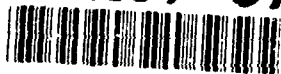


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Defense Spending and the Civilian Economy

C. R. Neu

October 1990

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A RAND NOTE

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Defense Spending and the Civilian Economy

C. R. Neu

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PREFACE

This Note grew out of a workshop titled "Civil and Military Technology" that was offered in the spring of 1988 in the RAND Graduate School. The workshop's aim was to explore in a systematic fashion how defense spending--either for research and development or for procurement--might accelerate or retard the rate of civilian technological progress. More generally, its aim was to characterize situations in which defense spending might generate benefits for the larger national economy that would offset (in most cases only partially) the costs that such spending imposes on that economy. Equally, it sought to characterize circumstances in which defense spending might impose costs on the larger economy beyond those reflected in simple budgetary figures.

The five students enrolled in the workshop were required to prepare case studies of particular industries or technologies, arguing in each case that defense spending had contributed either positively or negatively to the rate of technological progress or to international competitiveness in such a way as to affect the fortunes of the larger economy. The author's role as the workshop instructor was to lay a foundation in economic theory for deciding whether defense spending might or might not have benefited the larger economy. The students were to apply the relevant theoretical principles to their particular case studies. The industries or technologies chosen for case studies are listed at the end of this Preface, as are three of these case studies that were subsequently published in the RAND Graduate School Publication Series.

In trying to develop the theoretical framework, the author could find neither a single work nor any manageably small collection of works that provided a reasonably thorough discussion of how government spending in general or defense spending in particular might benefit or hinder the national economy. He was forced, therefore, to patch together a variety of readings and supplement these with an overly heavy

dose of lecturing in order to teach what he thought amounted to a complete framework.

What constituted a relatively minor pedagogical inconvenience for him, though, may constitute a serious gap in the literature that informs public-policy debates about the extent and character of defense spending. In recent years, it seems to have become common practice to justify proposed defense expenditures at least partially on the basis of their supposed contributions to the international competitiveness of one or another industry or to the general robustness of the U.S. industrial manufacturing base. Special pleadings have been made for Department of Defense funding of research and capital investment in semiconductor manufacturing technology, artificial intelligence, parallel-processing computer technology, and high-definition television. While all of these technologies have potential military applications, much of the case for government support has been based on a contention that such support would yield significant economic gains affecting nondefense sectors. Perhaps not surprisingly, the exact mechanisms by which these gains might come about were seldom specified by proponents of such spending. Opponents of Defense Department investments in these technologies have predicted, with similarly imprecise arguments, various sorts of negative consequences. The ensuing debate has had a mildly theological quality, resting more on belief and assertion than on analysis.

Concern about defense-spending effects on civilian industrial performance and technological progress has been further spurred by the prospect of major reductions in defense spending. If defense spending has had important positive consequences for the civilian economy, new governmental efforts might be required to generate benefits once produced by defense spending. But what precisely have these benefits been, and what kinds of new efforts will be necessary to continue them?

For these reasons, it seems an appropriate time to reconsider how defense spending may affect the civilian economy. This Note represents the author's effort to fill the gap, at least on a provisional basis, that he encountered in teaching the workshop. The aim is to discuss as completely as possible the circumstances in which defense spending may

be thought to benefit or hinder the national economy's performance. Probably nothing the Note says is new; probably all of the arguments presented here can be found somewhere in the economic literature. Any value added by the Note arises either from collecting these various arguments in one place or from the attempt to make the entire discussion accessible to policymakers who have some training in basic economics but who have neither the time nor the inclination to deal with arguments presented with the full panoply of economic jargon. As a practical means of attaining this latter goal, the Note is intended to be useful to future classes of fellows in the RAND Graduate School.

Both the original workshop and this Note were supported by a grant from the Pew Charitable Trusts of Philadelphia as a part of RAND's participation in the Pew Program for Integrating Economics and National Security. This Note is part of a continuing research program in International Economic Policy whose principal focus is the interface between international economics and national security issues, in RAND's National Security Research Division.

The following are topics of case studies completed for the RAND Graduate School workshop on "Civil and Military Technology," spring 1988:

- Jet transport aircraft
- Parallel-processing computing technology
- Microelectronics
- Computing technology
- Numerically controlled machine tools

Three of these case studies have subsequently been published:

Rachel Schmidt, *Civil and Military R&D Spending: The Case of Numerically Controlled Machine Tools*, The RAND Corporation, P-7471-RGS, July 1988.

Anna Slomovic, *Anteing Up: The Government's Role in the Micro-electronics Industry*, The RAND Corporation, P-7516-RGS, December 1988.

Susan W. Schechter, *The Effects of Military and Other Government Spending on the Computer Industry: The Early Years*, The RAND Corporation, P-7536-RGS, February 1989.

ACKNOWLEDGMENTS

I am indebted to the RAND Graduate School fellows who participated in the workshop on "Civil and Military Technology" and in a subsequent course on the economics of national security. These students suffered through the earliest and most muddled version of the ideas that form the basis for this Note. Concurrent and subsequent discussions with a number of my RAND colleagues, many of whom have given these issues considerable thought, helped eliminate some of the most egregious errors. Particular help was provided by my colleague Arthur Alexander, who offered a penetrating review of an earlier draft; the discussion in Sec. II derives almost entirely from his comments. Errors that remain after all of this valuable assistance can be blamed on no one but myself.

SUMMARY

Defense spending generally constitutes a burden on the civilian economy. Because maintaining a defense capability necessarily requires that resources be diverted from civilian to military uses, reductions are necessary either in the total supply of goods and services for current civilian consumption or in the investment necessary to support future civilian consumption. In market economies, prices reflect the opportunity costs of resources--the potential value of using them for other purposes. The economic burden of defense spending, then, can generally be estimated by the total defense budget, since this reflects the value of civilian goods forgone because resources were allocated to defense.

In some circumstances, though, defense spending may generate benefits for the civilian economy in addition to whatever contributions it makes to national security. These benefits may partially offset the burdens imposed by defense spending on the civilian economy, and the defense budget may in these cases reflect an overestimate of the true social costs of defense programs.

POTENTIAL BENEFITS OF DEFENSE SPENDING

Some of the circumstances in which defense spending might plausibly create benefits for the civilian economy are listed below.

Economies of Scale

In some manufacturing industries, costs per unit produce decline as output increases. By adding to total demand and thus bringing forth additional production, defense spending can help lower the costs of civilian goods produced by such industries. Because defense spending is often relatively insensitive to price, defense purchases will sometimes dominate markets in the early, high-cost periods when products are first being developed. In these circumstances, defense producers may bear the major burden of development costs, increasing the likelihood that a civilian market will develop subsequently at lower prices.

Spin-offs

Resources diverted to defense-related research and development (R&D) activities may sometimes produce technological innovations that have civilian applications.

Leftovers

Sometimes defense spending produces long-lived capital that can be utilized by the civilian sector when it is no longer required for military purposes. Perhaps the most important capital of this sort is the human capital produced by the training and experience that comes with military service, research in government laboratories, etc. This human capital is taken with individuals as they leave government service and is put to use in the civilian economy.

The Public-Good Nature of Information

Because information is hard to control, firms may not always exercise full control over the benefits of their own research. For this reason, firms will sometimes be unwilling to finance research that would be valuable to the economy as a whole. Defense Department support for R&D activities may help to overcome this reluctance to undertake research.

Private Versus Social Risk

In addition to the technological risk that is inherent in any research project, an individual firm faces the risk that even a fully successful research project will yield no profit if some other firm completes similar research first. Society, of course, benefits no matter which firm wins the technological race. As a result, firms will sometimes fail to undertake societally useful research. Once again, defense-supported R&D activities can help correct the situation.

International Monopoly Profits

Economies of scale achieved through defense-related production can give domestic producers a cost advantage over foreign producers. If the domestic producers lower prices only enough to capture markets from foreign producers, the remaining gap between prices and production costs--monopoly profits--can accrue to the domestic economy.

Capital-Market Failures

In some instances, firms may not be able to raise the capital necessary for research or fixed investment at prices that reflect the true riskiness of the projects they are undertaking. In these cases, defense support for R&D, investment subsidies, and guaranteed contracts can make it easier to raise the necessary resources.

SOME NON-BENEFITS OF DEFENSE SPENDING

It is sometimes argued that defense spending can benefit the domestic economy by strengthening so-called "linkage industries"--industries that produce inputs used by other industries. In the absence of market failures that result in these inputs being mispriced, however, there is no reason to believe that any particular cost or benefit will result from defense purchases from such industries.

Some proponents of defense spending also assert that defense spending creates more "good jobs at good wages" than do other kinds of public or private spending. Available evidence suggests, however, that the employment effects of defense and nondefense spending are essentially the same.

SOME POTENTIAL ADDITIONAL COSTS OF DEFENSE SPENDING

In some circumstances, defense spending may impose costs on the civilian economy beyond the simple diversion of resources.

"Misleading" Technological Progress

In some industries, the dominance of the military among early customers may lead firms to concentrate resources on the production items well-suited to military needs but ill-suited to civilian markets.

"Corruption" of Commercial Management

Some observers have argued that extended dealings with the Defense Department can "corrupt" corporate managers, instilling in them a style of operation that is unsuited to the civilian market. Little systematic evidence exists to support such assertions, but a number of major firms doing both military and civilian business apparently go to considerable lengths to disassociate the two operations.

Increased Market Volatility

Instability of defense-related demand throughout the postwar period may have increased the level of risk perceived by firms doing defense-related business, potential investors in these firms, and students preparing for technical careers. These perceptions may discourage investment in the physical and human capital needed for both defense-related and civilian production in some industries.

Restrictions on Information Dissemination

Restrictions on the dissemination of information acquired in the course of defense-sponsored R&D might hinder the profitable commercial exploitation of such information. This study was not able to identify any clear cases, however, where information might plausibly have been of greater commercial value if it had been acquired through nondefense rather than defense R&D efforts.

CONTENTS

PREFACE	iii
ACKNOWLEDGMENTS	vii
SUMMARY	ix
FIGURES	xv
Section	
I. INTRODUCTION	1
The Defense Burden	1
The Benefits of Defense Spending	3
Outline of This Note	4
II. THE INTERACTION OF DEFENSE AND CIVILIAN DEMANDS	5
Increasing Supply Costs	5
Decreasing Supply Costs	6
Segregated Defense and Civilian Markets	9
Spin-offs and Spin-ons	11
Dual-Use Products	14
When Is Defense Spending Likely to Generate Civilian Benefits?	15
III. SOME POTENTIAL BENEFITS OF DEFENSE SPENDING	20
Technological Spin-offs	20
Leftovers	22
The Public-Good Nature of Information	26
Private Versus Social Risk	29
International Monopoly Profits	31
Capital-Market Failures	34
IV. SOME NON-BENEFITS OF DEFENSE SPENDING	37
Linkage Industries	37
High-Value-Added Employment	41
V. SOME POTENTIAL ADDITIONAL COSTS OF DEFENSE SPENDING	44
"Misleading" Technological Progress	44
"Corruption" of Commercial Management	46
Increased Market Volatility	48
Restrictions on Information Dissemination	49
VI. SOME CONCLUDING THOUGHTS	51
The Importance of Market Failures	51
What Makes Defense Spending Special?	54

FIGURES

1. Increasing costs	5
2. Decreasing costs	8
3. Segregated markets	9
4. Defense spin-off	12
5. Defense "spin-on"	13
6. Dual-use product	14

I. INTRODUCTION

THE DEFENSE BURDEN

In most circumstances, defense spending constitutes an economic burden. Defense spending represents a diversion of real resources--manpower, raw materials, manufactured products, etc.--to military purposes and away from the civilian sector. Because fewer resources are available for civilian purposes, fewer things that are valued in the civilian sector are produced--less food, housing, or clothing; fewer automobiles, airplanes, refrigerators, or televisions; less child care or health care. Alternatively, fewer resources are available for investment. Because we divert resources to military purposes, we build fewer new factories and machines; build fewer new roads, bridges, or airports; do less research; provide less education. With less investment, the ability to produce both civilian and military goods grows more slowly than it would if defense spending were smaller.

