requests, of course, the economic value of the proposed sale is known, and it sometimes plays a part in decisionmaking. But when an exception is approved or disapproved, it sets a precendent for future requests; and it is important to know, when deciding whether to set such a precedent, what the future total of such exports would be. This information is currently not requested.

1. Among restricted items, as the dial of increased trade and technology transfer is turned, what additional sales would occur? (Over what time period? To which nations? From which nations?)
2. What likely *follow-up* or related sales would ensue (spare parts, repairs, and so forth)? Would these imply "dependency," or would there more likely be a "Japanese-style" catch-up?
3. To what extent would additional sales merely *substitute* for current exports? (Consider the effects of credits, quid pro quos, and so forth.)

These questions will be difficult to answer; but at present they are not even asked. Again, two *improvements* can be suggested: (1) to involve additional information sources and interests, and (2) to commission special studies.

Additional Information Sources

Within Commerce's Bureau of East-West Trade, the Office of Export Administration (OEA) handles export control matters. Basically, OEA is composed of administrators and technicians, highly competent in matters of licenses and product performance parameters, but not directed to the study of potential markets and follow-ons. There are, however, several trade promotion groups also within the Bureau, with economic and trade experts who have the training and information to provide estimates of potential communist demand for restricted goods.

The Technical Advisory Groups could be another potential source of market information. Largely composed of business representatives, they could expand their role from the provision of technical information to include estimates by the business community of possible sales.

Special Studies

Stein's methodology, as well as more traditional forms of market surveys, could be applied to key export control commodities by means of special studies. Stein's work could be extended to take account of particular types of computers--their demand and prices--instead of

relying on aggregates and mean prices; and perhaps, with sufficient information, his method could lead to estimates of expected sales, not just upper bounds.

Through both special studies and additional sources of information within the government, economic information could be systematically included as an important factor in list review decisions.

CONSIDERING THE BROADER POLITICAL IMPLICATIONS OF EXPORT CONTROLS

The COCOM list review process now includes little high-level participation. Advocacy by agencies predominates. Middle-level officials battle over the appropriate lines between permissible and restricted commodities.

As a result, important larger issues receive almost no attention. For example:

Case 1. Suppose that

1. The entire structure of COCOM controls seems to be *eroding* fast. It may well be true, as many think, that COCOM will effectively dissolve within three to five years.
2. The United States has an *advantage* over its COCOM allies in the production of many of the restricted goods--notably large computers. The Japanese and others will, in the opinion of some specialists, be able to equal current U.S. capabilities within a few years, but cannot now.

If these two facts are true, the policy question changes markedly. For if COCOM's erosion is inevitable (not to mention desirable) and if exactly when over the next five years does not matter--and if the U.S. comparative advantage in the restricted goods is largest now--the issue may be: How can the U.S. *dramatically relax* controls in the most advantageous way?

Timing is important. Would a dramatic U.S. initiative, perhaps proposing the removal of three-quarters of existing controls, be the best way to maximize U.S. benefits--by increasing the symbolic value, by enabling quid pro quos, by gaining unilateral credit instead of having the erosion occur slowly, painfully, and to no one's credit at

Paris COCOM negotiations? The export control issue may be dramatically different from the way it is currently viewed, escalating from bureaucratic line-drawing to high-level diplomacy, asking "which quid pro quo can be obtained?" rather than "which particular commodities should be restricted?"

The current list review process does not--and probably cannot--consider the issue of export controls as a *bargaining chip*. If they are to be so considered, then the highest levels of U.S. foreign policy determination should be involved.

For another example:

Case 2. Suppose that

1. Decisions about exception requests perform an important role of political *signalling* or of "fine tuning" détente, or they could perform such a role.
2. Simpler and more widely applied end-use safeguards could effectively rule out most serious military risks, without great transaction costs.

If the chief value of controls is as a *medium*, the policy problem once again shifts markedly. The United States might consider retaining (even lengthening) control lists and using exception requests to provide whatever loosening was desired. Once again, top-level leadership must enter.

Who should provide guidance on such issues? The White House Council for International Economic Policy (CIEP) and the National Security Council (NSC) are two candidates. CIEP has recently acquired experience in matters of COCOM controls by conducting an interagency study of restrictions of large computers. NSC, however, has in the past assumed the role of ultimate arbiter of COCOM exception requests, when interagency disagreements could not be resolved. In 1972, NSC ordered an undersecretary-level interagency study of COCOM controls in general, but NSC has failed to act since the report was submitted in early 1973.