It is possible, of course, that in some circumstances the resources needed for defense production may not be fully employed by the civilian economy. In periods of recession, for example, skilled workers may be unemployed, factories idle, resources unexploited. Defense spending that makes use of these unemployed resources will of course not displace civilian production. In these circumstances, defense spending will actually stimulate the economy, raising production in both the military and civilian sectors. Periods of pronounced recession are rare in the United States, however. And while there are almost always some unemployed resources in the economy, defense spending in the United States (and in most other industrialized countries) will almost always require the diversion of some resources from civilian purposes. Throughout this Note, I will focus on the consequences of defense spending when resources are fully employed.

Of course, defense spending is not without value. The world is and will remain a dangerous place. Most nations--and certainly the United States--must maintain military forces to protect the well-being of their

citizens. In the extreme, failure to allocate adequate resources to defense may result in a nation's losing control over all its resources. While there will always be debate over the appropriate level or composition of defense spending, few would argue that devoting no resources to defense would constitute a desirable national policy.¹

None of this changes the fact, though, that defense spending typically does nothing to meet civilian demand for goods and services. Because we devote some of our finite resources to defense, we must make do with fewer goods and services available for consumption, either today or some time in the future. Defense spending in most cases is a necessary evil. Most nations struggle to find the least costly way--the way that requires the smallest sacrifice of goods and services valued by the civilian economy--to meet their defense needs.

To say that defense spending constitutes an economic burden is not to say that everybody in an economy suffers because of defense spending. Defense spending creates numerous high paying, intellectually stimulating, and personally satisfying jobs. Many firms, their employees, and their shareholders have prospered as a result of defense spending. A sharp reduction in defense spending would no doubt bring dislocation and economic hardship to the people and the firms currently supplying defense needs.

However, because some people benefit from defense spending and would suffer from cutbacks does not mean that defense spending is beneficial for the entire civilian economy. Reduced defense spending would increase the supply of civilian goods and services, and at least the potential would exist of providing more goods and services to everyone, including former defense workers and defense investors. Former defense workers might realize these benefits by finding jobs in

¹One hopes, of course, that defense spending contributes positively to necessary defense capabilities. Nonetheless, numerous defense programs have contributed nothing or, worse, actually reduced defense capabilities. Also, many cases exist in which the contribution to defense capabilities is disputed. It is not my purpose to embrace these issues. I am concerned here only with the costs and benefits of defense spending beyond its effect (positive or negative) on defense capabilities.

other industries where output is expanding as a consequence of, say, reduced taxes (because government defense spending has fallen), increased government demand for nondefense products (because government spending has shifted to nondefense areas), or lower interest rates (because the government is borrowing less to cover defense costs). Of course no guarantee exists that everyone will actually be better off. The displaced workers and capital might never be reemployed in other sectors. The point, though, is that reducing defense expenditures would increase the total supply of civilian goods and services to be divided--somehow--among all citizens. On the other hand, increasing defense spending will decrease the total supply of civilian goods and services. It is in this sense that defense spending may be considered an economic burden.

In market economies, prices reflect the opportunity costs of resources--the potential value of using them for other purposes. The economic burden of defense spending, then, can be estimated by the total defense budget, since this reflects the value of civilian goods forgone because resources were allocated to defense.

THE BENEFITS OF DEFENSE SPENDING

The above characterization of the defense-spending burden, while generally correct, is not the entire story. The reader will have noted a liberal sprinkling of such phrases as "in most cases," "typically," "generally," and so on. These are necessary because some circumstances exist where defense spending may in fact contribute to the production of civilian goods and services. The most obvious examples of such contributions are "spin-offs" generated when defense-related research and development (R&D) spending results in products or processes with civilian applications. In real life, these positive contributions are seldom sufficient to outweigh the defense burden. But when the resources being spent on defense programs generate some benefit for the civilian economy, the defense budget will overestimate the value of civilian goods forgone to provide defense goods. In these cases, the economic burden of defense spending will be less than is suggested by the defense budget.

Also, circumstances exist where defense spending may do harm to the civilian economy beyond the losses resulting from diverted resources. A simple example might be land rendered unsuitable for residential development because of the noise of a nearby airfield. In these cases, the burden of defense programs may be larger than is suggested by budgetary outlays.

My aim in this Note is to describe the circumstances in which we might expect defense spending--either for R&D or for procurement--to generate economic gains or losses that are not reflected in defense budgets. In the process, I hope to generate a kind of checklist for analysts trying to assess the nonmilitary consequences of defense spending--a list of generic situations in which the social costs and benefits of defense spending may be larger or smaller than the defense budget suggests.

OUTLINE OF THIS NOTE

The next section of this Note offers a general framework for thinking about how defense spending may affect the civilian economy. Section III describes some specific circumstances in which defense spending may have beneficial consequences for the civilian economy. Section IV details some frequently alleged benefits of defense spending that are difficult to credit. Section V considers circumstances in which defense spending may do harm to the civilian economy, circumstances in which the social costs of defense spending are likely to be more than budgetary costs. Finally, Section VI offers some concluding comments, considers how defense spending may or may not be different from other types of government spending in its effects on the civilian economy, and draws some general conclusions about identifying circumstances in which defense spending may generate benefits for the civilian economy.

II. THE INTERACTION OF DEFENSE AND CIVILIAN DEMANDS

INCREASING SUPPLY COSTS

In the kind of markets usually imagined by economists, and probably in most real-world markets as well, defense spending places a burden on the civilian economy. Figure 1 illustrates the nature of this burden in a specific market. The line DD represents defense-related demand for the market in question. We imagine that this demand will be relatively small (that is, the defense demand curve is far over to the left side of the figure) and that defense-related demand is not very sensitive to price (the slope of the defense demand curve is quite steep). This insensitivity to price reflects the fact that defense demand typically arises out of some set of national security "requirements" that must be

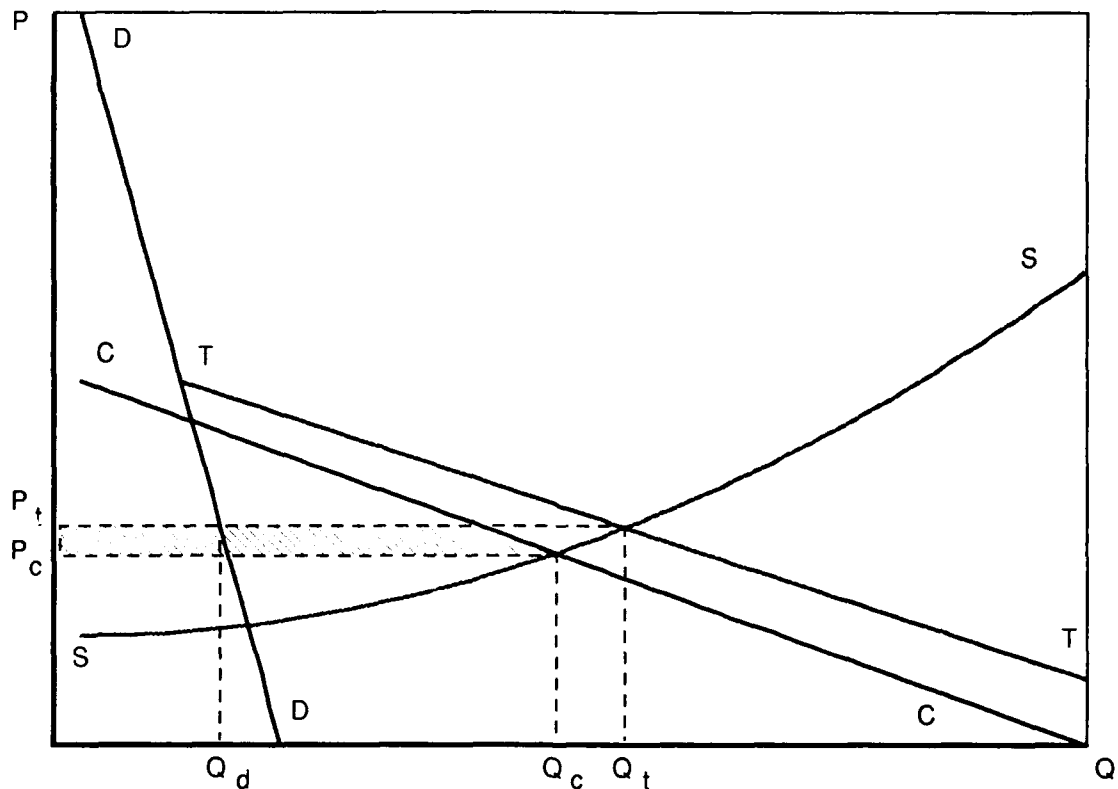


Fig. 1--Increasing costs

met at almost any cost. The line CC represents civilian demand for the same product. In contrast with defense demand, civilian demand is quite sensitive to price (the civilian demand curve is relatively flat), and at low prices civilian demand is much larger than defense demand. The curve SS is a standard upward-sloping supply curve, representing an industry with increasing costs per unit of output as the level of output rises. The line TT is the horizontal sum of defense and civilian demand and represents total demand--civilian plus defense--at a given price level.

In the absence of defense demand, the civilian economy would consume an amount Q_c at a price P_c . With defense demand, however, the price will rise to P_t . Total production and consumption will rise to Q_t . Of this total production, Q_d will be used to meet defense-related demand, and $Q_t - Q_d$ (an amount smaller than Q_c) will remain for civilian uses. The introduction of defense demand, then, raises the price and lowers the quantity of the goods consumed by the civilian sector, and civilian consumers are made worse off. The size of the burden imposed on the civilian sector is measured by the loss of consumer surplus (denoted by the shaded area in the figure) as a consequence of defense spending.

DECREASING SUPPLY COSTS

The situation is quite different, though, if the industry in question is characterized by economies of scale--that is, if the unit costs of production decline as the volume of production grows. There are a number of reasons why industries might enjoy economies of scale. Fixed administrative or research and development costs, for example, will constitute a smaller addition to true marginal costs when they are spread over a longer production run. Production of multiple copies of an item will allow a firm to perfect its production techniques and to move along a "learning curve" toward more efficient production. Large-scale production may make worthwhile the design or installation of specialized production equipment that will reduce costs.

For these and other reasons, many manufacturing processes show economies of scale, at least over some range of output levels. Producing the hundredth copy of some products is more costly than producing the thousandth or the ten thousandth. The more copies, the cheaper each will be. In these circumstances, purchases by one buyer will generate a positive externality for other buyers. Buying from a firm characterized by economies of scale will expand production. This will result in lower costs for all other units produced, and these lower costs can potentially be passed on to other buyers.

The relevance of this to defense spending is that some industries that are major suppliers of advanced military equipment are thought to show economies of scale. Some examples that spring readily to mind are the aircraft, microelectronics, computer, and communications equipment industries. It is also sometimes alleged that the military and civilian versions of some of these products or the processes by which each is produced are sufficiently similar that production of the military versions--military aircraft, military communications gear, microelectronics for military applications, etc.--can reduce the costs of producing similar civilian products.¹ For example, the techniques learned in building military aircraft may be applicable in building commercial transports. Similarly, some of the machine tools, design and test equipment, etc., used in the construction of military aircraft can be used in producing civilian aircraft. Making military versions of some sophisticated products can make a firm more efficient at making commercial versions of the same products.

Figure 2 illustrates how the civilian sector can benefit from military spending in industries characterized by economies of scale. The defense demand, civilian demand, and total demand curves (DD, CC, and TT, respectively) are the same as in Fig. 1. In Fig. 2, though, the supply curve, SS, is downward sloping, reflecting decreasing unit costs as the scale of production increases. Without any defense spending, the

¹This assertion is by no means universally accepted. For more on this, see the discussion in Sec. IV on the potential negative consequences of defense spending.