In either case, as the 1974-75 list review begins, *strong participation at the highest levels* may be necessary to avoid letting the most important aspects of export controls be decided by default.

Appendix
THE FORMAL STRUCTURE OF THE PROBLEM

The problem, starkly put, is to maximize U.S. benefits from trade with potential adversaries. Consider the case of the Soviet Union. Define the relevant U.S. utility function, U, as follows:

$$U = U(M_{SU}, E_{US}, P_{US}),$$

where M_{SU} is the military power of the Soviet Union, E_{US} is the economic welfare of the United States, and P_{US} refers to the political benefits to the United States. Presumably, U.S. benefits decrease as M_{SU} increases, but they increase with E_{US} and P_{US}.* The rub is that increased trade with the Soviet Union presumably increases E_{US}, P_{US}, *and* M_{SU}.† Since the military disbenefits of increased exports may or may not outweigh the economic and political benefits, increased trade cannot necessarily be said to increase U. The analytical problems are to: (1) estimate how M_{SU}, E_{US}, and P_{US} vary with the level and types of trade; (2) combine M_{SU}, E_{US}, and P_{US} into a single metric of utility, U;‡ and (3) set the level of trade T at the level where U is maximized.

This report has dealt with a number of issues in estimating the effect of M_{SU} on U and the effect of T on M_{SU}.

First, is $\partial U/\partial M_{SU}$ in fact negative, as often presumed? Since stability, multipolarity, deterrence, sufficiency, and other nonzerosum notions are central to U.S. defense policy, it is not clear that every gain in Soviet military power is a U.S. loss, nor that COCOM policy should treat all countries in the "communist bloc" alike.** It might

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*That is, $\partial U/\partial M_{SU} < 0$, $\partial U/\partial E_{US} > 0$, and $\partial U/\partial P_{US} > 0$.

†That is, $\partial M_{SU}/\partial_T > 0$, $\partial E_{US}/\partial_T > 0$, and $\partial P_{US}/\partial_T > 0$.

‡U can be visualized as a tradeoff function among security risks, economic benefits, and political benefits.

**See pp. 55-62.

also be argued that trade affects the Soviet desire to use its military might, thus, in effect, lowering the disutility to the United States of M_{SU}. The pros and cons on this point are plentiful, and the issue seems difficult to assess empirically.*

If $\partial U/\partial M_{SU}$ is negative, how does trade, T, affect M_{SU}? Suppose the Soviet Union comprises a military sector, M, and a civilian sector, C. Suppose further that T conveys two kinds of gains in efficiency: (1) resource-saving gains, R, and (2) capability-enhancing gains at time t, τ_t (for technology). Then define M_{SU} as follows:

$$M_{SU} = M_{SU}(R_M, \tau_{tM}, R_C, \tau_{tC}).$$

The impact of trade on M_{SU} can then be decomposed into several issues.

(1) The fungibility question: What is the value of $\partial R_M/\partial R_C$? It has generally been argued that in a communist economy $\partial R_M/\partial R_C \to 1$, but clearly it depends on the time span, t. As $t \to 0$, $\partial R_M/\partial R_C \to 0$. If the Soviet Union wants to transfer resources from its civilian to its military sector, it probably is able to do so in the medium-run (say, t = 3 to 5 years). Unless short-run Soviet savings of military resources are what export controls desire to avoid, resources saved in the civilian sector can be considered the same as resources saved in the military sector. The end-user is not important insofar as resource-saving goods are concerned.†

(2) $\partial M_{SU}/\partial R_M \approx 0$, unless ΔR_M is very large. This seems to be the declared U.S. view of the nature of modern military power. It is true if the Soviet military already receives absolute budget priority; it is implied if the current COCOM policy of allowing unlimited exports of many goods with potential military uses (trucks, small computers, food, and so on) is not considered harmful to national security.‡

(3) *A fortiori*, $\partial M_{SU}/\partial R_C \approx 0$, unless ΔR_C is very large.

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*See pp. 9-11, 50-54.

†See pp. 27-30.

‡See pp. 30-32.