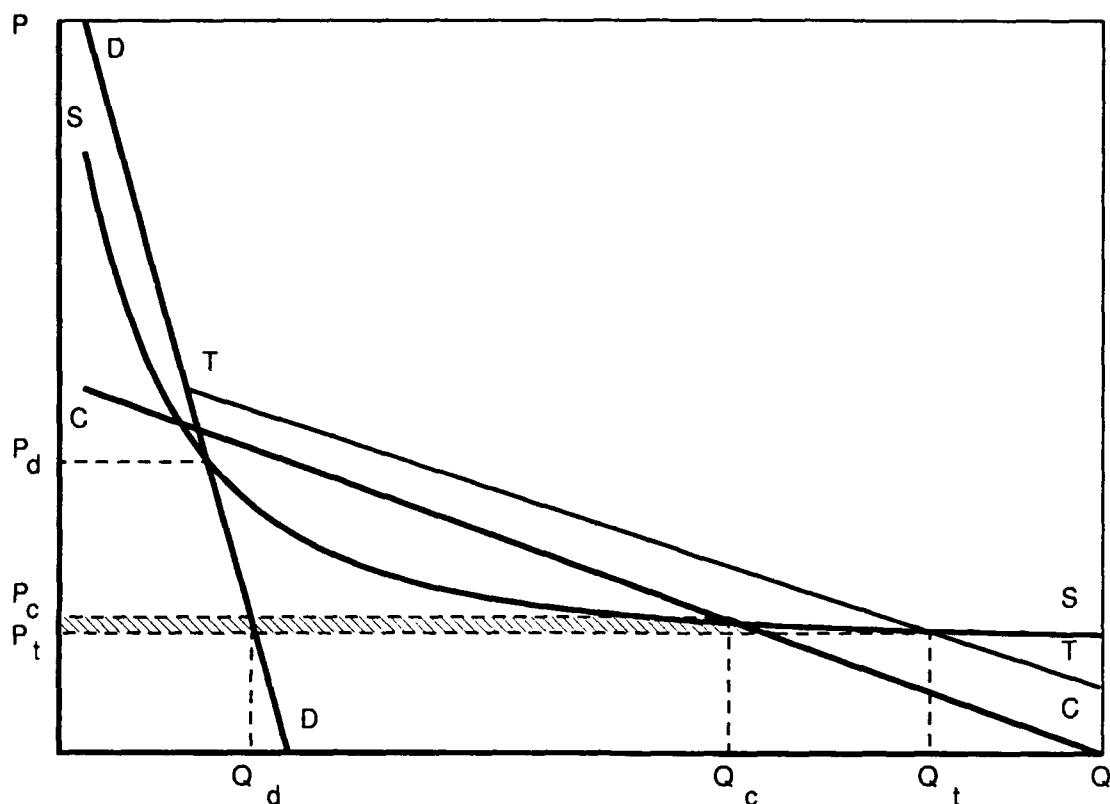


Fig. 2--Decreasing costs

civilian sector would consume Q_c of the good in question at price P_c . With the introduction of defense demand, though, the price will fall to P_t , and civilian consumption will rise to $Q_t - Q_d$. With more consumption and lower prices, the civilian sector is unambiguously better off. The gain accruing to the civilian sector as a consequence of defense spending in this case is measured by the increase in civilian consumer surplus, shown by the shaded area in the figure.

Note also that the defense sector benefits from the existence of the civilian demand. If there were no civilian demand, defense purchasers would be paying a price P_d . With civilian buyers, the price for defense buyers falls sharply to P_t .

SEGREGATED DEFENSE AND CIVILIAN MARKETS

The gains that the defense and civilian sectors can each realize because of the existence of the other are not guaranteed, however, by declining production costs. Figure 3 illustrates a case slightly different from the one represented in Fig. 2. Defense demand, civilian demand, and total demand are the same in the two figures, and the supply curve is downward sloping in both. In Fig. 3, though, the supply curve crosses the defense demand curve (at point A) *above* the intersection of the defense demand curve and the total demand curve. While it is *possible* in this case that defense demand will lead to benefits for the civilian sector, this result is not guaranteed. Indeed, no guarantee exists that there will be any civilian consumption at all.

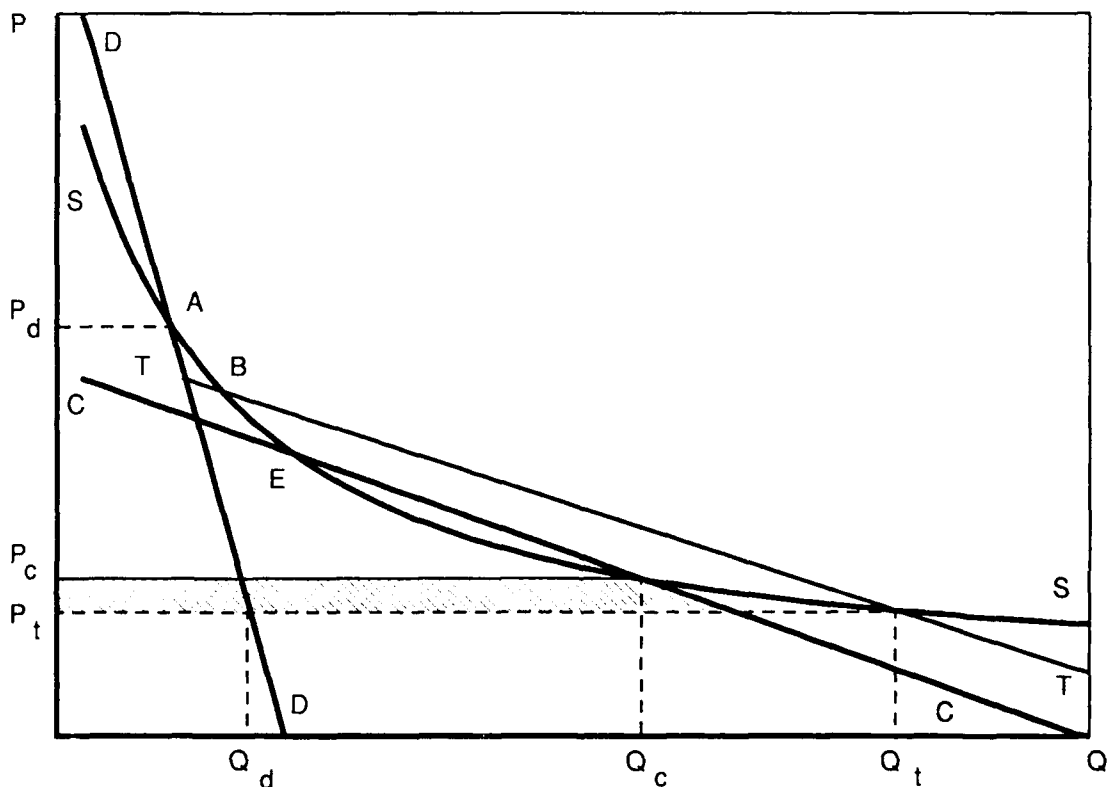


Fig. 3--Segregated markets

The reason for this is that the defense and civilian markets are segregated from each other. Suppose, perhaps not unreasonably, that the military demands the product in question before civilian applications have been recognized and that only enough is produced to meet military demand. (Production level and price are represented by point A.) Producers with certain knowledge of impending civilian demand might be willing to expand production sufficiently to satisfy this demand also. But if there is uncertainty about the location or even the existence of the civilian demand curve, producers may not see any advantage in producing more than is necessary to meet military demand. If the industry produces just a bit more output than is demanded by the military, supply will exceed demand, inventories will grow, and producers will likely decide to reduce output until they get back to point A. In the usual economic jargon, point A is a stable equilibrium; deviations from this output level will result in incentives for producers to expand or contract output as necessary to return to this point.

If, however, output somehow expands to the level represented by point B, producers will start to see civilian demand. At a production level a bit above that represented by point B, supply will be less than demand, inventories will be falling, and producers will see an opportunity to increase output. Output will grow until it reaches Q_t , and price will fall to P_t . Military purchasers will enjoy a price reduction from P_d to P_t . Civilian consumers will have the benefit of the product, which might have been denied to them entirely. Even if the industry would have produced enough to meet civilian demand without any military demand, the existence of military demand lowers the civilian price from P_c to P_t and generates increased consumer surplus equivalent to the shaded area in Fig. 3.

But for each sector to enjoy these benefits, total output somehow has to be moved "over the hump" from point A, where only military demand is being met, to point B, where civilian demand becomes apparent. In circumstances like these, a government program to identify civilian uses for products first developed for the military might profit both the

military and civilian sectors. The aim of this program would be to convince producers that there really is a civilian market for a particular product if only production could be expanded enough to bring the price down a bit further. Alternatively, the government could simply increase its purchases a bit, perhaps stockpiling the extra production, to push production costs below the level where civilian demand appears.

In the example above, military and civilian demand are segregated by time; the military demand developed before the civilian demand. It is also possible (indeed, it seems more likely) that military and civilian markets may be segregated by the nature of the product itself; the military version is not immediately suited to the civilian market. An entrepreneur who sees the possibility of adapting the product to civilian use will make the investment necessary to reduce costs sufficiently to tap the civilian market. If no entrepreneur has this insight, though, both military and civilian sectors will forgo a potentially substantial benefit. Military and civilian markets can also be segregated by uncertainty. Entrepreneurs may believe that there is a civilian market out there; but because they are unsure about where the civilian demand curve really lies, they may be loath to undertake the investment necessary to capture this market. In all of these cases, there may be a good reason for government action to move production "over the hump." Not only will such activity benefit civilian consumers, whose interests the government presumably seeks to represent, but it may benefit the government directly because in the end the government will pay less for an increased volume of militarily useful purchases.

SPIN-OFFS AND SPIN-ONS

This same framework of supply-and-demand analysis serves to illustrate a situation where civilian demand for a product in the absence of military demand would not be possible. We might characterize such cases as giving rise to the possibility of defense "spin-offs"; defense demand for a product makes possible a civilian market that would

not have existed otherwise. Figure 4 shows exactly the same demand curves (DD, CC, and TT) that we have seen in earlier figures. It also shows a downward-sloping supply curve as in Figs. 2 and 3. In Fig. 4, however, the supply curve never crosses the civilian demand curve. If there were no defense demand, there would never be any production for civilian buyers--even if producers had perfect knowledge of both their costs of production and the civilian demand curve. Prices could never be brought low enough to generate any civilian purchases.

The supply curve does, however, cross the total demand curve (the sum of civilian and military demand). Total production of Q_t will allow defense consumption of Q_d and civilian consumption of Q_c at price P_t . The military will benefit through a major reduction in price--from P_d if the military is the sole buyer to P_t if both defense and civilian demand are met. As in the previous case, however, some government activity may

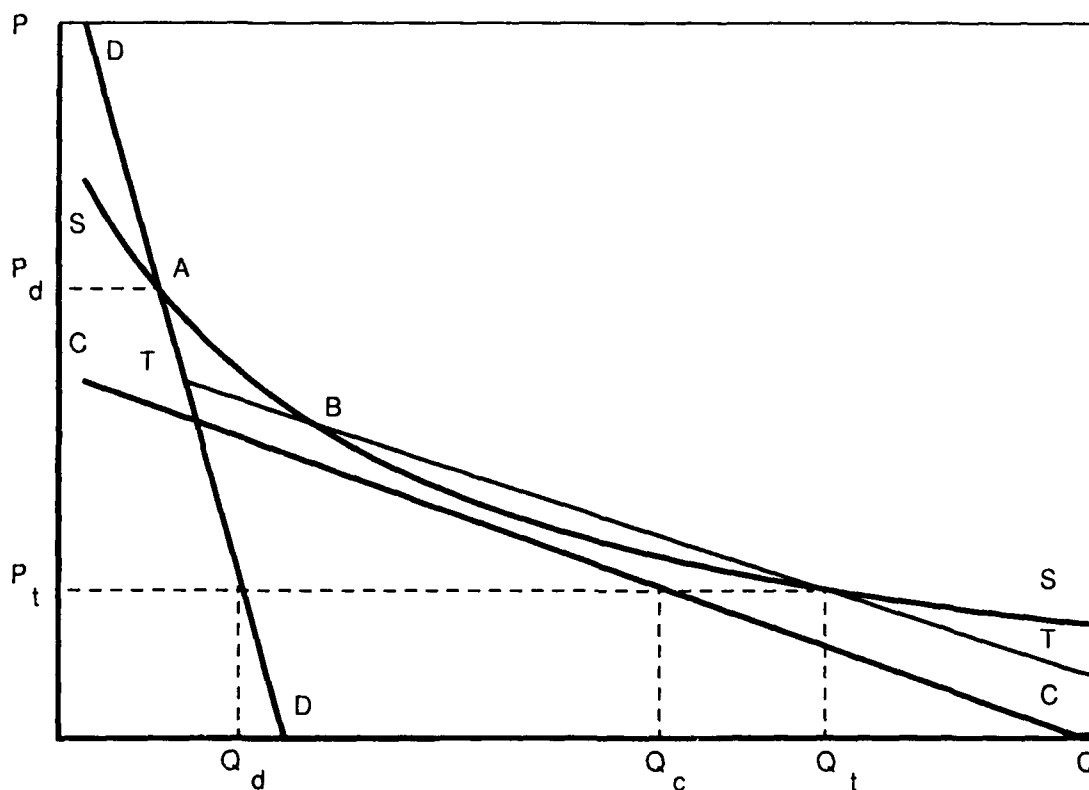


Fig. 4--Defense spin-off

be necessary to move production "over the hump" from point A, where only military demand is being met, to point B, where production costs fall low enough to attract some civilian demand.

Figure 5 shows the reverse case--a case of a defense "spin-on." In this figure, the supply curve does not intersect the military demand curve. Without civilian demand, the military would make no purchases; the military is interested in buying only after large-scale production for the civilian market (Q_c) has brought the price down to P_t . Notice that the civilian sector does not go unrewarded for having made military purchases desirable. The addition of military demand lowers the price from P_c , the price to the civilian sector without any military demand, to P_t . The gain in consumer surplus by the civilian sector is shown by the shaded area.

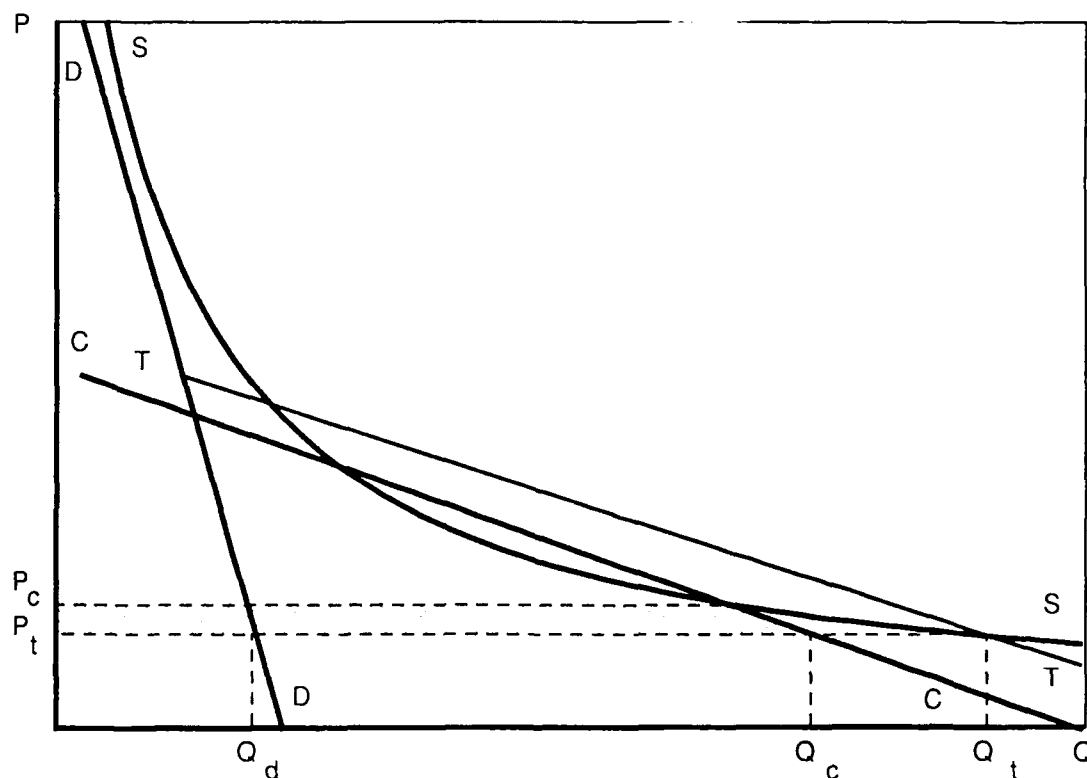


Fig. 5--Defense "spin-on"

DUAL-USE PRODUCTS

Figure 6 illustrates one final situation that might arise if production costs decrease with the scale of production. In this figure, the supply curve crosses neither the defense nor the civilian demand curve. Left to itself, neither sector would consume any of the good. If sector demands are combined, though, production of Q_t becomes possible with Q_d going to the defense sector and Q_c to civilian uses. As in some of the above cases, some government intervention might be necessary to move production to the point where both defense and civilian demand become apparent.

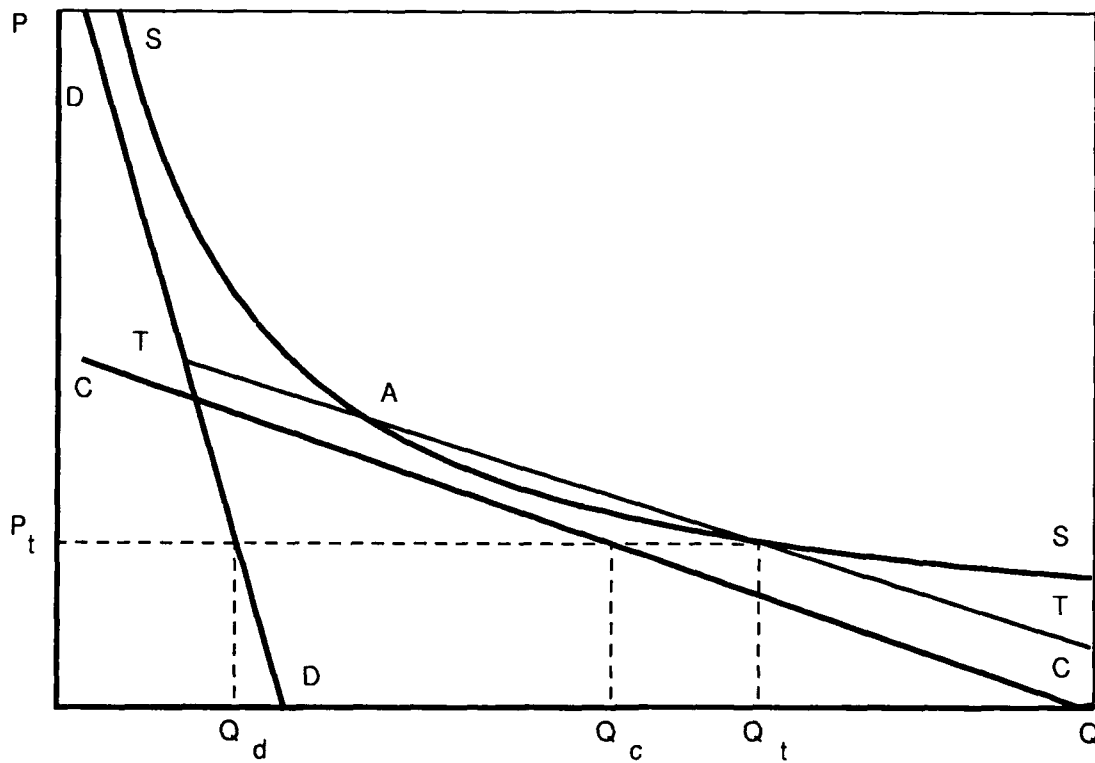


Fig. 6--Dual-use product

WHEN IS DEFENSE SPENDING LIKELY TO GENERATE CIVILIAN BENEFITS?

We have seen a number of generic cases in which defense spending brought about some benefits for the civilian economy. What these cases had in common was that the industry being considered showed economies of scale. The introduction of defense spending into these markets led to higher levels of output and consequently lower costs of production. The civilian market benefited from these lower costs. The principle illustrated here can be stated somewhat more generally: We should expect defense spending to generate benefits for the civilian economy whenever this spending results in lower production costs (or higher production efficiency) than would have been the case in the absence of defense spending. The simplest way that such a situation can come about is through economies of scale; but other ways are possible. In the next section of this Note, we will consider some other situations in which defense spending may reduce production costs or increase efficiency in the civilian sector.

Before turning to these other situations, though, we can use the general framework just developed to gain further insight into the kinds of situations that are most likely to produce civilian gains from defense spending.

Consider again the situation depicted in Fig. 3. At low levels of production--perhaps in the very early history of the industry--production costs are much higher than the price that civilian consumers are willing to pay for the product. In the absence of defense spending, it will not be until output has reached a considerable level (represented by point E in the figure) that prices will be low enough to generate any civilian purchases. Output investment at this level may be too much of a risk for most entrepreneurs, particularly since the exact position of the civilian demand curve is likely to be uncertain. (This is, after all, a new product.) Without defense spending, no one may be willing to take the risk of expanding production enough to attract civilian consumers, and the industry will die before it is properly born.

But because the military values this product highly, there is defense demand for it even at the prices that have to be charged at very low production levels. Entrepreneurs will have an incentive to expand production at least as far as is necessary to meet defense demand (point A). In the process, defense spending will "carry" the price down to P_d . From this point, entrepreneurs must invest in a much smaller increment in production (to point B) in order to begin capturing civilian demand. In this case, price-insensitive defense demand serves to start production and to bring down prices from initially very high levels. In the process, this defense demand reduces the size of the gamble that entrepreneurs face in expanding production enough to tap civilian demand, making it more likely that some entrepreneurs will take this gamble.

The steeper the early part of the supply curve, the more likely that some demander who attaches a very high value to the product will be required to "carry" the price down to levels where the civilian market is within entrepreneurial striking distance. Very steep supply curves at low levels of output will characterize industries with very high front-end costs: high R&D expenditures, complex production processes, etc. Thus, these kinds of industries are where we are most likely to find examples of defense spending benefiting the civilian economy. It is perhaps not surprising, therefore, that we frequently hear of reports of new civilian markets that have allegedly been opened by defense spending on jet transport aircraft, computers, microelectronics, etc., but we seldom hear such reports about defense spending on autos, trucks, ships, and so on. The former industries were in their infancy (and plausibly still are) on the steep parts of their cost curves when defense demand accounted for a substantial share of their total output. The latter were (are) presumably not.

Notice also in Fig. 3 that the scale of defense spending affects the size of the entrepreneurial "gap" that has to be crossed if a civilian market is to develop. Imagine, for example, that defense spending on the product in question is increased--that is, that the amount demanded by the military increases at every price level. This

would shift the defense demand curve (DD) to the right. The further it moves to the right, the lower the price of the product is "carried," and the smaller the risk that entrepreneurs must take in attempting to cut costs enough to meet civilian demand. If the defense demand curve shifts far enough to pass through point B, the entrepreneurial "gap" is eliminated completely.

This framework also sheds some light on how the costs of achieving economies of scale will be borne in particular cases. If defense and civilian markets for a product are widely segregated--in time, in product design, or by uncertainty--one might expect entrepreneurs to be willing to invest only in what they can immediately see. For example, if it is widely believed that the civilian version of a particular product will have to be very different from the military version, entrepreneurs making the military version will be less likely to undertake the investment necessary to develop a civilian version than would be the case for more similar military and civilian versions. If military demand for this product precedes civilian demand, then in segregated markets producers for the military will probably bear most of the costs of moving down the supply curve from initially low levels of production to higher, less costly levels. These costs--in the form of R&D, capital expenditures, etc.--will largely be passed on to the military. If at some future time it appears feasible to serve a civilian market as well, less investment will be required (the "gap" will be smaller), and the military may have paid most of the front-end costs of civilian production. This suggests that the biggest civilian payoffs from military spending are likely to be found in industries where civilian and military markets have been particularly segregated. But, while payoffs in these industries are likely to be large if they occur, the likelihood that there will be any payoff at all is probably smaller than in less segregated markets. If the degree of segregation is too great, there may never be any civilian market at all.

Finally, it is interesting to use this framework to speculate about the likely direction in which technologies or benefits will flow. We have seen that both "spin-offs" and "spin-ons" are possible and that

each sector may benefit from the existence of the other when there are economies of scale. If we attach a temporal interpretation to the downward-sloping supply curve, though, we arrive at a suggestion that the likely flow of benefits and technologies should be from the military to the civilian sector. Imagine, for example, that the natural path of an industry is to move from low levels of production at high costs to higher production levels at lower costs. If this is the case, then high demand that is insensitive to price will be served first, while lower, more price-sensitive demand will be met later. If any military demand exists for a product at all, it is likely to be relatively insensitive to price. (It is hard to think of circumstances in which the civilian demand curve may be less sensitive to price than the military demand curve.) Thus, when both military and civilian demand potentially exist for a product, the military demand will probably be met first, and we should see more technologies moving from military to civilian applications than the other way around.