(4) There may, however, exist some $\Delta\tau_{tM}$ for which $\Delta M_{SU}/\Delta\tau_{tM} > 0$. (It is, of course, not true that all advances in military technology appreciably change military power.*)

(a) $\partial M_{SU}/\partial\tau_{tM}$ depends on t, the weighting of Soviet military power in the U.S. utility function over time, substitution possibilities in the Soviet military, and the nature of Soviet military requirements and doctrines. In the case of large computers, a preliminary investigation suggested that $\partial M_{SU}/\partial\tau_{tM} \approx 0$, with possible exceptions of computer applications in ABM and atmospheric modeling. For small computers, however, $\partial M_{SU}/\partial\tau_{tM}$ may be sizable.†

(b) How does military technology advance with increased resources? $\partial\tau_{tM}/\partial R_M \approx 0$ over the short-run if the Soviets already grant military R&D the highest priority; if the policy of encouraging joint U.S.-Soviet research in high technology fields like computers is not considered harmful to national security; and if, as embargo advocates aver, controls are designed to affect only the "technology of the factory," but not "the technology of the laboratory." (The key notion is that *exporting* a certain technology has a different effect than other exports that *free resources* for R&D in the same technology or than joint R&D in that technology.) This result implies that export control policy is concerned with temporal leads in technology rather than quantitative leads in resources.‡

(c) The extractability and end-use issues. What is the value of $\partial\tau_{tM}/\partial\tau_{tC}$? If for a particular technology $\partial M_{SU}/\partial\tau_{tM} \approx 0$, then this question is not important. If $\partial M_{SU}/\partial\tau_{tM}$ is positive and significant, however, the question of whether to export depends on (1) the ability to assure civilian end-use, (2) the ease of adaptation of the civilian good to a military use (often low in the case of computers because of the need for specialized software), (3) the extractability of the technology (how easily can a significant $\Delta\tau_{tM}$ be obtained from an acquired $\Delta\tau_{tC}$?), and (4) the leakiness of the embargo.**

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*See pp. 31-35.

†See pp. 35-50.

‡See pp. 16-17, 31-35.

**See, among others, pp. 47-49.

(5) Is an embargo effective? For export controls to be effective, $\partial M_{SU}/\partial \tau_{tM}$ without controls must be greater than $\partial M_{SU}/\partial \tau_{tM}$ with controls. But these two will be equal insofar as (1) $\partial M_{SU}/\partial \tau_{tM}$ depends only on the availability of a single example of the restricted technology at time t, and (2) $\partial M_{SU}/\partial \tau_{tM}$ refers only to the possibility of "technological surprise."*

(6) Is an embargo efficient? For an embargo to be preferable to a tariff, it might first appear that ΔM_{SU} from a restricted commodity must be infinite; since otherwise *some* price would compensate for the security disbenefit created, and an export tariff would be preferred to absolute restriction. But administrative costs of a tariff system might well outweigh its theoretical advantages.†

The discussion can be summarized as follows:

- Export control policy should not concern itself with the end-user in the Soviet Union except when $\partial M_{SU}/\partial \tau_{tM} > 0$ and when $\partial \tau_{tM}/\partial \tau_{tC}$ is approximately equal to zero or can be made to approach it, perhaps through end-use controls. These are the key parameters of the problem.
- Export control policy, if it is to be consistent with the rest of the East-West trade policy of the United States and its COCOM allies, should not be concerned with the resources that the communist country is able to save through the transaction. The only restricted items should be those that enhance communist military capabilities in ways different from allowed trade, encouraged joint research, the uncontrollable flow of scientific and technological information, and acquisition of the same item through alternative and perhaps illicit means.

  When assessing the effect of an export on communist military capabilities, export control policy should consider:

  1. Whether a particular gain would be harmful to U.S. security, or merely an insignificant addition to an

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*See pp. 65-71.

†See pp. 71-73.

already sufficient force, or possibly even a stabilizing and beneficial change.

2. Substitution possibilities within the communist armed forces, which may imply that the *technological* capability that is enhanced does not enhance the communist *military* capability.
3. That alternative military needs and doctrines may imply different technological requirements.

- Finally, export controls may have other important uses besides restricting T: for example, as a bargaining chip or a political signalling device. Under plausible assumptions, these other uses may dominate the problem of deriving control lists and allowing exceptions.*

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*See pp. 74-78, 85-86.

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