We saw in Fig. 5, however, that if military demand is at a low enough level the military demand curve will not cross the supply curve. In these circumstances, military demand will arise only after an industry has been built to satisfy civilian demand. In such cases, technology would flow from civilian to military applications. We might use this insight to speculate on the directions of technological flow that have been observed at different periods in the past. In recent years, many observers have suggested that more technologies were flowing from the civilian to the military sector than the other way around. As evidence of this trend, these observers note that the computational and communications systems built into the current generations of many Western military systems are not as advanced as those available to civilian users. This may be a reflection of low military spending levels and low military demand in the mid-1970s. New technologies that were developed during this period were perhaps more likely to appear in civilian markets, capturing military attention only when costs or uncertainties about the technology's characteristics had been reduced by extensive production for civilian markets. Plausibly, a lag of several

years may exist between the appearance of a technology in one sector and its adaptation to the other, and thus we saw some of the effects of the 1970s' decline in defense spending only in the 1980s.² The flow of technology from military to civilian applications that is generally believed to have marked the 1950s and 1960s (e.g., jet aircraft, computers, radar) may reflect the delayed consequences of high defense spending during World War II. And the flow of automotive technology from civilian to military applications (reflected, perhaps in the development of the battle tank) during World War I might be the result of low defense spending during the early years of this century. These examples are little more than speculation on my part, but they are consistent with the theoretical framework developed above.

²This decline may also reflect nothing more than the long gestation periods of some military systems, which therefore incorporate technologies available years ago when the systems were first designed. In contrast, civilian products may come to market more quickly and so may incorporate technologies of more recent vintage. I know of no careful studies of these "vintage effects."

III. SOME POTENTIAL BENEFITS OF DEFENSE SPENDING

In this section, I will discuss some specific circumstances in which defense spending may give rise to benefits for the civilian economy.

TECHNOLOGICAL SPIN-OFFS

The simplest example of how defense spending may benefit the civilian economy is the case of a technological "spin-off"--a technological advance resulting from defense R&D spending that has civilian application. The benefit to the civilian economy in such cases lies in the fact that the resources apparently diverted from civilian use to support the military R&D effort were, it turns out, not entirely diverted after all. Despite the fact that these resources were used for military purposes, they also contributed to civilian technological progress much as they would have if at least some of them had been used in a civilian R&D effort.

In the usual economic jargon, technological spin-offs are examples of a positive externality. Defense R&D spending produces something in addition to products useful for defense. The civilian economy is the benefactor of this serendipitous externality.

Frequently cited examples of technological spin-offs are jet transport aircraft, radar, and mainframe computers. At various stages in the development of each of these technologies, defense-related R&D activity produced important technological progress, progress that contributed significantly to the application of each technology to civilian uses. In the cases of jet aircraft and computers, though, some important groundwork for military applications had been laid by previous civilian R&D efforts. While it is impossible to deny that defense-related R&D has on some occasions resulted in significant benefits for the civilian economy, it would be wrong to imagine that the "flow" of technology is exclusively or even predominantly in one direction. Indeed, in recent years conventional wisdom has it that the technology

employed in the civilian electronics market is considerably in advance of what is employed in even the most advanced weapon systems and that in this field at least the flow of technology is from civilian to military uses. There seems to be no "typical" pattern of technology flow between military and civilian applications; enough searching will turn up an example of almost any pattern one can imagine. There seems little doubt, though, that at certain junctures in the development of some technologies, defense-related R&D can result in technological advances that are of value to the civilian sector.¹

Spin-off-like benefits may also be generated less directly. Even if defense-related R&D produces no technological advance that has direct civilian application, defense-related R&D activities may contribute to a research environment that through seminars, journal articles, informal discussions, and so on will foster other advances that are of direct civilian value. Similarly, exposure of civilian researchers, production engineers, industrial designers, and other such people to military research and production techniques may generate new ideas that have civilian value. Even the movement of individual researchers, managers, and researchers from the military to the civilian sector may create benefits for the civilian sector. In the hopes of capturing such benefits, some observers urge that defense-related R&D be physically and institutionally integrated with or at least located in close proximity to civilian research efforts. While some research suggests that the most effective means for transferring technological know-how is face-to-face personal interaction,² there seems to be little rigorous support for the proposition that institutional or geographic proximity facilitates such transfers. Somewhat ironically, the same study that

¹For a brief survey of some empirical evidence on spin-offs from military R&D, see Frank Lichtenberg, "Assessing the Impact of Federal R&D Expenditure on Private R&D Activity," a paper presented to the National Academies of Sciences/Engineering workshop on *The Federal Role in Research and Development*, Washington, D.C., November 21-22, 1985.

²Thomas J. Allen, Diane B. Hyman, and David L. Pinckney, "Transferring Technology to the Small Manufacturing Firm: A Study of Technology Transfer in Three Countries," *Research Policy*, Vol. 12, August 1983, pp. 199-211.

found personal interactions to be important found that often the source of the transferred technology is not local at all, but foreign. Nonetheless, the idea that proximity encourages the diffusion of potentially valuable information has obvious intuitive appeal. Proponents point to such agglomerations of military and civilian research as Silicon Valley, Boston's Route 128, Bell Laboratories, and perhaps even The RAND Corporation as examples of how military and civilian research can contribute each to the other.³

There seems to be little of a systematic nature that can be said about spin-offs. No one denies that spin-offs occur from time to time; too many examples exist for anyone to believe otherwise. There is considerable debate, however, over how frequent or how significant these spin-offs are. The analysis developed in Sec. II suggests that apparent spin-offs are more likely for technologies exhibiting large front-end developmental costs; technologies where military and civilian markets are widely separated by time, product design, or uncertainty about ultimate demand; and technologies that are in the process of development during times (such as war) of high and price-insensitive military spending. None of these theoretical propositions has any empirical support, however, and the occurrence of commercially valuable spin-offs has no apparent pattern--certainly no way exists of predicting what kinds of defense spending are most likely to give rise to spin-offs.

LEFTOVERS

A related sort of benefit for the civilian economy may arise when defense spending creates long-lived capital that can be put to productive civilian uses when it is no longer needed for defense purposes. More prosaically, defense spending can produce capital "leftovers." Sometimes surplus materiel or equipment can be sold by the military to the civilian sector. In these cases, the military captures the positive externality, and the defense budget (because it reflects

³Another view, discussed below, holds that immersion in defense-related research or production can corrupt researchers or managers in ways that make them unfit for civilian work.

the costs recouped through the sale of the surplus materiel) remains a roughly accurate estimate of the total social costs of the defense program in question.

In other cases, though, the military cannot or does not recoup any costs when it transfers capital to the civilian sector. Often, the military purchases specialized test equipment, computers, manufacturing machinery, etc., for defense contractors. Some of this equipment may remain with and be utilized by the contractor on completion of the defense project without any payment to the Defense Department. Similarly, equipment needed for military contracts may be operated for civilian purposes at something near zero marginal cost when it is not needed for defense work. Computers paid for by the military, for example, might be used on nights and weekends at no loss to the military and with potentially significant gains to the civilian sector.

The most important leftover capital that results from military spending, though, may be human capital. The military certainly supports, directly or indirectly, extensive training activities--of military personnel; production workers at defense contractors; and researchers in universities, government laboratories, and commercial research institutions. Some of the skills acquired as a result of this training have no particular civilian value--the ability to launch intercontinental ballistic missiles, to pick an extreme example. Many of the skills acquired, though, are potentially valuable in civilian life. High school graduates may develop valuable habits of discipline, responsibility, and self-reliance as a result of military service. Air Force and Navy personnel may develop valuable skills of airmanship and seamanship. Mechanics who maintain military aircraft may subsequently do the same for commercial planes. Engineers working on military projects may learn techniques that are useful in civilian applications. To the extent that individuals carry these skills with them to civilian endeavors, the civilian economy may benefit from defense spending.

Some evidence exists that military service does impart capabilities valued by the private sector. Veterans typically earn more in subsequent civilian jobs than do similarly skilled nonveterans.⁴ As

⁴For a summary of some studies of this issue and for evidence on the experiences of post-draft-era veterans, see Stephen L. Magnum and

might be expected, the value of military experience seems to be greater for veterans with less formal education. Interestingly, the experience of Vietnam-era veterans seems to be different from that of other veterans in both earlier and later periods. Subsequent civilian earnings of Vietnam veterans appear to be lower than the earnings of similarly skilled nonveterans.⁵ Some studies have examined the experience of workers laid off from jobs in defense-related industries.⁶ Not surprisingly, most laid-off defense workers find new jobs, but typically these new jobs are at lower wages than their previous defense work. Without a control group of similarly skilled nondefense workers, though, it is impossible to assess the contribution of defense-related experience to the skills of these workers.

The Defense Department cannot, of course, be compensated directly for teaching a soldier or an engineer skills that are valuable in the civilian economy. In most cases, individuals cannot be required to compensate the Defense Department for their training when they leave military service. Neither can the private firms that hire former servicemen or engineers from government-supported labs be required to compensate the government for skills or experience acquired at government expense. The Defense Department may, however, be compensated indirectly. Pilots, for example, may accept lower wages in the Air Force than in some other jobs because they know that at some future time they will be able to earn much higher salaries as commercial airline pilots. In this way, the Defense Department is in fact compensated, at least to a degree, for the training it provides. Similarly, scientists

David E. Ball, "The Transferability of Military-Provided Occupational Training in the Post-Draft Era," *Industrial and Labor Relations Review*, January 1989, pp. 230-245.

⁵Saul Schwartz, "The Relative Earnings of Vietnam and Korean-Era Veterans," *Industrial and Labor Relations Review*, July 1986, pp. 564-572. See also Mark C. Berger and Barry T. Hirsch, "The Civilian Earnings Experience of Vietnam-Era Veterans," *The Journal of Human Resources*, Fall 1983, pp. 455-479.

⁶See Leslie Fishman, Jay Allen, Byron Bunger, and Curtis Eaton, *Reemployment Experiences of Defense Workers: A Statistical Analysis of the Boeing, Martin, and Republic Layoffs*, U.S. Arms Control and Disarmament Agency, ACDA/E-113, Washington, D.C., December 1968.

and engineers may be willing to work at relatively low salaries in government laboratories or on defense-related projects in order to gain experience or access to specialized equipment that will allow them subsequently to earn higher salaries in civilian work.

In perfect labor markets, individuals would recognize the future value of defense-related training, and the wage that they would accept for serving the defense needs of the country would reflect the value of this training. In order to argue that some net social benefit offsets the costs of defense programs, then, it is necessary to argue that some sort of deviation from perfect market conditions prevents those individuals who receive valuable training or experience from defense programs from "paying" for this training, while they receive it, in the form of lower wages.

A failure of this sort might come about if individuals do not recognize the value of the training they receive. Air Force pilots are probably very aware of the employment opportunities that are open to them as a result of military flight training, and there is no reason to suspect a market failure in this case. In contrast, young enlisted men may not fully recognize the civilian value of habits and modes of behavior that can be instilled in them during military service. As a result they may not be willing to accept anything lower than the current civilian wage for their military service, and spending for military manpower may produce benefits that are not captured by the military in the form of lower wage costs. In this connection, it is interesting to note that writers who have focused on the potential benefits of military spending for economic development often point to the socializing and training functions of the military as important contributors to a nation's stock of human capital.⁷ It is also interesting to note that, in their recruiting efforts, the U.S. military services make a serious effort to play up the civilian value of military training in an effort to recapture some of the external value generated by their training programs.

⁷See, for example, Emile Benoit, *Defense and Economic Growth in Developing Countries*, D.C. Heath, 1973.

Whereas it is possible that soldiers may systematically undervalue the training they receive while in the military, one can scarcely advance this as a general proposition. Many instances illustrate--at various times, in different countries, and for particular social groups--that military service has been clearly recognized as a reliable route to a better civilian life. (A classic example was Nepalese enlistment in British Gurkha regiments.) An interesting field for future research would be the degree to which the value of defense-related training is captured by the defense establishment.

Ironically, one of the worst characteristics of U.S. defense policy--the boom and bust cycles of defense spending--may be minimally redeemed because it produces leftovers of human and physical capital. The cyclic nature of defense spending is widely and justifiably criticized as wasteful; production bases are built up to support very high levels of output in boom years and then idled in bust years. If the resources that make up the production base in boom years are truly idled in bust years, the result is pure waste. Some of these resources--particularly the human resources--have potential value for the civilian sector, so bust years of defense spending do not produce pure waste. The civilian sector probably benefited, for example, from the boom in space-related R&D in the 1960s and the subsequent bust that marked the 1970s. The result in the 1970s was a temporarily increased supply of experienced scientists and engineers--previously employed in the defense sector--available for work in the civilian sector.

THE PUBLIC-GOOD NATURE OF INFORMATION

Economists have long recognized an argument for government support of research activities. The product of research, according to this argument, is information, and information is difficult to control. Despite the existence of patents and copyrights, a firm may be unable to appropriate for itself the full benefits of its research activities. Because it cannot reliably restrict the diffusion of commercially valuable information, a firm may spend its resources on a research project only to see the fruits of this research appropriated by other

firms. Information may become a public good, available to all, no matter who originally paid to produce it. Put another way, research activity may in some cases produce positive externalities, benefiting firms other than the one that paid for the research.

This leads to a market failure. Because a firm will not be able to capture the full benefits of its research activity, it will undertake less research than is socially optimal. When calculating the benefits of a particular research project, a firm will see only the benefits that may accrue to itself. By ignoring the benefits that its research will generate for others, it will underestimate the true social value of the project and in some cases will decide that the benefits of a particular project may not be worth the cost. Research projects that could reasonably be expected to generate positive net social benefits will not be undertaken. Repeat this many times throughout an economy, and the result will be a lower level of research than is socially optimal.

The standard solution for this type of market failure is for the government to subsidize research activities. This lowers the cost of research to producing firms and encourages them to undertake more research projects, offsetting the incentives to undertake too few that arise because of the public-good nature of research.

Applying this general argument for governmental support of R&D activities to Defense Department activities is not entirely straightforward. The Department of Defense sponsors a large volume of research and in this way may help to overcome a natural tendency for the private sector to produce too little research. One might therefore argue that the total social costs of military R&D efforts are overstated by budgetary allocations to these efforts.⁸ This is certainly so when defense-supported R&D may be expected to generate commercially useful

⁸Military support for research might have been especially valuable in the early development of integrated circuits. In the early days of this industry, integrated circuits were generally considered unpatentable, and thus concern over the ability of firms to capture the benefits of their innovations was particularly severe. For more on this subject, see Richard C. Levin, "The Semiconductor Industry," in Richard R. Nelson (Ed.), *Government and Technical Progress*, Pergamon Press, 1982, pp. 9-100.

technological advances. Clearly a social benefit exists beyond whatever the research contributes to national security. In these cases, the benefit will be two-fold, arising from both the spin-off and the encouragement of a higher level of commercially valuable research.

But what about the case in which military R&D produces no useful technological advance to the civilian economy? Here the matter becomes a little more complex. To explore this case, let us consider the issue of whether the Defense Department should ever fund R&D efforts directly. It is sometimes argued that the Defense Department should simply announce that it intends to procure aircraft, missiles, sensors, computers, or whatever with specified operational characteristics and that if more than one firm can produce the needed item the department will choose whichever system offers the best performance or the lowest price. The attraction of a major procurement contract, the argument continues, should be sufficient to encourage firms to undertake the research necessary to produce the required equipment. But, if a firm fears that rivals will benefit from any technological progress it makes through its own efforts, it may be loath to undertake the necessary research. It might even choose to do no research, waiting to capitalize on progress made by some other firm. This kind of situation could arise if the Defense Department refuses (as it wisely might) to grant a permanent monopoly to the first supplier of a system. In these circumstances, research may give a firm a lead over its competitors and allow it to capture the first contract offered for a particular system. In subsequent years, though, other firms might copy its techniques and successfully win some or all of the market.

Who will be the loser if firms choose not to pursue research activities aggressively? The answer is that the Defense Department will be the loser. It will have to pay more for a weapons system or accept lesser performance. With regard to research that has purely military value, then, offsetting the tendencies by firms to do too little research will be reflected in the budget for military procurement. There will then be no reason to believe that the total costs of defense-related activities--including both R&D and acquisition costs--will be

overestimates of the social costs of these activities. Research support may indeed produce positive externalities, but these externalities will be captured largely by other parts of the defense budget. In searching for circumstances, then, where defense R&D spending generates benefits for the civilian economy, we must restrict our search to research projects that have some possible relevance to civilian concerns.

PRIVATE VERSUS SOCIAL RISK

Private firms may also choose to finance less than the socially optimal amount of R&D activity when private risks (the risks perceived by individual firms) deviate from social risks (the risks borne by the larger economy). In the simplest case, this kind of deviation could arise when more than one firm is competing to develop a particular technology. (Since we are discussing the role of defense spending, it will be most natural to imagine firms working to develop a technology with some military application. This argument applies equally well, though, when the technology in question has only civilian applications.) Some risk is always inherent in developing a new technology: It may not work as expected; it may be more costly than expected; planned production techniques may not be appropriate. There is always some risk that the development effort will come to naught and that the resources spent in this effort will have been wasted. This is a true social risk. If resources spent in development produce nothing, fewer of these resources will be available for other purposes. The total production of goods and services will be less as a result. The optimal level of R&D activity will depend on the likelihood of success. If the odds in favor of success are high, a project should be undertaken. If they are low, perhaps it should not be.

Individual firms face the technological risk that underlies the social risk. Their research efforts may not bear fruit. Individual firms face a further risk, however. Even a fully successful research effort may profit a firm nothing if, for example, this success comes after some other firm has already captured the relevant market. Since most firms are risk averse, the amount that firms are willing to risk on

a particular project will decline more rapidly than do their chances of commercial success. Each of three firms with equal chances at winning the race to develop some new technology may be expected to spend *less* than one-third as much on the development effort than it would if it were the only firm competing for the available market. As a result, the total research effort will be less when three firms are competing than when only one is active. The result will be a level of R&D activity that is lower than is socially optimal. Typically, a divergence between private and social costs (in this case, risk) will result in a market failure--a failure of private markets to produce the socially optimal amount of something (in this case, research).

Possible remedies for this sort of market failure are for the government to encourage firms to leave a given field until only a single firm is left or to encourage several firms to act as a single firm, pooling their research. (It is often alleged that the Japanese Ministry of International Trade and Industry--MITI--intervenes in these ways.) But conferring monopoly status on a single firm or a group of firms with the potential to act as a cartel will create other problems of market failure further down the line. It might be better for the government to subsidize R&D activities at all the group firms sufficiently to overcome the shortfall in such activities (as measured by the deviation from the amount of R&D that might be undertaken by a single firm) associated with the risk aversion of individual firms.⁹ When defense spending supports R&D with potential civilian applications, then, it may contribute to the civilian economy by narrowing the gap between private and social risk.

⁹Kenneth Arrow and Robert Lind have gone so far as to argue that society should never be risk averse and that any aggregate risk aversion reflects a market failure. See Kenneth J. Arrow and Robert C. Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review*, June 1970, pp. 364-378.

INTERNATIONAL MONOPOLY PROFITS

We saw above how defense spending can generate benefits for the civilian economy in industries marked by economies of scale. Defense purchases increase the output of the industry, simultaneously lowering costs for civilian consumers of the same or similar products. We can extend this line of reasoning to international trade to illustrate another possible benefit arising from defense spending.

By generating a high volume of production and a consequent reduction in production costs, defense spending can increase the competitiveness of local industries in international markets. Defense spending can bestow on an industry a comparative advantage--an ability to produce a particular product at a cost that is low relative to the costs of producing other products--in much the same way as would the discovery of some natural resource--a cheap source of energy or raw materials, for example. Larger scale production can in this sense have the same effect as an increase in the factor endowment of a country.

An increase in the endowment of productive factors will almost certainly do no harm to a country, and it can potentially be highly beneficial. The ability to produce particular products more cheaply than firms can in the rest of the world will provide local producers with an opportunity to increase their profits; this opportunity consists of pricing their products in world markets slightly below similar products of foreign competitors and keeping for themselves the difference between the resulting price and their now lower costs. Some of these profits may be retained by the firm, some may be paid to workers in the form of higher wages, some may go to the government in the form of higher taxes, etc. There is no reason for any of these interests to become worse off, and there is a clear possibility that each could benefit. Domestic consumers of the products in question also stand to gain. Even if producers do not reduce prices by the full extent of their cost reductions, prices will be somewhat lower than they were before the economies of scale were achieved. (They could not be higher. If they were, local consumers would have an incentive to buy foreign versions of the product.) Thus, all domestic interests--

producers, workers, governments, consumers--will enjoy at least the possibility of gain as a result of the new economies of scale.

Foreign consumers will also benefit as a result of the lower prices they pay for now-imported versions of something that had previously been produced locally. The only losers will be foreign producers, whose products will be no longer competitive in world markets. Foreign consumers may or may not have gained more than foreign producers lost, and whether foreigners are on net better or worse off will depend on the specifics of any particular case. All domestic interests will benefit, though, or at least remain unharmed.

The structure of the domestic industry may have an influence on the distribution of benefits between domestic and foreign interests. Suppose that defense production is spread among a number of local firms in such a way that all gain important economies of scale. Each of these firms will presumably seek to maximize its share of the total domestic and foreign markets for the civilian version of the product in question. Since the previous world price was above current marginal costs, each firm would be able to increase its profits by undercutting that price somewhat and selling a larger volume. Having done this once, firms might realize that the going price was still above the marginal cost of production, and they would be tempted to undercut the going price yet further to earn yet higher profits, and so on. This sort of behavior might go on until the going price had fallen all the way down to the new lower marginal cost of production. If this happens, firms would have given up their opportunity for increased profits and probably their ability to pay higher wages to their workers. Local consumers of the product would certainly be better off, because the price of the product would have fallen. An important factor, though, is that foreign consumers would also be better off, enjoying sharply lower prices for the product. If foreign sales constitute a large share of the total market for this product (an increasingly common phenomenon), then much of the benefit of lower production cost will have been captured by foreign rather than domestic interests. Defense spending in the United States may have generated important gains for foreign consumers.

One way to make sure that the gains arising from defense procurement spending remain at home is to concentrate cost reductions in a single firm--sometimes referred to as a "national champion"--that will act as a monopolist in foreign markets. This happened naturally in the commercial jet transport industry, where Boeing (until recently) enjoyed a near monopoly in both domestic and foreign markets. The extent to which Boeing's preeminence in the commercial transport market was or is the result of U.S. defense spending is an issue that is bitterly contested among academics and among national trade negotiators. There seems little doubt, however, that by virtue of its vast scale of production Boeing has achieved an important cost advantage over its domestic and foreign rivals and has been able on occasions to earn monopoly profits.

The early dominance of IBM in international markets for computer mainframes may provide another example of a situation in which a single firm gained sufficient economies of scale to extract monopoly profits from both foreign and domestic customers. Inasmuch as IBM's early mainframe computers were bought exclusively by the U.S. government (and almost exclusively by the Department of Defense), one might attach some credence to the proposition that defense procurement provided the basis for significant gains to the U.S. economy at the expense of foreigners.

The microelectronics industry may provide an example in which intense competition among U.S. producers resulted in the advantages of technological leadership being captured to a large degree by foreign consumers. Without monopoly profits, U.S. producers may have found it difficult to maintain the level of investment necessary to maintain technological leadership, and this leadership is now widely seen as having passed to Japan. It is often alleged (but by no means conclusively proven) that Japanese policies of coordinating the actions of Japanese firms in foreign markets will ensure that the competitive benefits of Japanese technical leadership will not be similarly dissipated. Whatever the truth of these allegations, it is hard to believe that any Japanese policies discouraging price competition among Japanese microelectronics producers could have been as effective at

maintaining Japanese monopoly profits as was the 1987 agreement between the United States and Japan on international trade in semiconductors. This agreement forced Japanese firms to keep export prices for their products high. It sometimes seems that if the U.S. trade policy did not exist the Japanese trade ministry would have to invent it.

Defense spending that helps a local industry achieve efficient scale may also produce a benefit for the civilian economy if it reduces the ability of foreign producers to earn monopoly profits on sales to U.S. customers. (This is the basic idea that underlies arguments for protection of "infant industries" in developing countries until they have reached efficient scale.) It is hard to think of past examples of such benefits; it might credibly be argued that few foreign producers have earned monopoly profits on sales to the United States. When they have, the product in question has almost always been some sort of basic commodity or raw material--petroleum is the clearest example--rather than a manufactured product whose production is marked by economies of scale. Proponents of greater U.S. autonomy in the production of militarily relevant products may someday adopt such arguments. To date, though, arguments for autonomy have typically been based on the dubious proposition that reliance on foreign sources of supply makes the United States vulnerable to foreign pressure in time of crisis.

CAPITAL-MARKET FAILURES

A final kind of benefit for the civilian economy that might arise out of defense spending needs to be noted--not so much because it is likely to be important quantitatively (it probably is not), but because it is widely cited by the less restrained boosters of defense spending and because it cannot be dismissed out of hand. This potential benefit arises out of capital-market failures. Specifically, it is alleged that some firms are unable to raise capital resources--to finance R&D activities, to build necessary plant and equipment, etc.--at a rate of return that accurately reflects the risks faced by potential providers of capital. For one reason or another, certain firms are barred from easy access to capital markets. The common complaint about this kind of

market failure alleges that a firm simply "does not have the resources" to undertake the development or the production of some product. This is usually followed by an argument that the product in question is "essential" for the nation and that the government should therefore provide the capital resources necessary. Claims of this sort have been made recently on behalf of U.S. producers of semiconductor manufacturing equipment and potential U.S. producers of high-definition television.

Most of the time, arguments of this sort can be easily dismissed. When the allegedly disadvantaged firm is an established manufacturer or a major defense contractor, it is difficult to understand why traditional capital-market instruments--bank lending, corporate bonds, equity issuance--cannot be used to raise the necessary capital. True, firms will sometimes (perhaps always) have to pay more for the capital than they would like, but there is no particular reason to believe that the rate of return demanded by the market reflects an incorrect assessment of the risks and potential payoffs of the proposed project. For any branch of the government simply to subsidize the capital-raising activities of major firms would be to use government resources for other than their most productive purposes.

Smaller or newer firms may face more barriers to capital resources, but the rise of venture-capital firms and even venture-capital mutual funds in recent years suggests that these firms do enjoy increasing access to capital markets. Because the cost of capital to these firms is high is not in itself evidence of market failure. These firms, after all, may appear (and be) quite risky.

U.S. capital markets are without doubt the most smoothly functioning in the world, and it is tempting to dismiss all complaints about restricted access to these markets. A number of times in recent years, however, we have seen major innovations in U.S. capital markets, and after the fact it has been clear that these innovations have dramatically increased the availability of capital or reduced its price to certain classes of firms. The rise of junk bonds and asset-backed securities are perhaps the most striking recent examples of such innovations. In retrospect, it is easy to see that in fact important

market failures have occurred that have been corrected or reduced by these innovations. Few observers recognized these market failures before the innovations that reduced them appeared on the scene. (Indeed, this is one of the principal reasons that the innovators made so much money on their new ideas.)

In light of such recent experiences, it would be foolhardy to suggest that all imperfections have now been removed in U.S. capital markets. One must admit, therefore, that it is possible that important barriers do face some firms in raising capital. If this is the case, then less than the optimal amount of research and development will be undertaken and less than the optimal amount of investment in plant and equipment will take place. Defense Department support for R&D activities or for capital equipment might help to alleviate the negative effects of imperfect capital markets. The government, after all, has the best imaginable access to capital markets, and by borrowing in its own name and passing the proceeds on to firms with limited access the government can, in theory at least, reallocate resources to more productive uses.

The trick in all of this is identifying circumstances in which firms really do face some sort of barrier to raising capital, other than simple market skepticism about their prospects for success. Our recent experience suggests that capital-market failures are apparent only after they have been removed, and it is therefore hard to suggest any practical way to target Defense Department support for firms with limited access to capital markets.

IV. SOME NON-BENEFITS OF DEFENSE SPENDING

In the preceding section, we reviewed briefly some circumstances where defense spending would possibly (but not assuredly) produce some benefits for the civilian economy. When they occur, these benefits can at least partially offset some of the burden that defense spending inevitably imposes on the civilian economy. In this section, I will discuss two particular situations in which defense spending will not produce benefits for the civilian economy. I consider these two situations because they are often cited (incorrectly) as likely to give rise to civilian benefits.

LINKAGE INDUSTRIES

One frequently hears that it is particularly important for a country to maintain the health of those industries that produce inputs for other industries. The idea is that a strong steel industry, for example, will produce plentiful, cheap steel and thus help to strengthen the automobile industry. More current examples of such "linkage industries" might include microelectronics, computation equipment, machine tools, and speciality metals. In the last year, concern seems to have spread even to the producers of inputs to the producers of yet other inputs. Witness the consternation that was caused by the proposed sale to a West German firm of a principal U.S. maker of semiconductor manufacturing equipment.

Defense spending is seen as important in this connection because the Defense Department is the ultimate consumer of products which in turn require some important intermediate products. Defense procurement indirectly stimulates demands for steel, speciality metals, machine tools, semiconductors, and so on. Defense spending is seen as a way of keeping U.S. producers of intermediate products healthy. Their health is then supposed to contribute to the health of numerous other U.S. industries having little or nothing to do with defense production.

This argument has a certain intuitive appeal. It might seem, for example, that producing semiconductors or machine tools is somehow "more important" than producing video games or panty hose. Further, it may be natural to imagine that domestic rather than foreign supply of important intermediate products will provide some advantages for domestic users of these products. Thus, it would seem, government actions (including defense spending) that support domestic intermediate product industries might produce some benefits for the civilian economy.

Neither of these intuitions is correct, however. In competitive markets, the prices of intermediate goods will reflect their marginal contributions to the value of final goods. A dollar's worth of semiconductors adds a dollar to the value of the final products in which they are incorporated. In the absence of any identifiable market failure, one would expect (1) markets to value intermediate products correctly and (2) market forces to bring forth the correct supply of such products. Attempts to encourage the production of larger amounts of intermediate products would be wasteful. Spending a dollar to produce an additional semiconductor is probably pointless if it will add only ninety cents to the value of some final product.¹

More to the point, however, there is in general no reason to believe that U.S. users of intermediate products are better off if they buy these products from U.S. firms than if they buy them from foreign firms. No evidence exists that intermediate product producers in any country systematically offer lower prices or higher quality products to their countrymen than they do to anyone else. (Firms that behaved this way would eventually impoverish themselves and presumably go out of business.) Indeed, in the United States at least, the loudest cries for governmental support or protection of a domestic intermediate-product

¹I am not arguing here that defense spending cannot produce civilian benefits by creating economies of scale and thus lower costs in intermediate product industries. Lower intermediate-product prices that come about as a result of defense spending will, indeed, constitute a benefit for the civilian economy--as we have already noted. The point here is that there is no benefit in trying to stimulate production of intermediate products *just because they are inputs to many other industries.*

industry seem to arise when foreign producers are offering *lower* prices or *higher* quality than their U.S. competitors. If there is no particular advantage in buying intermediate products from a domestic producer, there can be no particular advantage in defense procurement that keeps domestic producers in business.²

There may, of course, be national-security advantages in producing militarily important intermediate products domestically rather than importing them. Domestic production may, for example, lower the risk of supply interruptions in the event of some crisis. This may be an important national-interest advantage in certain circumstances. It will, however, produce no benefit for the civilian economy. On the contrary, buying insurance against supply interruptions through a policy of autarky will be costly for the civilian economy, since the domestic economy will end up supporting either through taxes or higher prices domestic producers who are less efficient than their foreign competitors.

One particular intermediate product may be worth a moment's special attention. An intermediate product that is common to almost every economic undertaking--whether civil or military--is capital. Factories have to be built, machines installed, working inventories accumulated, etc. These real-capital requirements have to be financed through retained earnings, through security flotations, or through borrowing. If the cost of this financing is high--that is, if interest rates on borrowed funds are high, if the dividends necessary to entice investors to purchase new stock issues are high, or if the need to pay dividends reduces a firm's ability to retain earnings--the rate of capital formation will be slowed. With less capital formation, economic growth--the ability to produce both military and civilian products--will slow.

²As noted in the previous section, there may be some economic advantage in maintaining a domestic industry if this prevents the establishment of a foreign monopoly able to extract monopoly profits from its dealings with U.S. customers. Such foreign monopolies have arisen with respect to some commodities--oil is a painful example--but it is hard to think of a case where foreigners have earned significant monopoly profits on trade with the United States involving manufactured intermediate goods.

All other things being equal, government policies ought to be aimed at keeping the costs of capital low, thereby encouraging investment.

But can government policies affect the cost of capital? The standard view among economists is that government policy can influence the real cost of capital (the cost of capital after adjusting for inflation) in the short run but not in the long run. There is considerable debate, though, over how long the long run really is, whether we can expect to arrive at the long run in a time frame that is relevant for public policy, and whether an infinite string of short runs will keep us from ever observing the predicted long-term outcomes. In the short run (whatever that may be), heavy government borrowing to cover fiscal deficits and government policies that discourage private saving will increase the real costs of capital, and this will slow economic growth. Defense spending financed by taxes will reduce disposable income in the civilian economy directly. Defense spending financed by government borrowing will increase the cost of capital to the civilian economy. Either way, real resources will be transferred from civilian to military uses. This is just another way in which the burden of defense spending on the civilian economy will be manifested.

But if the cost of capital rises in the United States, will foreign capital not be attracted by the higher rate of return prevailing here? If enough foreign capital is attracted, will the cost of capital in the United States not revert to world levels? If so, there is little reason to fear that U.S. government policies will raise the cost of capital in the United States for any extended period. We have become used to speaking of international capital markets, and it is perhaps natural to think that if the cost of capital were momentarily higher in one country than elsewhere capital would flow in from abroad, quickly equalizing the cost of capital in all countries. Feldstein and Horioka,³ however, have demonstrated that national saving rates are correlated with national investment rates, suggesting that international capital flows do not

³Martin Feldstein and Charles Horioka, "Domestic Saving and International Capital Flows," *The Economic Journal*, June 1980, pp. 314-329.

equalize capital costs across national boundaries. More recently, much has been made of apparent differences in the costs of capital in the United States and Japan, with some observers citing these differences as important contributors to differences in the two countries' rates of economic growth.⁴

The point is that government policies apparently can raise the costs of capital in individual countries, and that higher capital costs will retard growth. Therefore, if the government wishes to use defense spending to facilitate economic growth by keeping the costs of capital low, it should eschew deficit financing of defense expenditures (or any other kind of government expenditure, for that matter).

HIGH-VALUE-ADDED EMPLOYMENT

It is sometimes argued that defense spending is particularly desirable as a mechanism for stimulating the economy because it produces more "good jobs at good pay" than do other types of government spending or the private spending that would result from reduced taxes. The argument here is that defense spending (and defense procurement in particular) is concentrated in industries using advanced technologies and employing relatively large amounts of capital per worker. This capital intensity contributes to high worker productivity, which in turn results in high wages. In the current environment, marked by increasing concern over the "quality" of jobs created in the United States, this argument has found some adherents.

Unfortunately, the argument has two serious flaws. The first is theoretical. If defense spending is truly concentrated in capital-intensive industries, then the jobs created as an immediate consequence of defense spending would probably be higher paying, "better" jobs than those resulting directly from other kinds of spending. Defense spending would also necessarily create fewer jobs than would other kinds of spending. A billion dollars will buy fewer workers at \$75,000 per year

⁴See, for example, George N. Hatsopoulos, Paul R. Krugman, and Lawrence H. Summers, "U.S. Competitiveness: Beyond the Trade Deficit," *Science*, July 15, 1988, pp. 299-307.

than it might workers at \$25,000 per year, particularly since the large amounts of capital equipment necessary to support the activities of the high-productivity workers also have to be bought. (This fact of accounting life has been recognized for years by critics of defense spending, who argue that defense spending is a bad tool for economic stimulation precisely because it produces a relatively small number of jobs. Some critics have gone so far as to suggest that defense spending actually decreases employment.⁵)

The jobs created as a direct consequence of defense or other spending, however, are not the full story. An increase in spending of any kind will also result in indirect job creation as, for example, new workers in a defense plant go to more movies and restaurants, buy new cars, take longer vacations, etc. A group of workers with new \$75,000 per year jobs will generate more indirect employment than will a similar number of \$25,000 per year workers. Thus, the gap between the number of jobs created as a result of defense spending and as a result of other kinds of spending will be narrowed, perhaps even eliminated. Will these indirectly created jobs be high paying, "good quality" jobs? That is hard to say. It will to a large degree depend on the qualifications of workers available to fill these jobs and the prevailing cost of capital (generally, the level of interest rates) when firms decide how many and what kinds of workers to hire. There is, though, no compelling theoretical reason to believe that, overall, the quantity or quality of jobs created as a result of defense spending will be significantly different from what would result from an increase in some other kind of spending.

The second flaw in the basic argument is empirical. Little evidence exists showing that, overall, the defense sector is significantly more capital intensive than the economy generally.⁶

⁵See Marion Anderson, *The Empty Pork Barrel: Unemployment and the Pentagon Budget*, Employment Research Associates, East Lansing, Michigan, 1982.

⁶For more on this subject and on the employment effects of defense spending in general, see Gordon Adams and Donald Gold, *Defense Spending and the Economy: Does the Defense Dollar Make a Difference?* Center on Budget and Policy Priorities, Washington, D.C., 1987, especially Chapter 4, "Defense Spending and Employment."

Building airframes, engines, or missiles is a very capital-intensive activity; but electronics assembly, shipbuilding, and manufacturing communications equipment are much less so. If defense spending is not particularly capital intensive, then the basis for the argument that defense spending creates "good jobs at good wages" largely disappears.

The most careful and complete study on the employment effects of defense spending in recent years, done by the Congressional Budget Office, concludes that "additional spending on defense and non-defense purchases of goods and services appear to have roughly equal expansionary effects on employment in the short run."⁷

Because defense and nondefense spending have roughly similar employment effects nationwide does not of course mean that the local impacts of the two kinds of spending will be the same. Some kinds of defense spending are clearly much more capital intensive than other kinds of government or civilian spending. (Research activities, for example, will make use of large amounts of both human and physical capital.) The communities in which such activities are located will experience all of the direct employment effects but probably only a few of the indirect effects. For these communities, the overall national effects will be of little concern, and the communities may have strong preferences for the creation of relatively few high paying jobs or many more lower paying jobs, depending on their particular circumstances. At the national level, though, there seems little reason to choose defense over nondefense spending as a mechanism for job creation.

⁷Congressional Budget Office, *Defense Spending and the Economy*, Washington, D.C., 1983.

V. SOME POTENTIAL ADDITIONAL COSTS OF DEFENSE SPENDING

In Sec. III, I noted some circumstances in which defense budgets might overstate the true social costs of defense spending, circumstances in which defense spending might generate benefits for the civilian economy that might partially offset the resource costs of that defense spending. In this section, I will turn my attention to circumstances in which defense budgets may underestimate the costs imposed on the civilian sector by defense spending, circumstances in which defense spending may do actual harm to the civilian sector beyond simply diverting resources from civilian uses.

"MISLEADING" TECHNOLOGICAL PROGRESS

Some military systems must be able to operate in hostile environments. Others must show very high reliability or be capable of unusual endurance. Yet others must be compatible with military systems already fielded. For these and similar reasons, military systems must sometimes meet specifications--so-called military specifications, or "mil specs"--that are neither necessary nor desirable in similar civilian products. Some military microelectronic components, for example, may need to withstand heavy doses of various kinds of radiation or be shielded against electromagnetic pulse. Building such capabilities into components destined for commercial television sets would, of course, be foolish.

Even in the absence of special military requirements, the nature of Defense Department procurement activities is often such that the military must provide highly detailed specifications for many items. When procurement competitions are aimed principally at finding the lowest-priced producer of a satisfactory product, detailed specifications of what constitutes a satisfactory product are necessary.¹ Perhaps inevitably, these detailed specifications are

¹Sometimes the level of detail in these specifications borders on the comical. See, for example, Jacques S. Gansler, "How the Pentagon Buys Fruitcake," *Air Force Magazine*, June 1989, pp. 94-97.

sometimes at odds with the characteristics of similar products destined for civilian markets.

There is considerable debate over the necessity and the wisdom of current military specifications for many products. Some analysts argue that prevailing commercial standards are quite adequate for many military applications and that the military could save significant amounts of money by dropping detailed military specifications for those applications. It is not my aim to discuss the relative merits of the differing views in this debate. What is important for my purposes is that many products are in fact produced to military specifications and that these products differ significantly from their closest civilian counterparts.

It is sometimes argued that, in cases where the military accounts for a large fraction of the early market for a product, the requirement to meet military specifications can force firms to develop products that are unsuited to civilian markets--because they are too costly or too capable. If the resources expended to produce military versions of products produce nothing of value for the civilian sector, we would have a simple diversion of resources from civilian to defense purposes, and defense budgets would be a more or less accurate reflection of the costs of this diversion. Some have suggested, though, that production to military specifications may be yet more harmful in that it can divert civilian development efforts into unproductive or inappropriate paths, not only by consuming resources that could have been used for civilian purposes but also by rendering resources left for civilian use less productive. Defense spending may, in short, "mislead" civilian technological progress.

The exact mechanisms by which these additional costs may be levied on the civilian sector do not seem to be spelled out clearly. It may be, though, that, because resources available for development efforts are limited in the short run or because there are important economies of scale, firms are unable or unwilling to produce distinct military and civilian versions during the early development stages of new products. If the military is the primary or the most reliable customer,

development efforts will naturally be focused on meeting the needs of the military, perhaps to the detriment of sales in the civilian market.

The semiconductor industry may illustrate a case in which meeting military requirements may have cost U.S. producers their original dominant position in world markets. It may be that, by producing to military specifications, some U.S. manufacturers lost touch with rapidly growing civilian markets with very different requirements and so lost these civilian markets to Japanese firms.² Rachel Schmidt has argued that something similar happened during the early years of the U.S. numerically controlled machine tools industry. The U.S. military heavily supported early development efforts of U.S. firms. By insisting on performance standards that were beyond what were required by the emerging civilian market for these tools, however, the military quite plausibly hindered the development of the U.S. machine tools industry.³

"CORRUPTION" OF COMMERCIAL MANAGEMENT

Defense spending may impose another cost on the civilian economy, as manifest in the suggestion that continued dealing with the Defense Department can "corrupt" corporate managers, researchers, and designers, making them unfit for productive work in the civilian sector. The idea behind this assertion is that military and civilian markets are so different that managers who learn to succeed in one market are almost by definition incapable of operating in the other. Prolonged exposure to the cost-based contracting policies of the Defense Department, for example, is sometimes said to destroy a manager's nose for the kind of cost-saving innovation that is crucial for success in the civilian market. Similarly, the kind of mind that can deal successfully with the very detailed requirements of military specifications may not be sufficiently flexible to deal with the "close enough" ethos thought to

²See Richard C. Levin, "The Semiconductor Industry," in Richard R. Nelson (Ed.), *Government and Technical Progress*, Pergamon Press, 1982, pp. 9-100.

³Rachel Schmidt, *Civil and Military R&D Spending: The Case of Numerically Controlled Machine Tools*, The RAND Corporation, P-7471-RGS, July 1988.

dominate civilian markets. Proponents of this view note that the firms or the divisions of firms that perform defense work do this kind of work almost exclusively. The median ratio of defense sales to total sales of the defense divisions of the 108 largest defense contractors was 0.79 in 1985.⁴ Such a high degree of specialization in defense work might easily breed, it is argued, a distinctive way of doing things, a distinctive approach to business decisionmaking.

On its face, this argument is less than fully convincing. While it is plausible that prolonged dealings with the Defense Department can result in new modes of behavior, it is hard to believe that corporate managers become irredeemably corrupt as a result of their experience. The argument has the ring of oversimplified and attention grabbing (perhaps because it is oversimplified) anecdote. To my knowledge, no serious studies have ever shown that such "corruption" is a significant factor in industrial performance.

What keeps one from dismissing such arguments out of hand, though, is that a number of large and successful companies that do both military and civilian business apparently go to considerable lengths to separate their civilian and military operations, trying to keep each functioning successfully in its own milieu with its own way of doing business and without mixing two alien cultures. (Boeing is the most frequently cited firm that behaves this way.) Because a few successful firms behave in a certain way does not, of course, constitute proof that this kind of behavior is really beneficial. It does suggest, though, that people who are in a position to observe the two styles of operation and their respective effects on managers and who presumably have a strong interest in finding productive management arrangements believe that there is something to this idea.⁵

⁴Arthur J. Alexander, Paul T. Hill, Susan J. Bodilly, *The Defense Department's Support of Industry's Independent Research and Development (IR&D): Analyses and Evaluation*, The RAND Corporation, R-3649-ACQ, April 1989, p. 45.

⁵Some work currently under way at The RAND Corporation is aimed at trying to identify more systematically the extent of and the reasons for separation of military and civilian R&D activities.

INCREASED MARKET VOLATILITY

Another potential cost to the civilian economy arises out of the uneven pattern of U.S. defense spending during the postwar period. Defense spending fell sharply at the end of World War II only to rise sharply a few years later because of the Korean War and the onset of the Cold War. Spending fell again, as a share of GNP, from the mid-1950s to the mid-1960s, when the Vietnam War pushed it higher again. The late 1960s through the late 1970s saw another decline, which was reversed by the Carter/Reagan defense buildup of the late 1970s and early 1980s. We are now once again in a period of substantially declining military expenditure.

Although not perfectly correlated with total defense spending, defense outlays for R&D and procurement have shown similar fluctuations over this period, at some times absorbing large numbers of skilled scientists, engineers, and production workers and at other times returning such workers to the civilian sector. Because the training periods for scientists, engineers, and skilled workers are long, the supply of such professionals is quite inelastic in the short run. As a result, changes in defense demand for such workers can strongly influence wages.⁶

Students choosing a path of study that will lead to a career eight or ten years in the future have to make guesses about the wages they will likely command when they finish their training. Because most people are risk averse, the volatility in the wages of technical workers introduced by fluctuations in defense spending might plausibly discourage some students from choosing to pursue technical studies. I know of no clear evidence about the existence or the magnitude of such effects, but if students really are dissuaded from technical careers by the prospect of uncertain wages, unstable defense spending will be imposing real costs on the civilian economy--in the forms of increased uncertainty and distorted career choices--beyond the simple diversion of

⁶Richard B. Freeman, "Supply and Salary Adjustments to the Changing Science Manpower Market: Physics, 1948-1973," *American Economic Review*, March 1975, pp. 27-39.

resources reflected in defense budgets. Similar arguments could be made with regard to long lead-time physical capital also.

RESTRICTIONS ON INFORMATION DISSEMINATION

Defense spending for research and development is distinguished from similar spending by other government agencies and by private firms in that some of the information produced as a result of this spending is classified and cannot be freely disseminated. There is of course continual debate over what information should or should not be restricted but little argument over the idea that at least some kinds of militarily relevant information should be closely held. Information that cannot be disseminated to the civilian sector cannot benefit that sector to any significant degree, and military R&D projects that produce mostly classified information will presumably produce little in the way of commercially valuable spin-offs. In these cases, the resources diverted from civilian use will have been truly lost to the civilian sector.

It is sometimes argued, though, that the information restrictions that arise out of defense-related R&D can extend further, hampering the flow of information not directly relevant to defense programs. One hears anecdotes about firms refusing to accept Defense Department funding for research projects out of fear of losing control over commercially valuable information. The assumption seems to be that if a firm develops something independently, it may do with it what it pleases (subject to more general export restrictions). If, on the other hand, a project is funded by the Defense Department, the firm must abide by Defense Department restrictions.

If it is in fact true that Defense Department support can, in itself, result in restrictions on the dissemination of commercially valuable information, the value of that information will be lessened, and the civilian economy will suffer. There is little evidence, though, that this is really the case. Typically, patent rights growing out of government-sponsored research are vested in the government and not in the innovating firm. This may affect the distribution of some

commercial gains, but it will not necessarily lead to more restricted dissemination of information than if the firm had retained the patent rights. Indeed, the government might be more willing to offer the information to other users. The government also has the power--although it is rarely used--to classify information developed independently and to restrict its dissemination. Thus, independent funding of research and development does not constitute an iron-clad guarantee of a firm's freedom to use information in any way it desires. I know of no clear-cut case in which restrictions imposed by the Defense Department have restricted the commercial value of research and in which private funding of the same research would plausibly have resulted in wider dissemination of valuable information. The possibility that this may have happened cannot be dismissed, however, and this potential cost for the civilian economy is worth including on this checklist of possible costs and benefits of defense spending.

VI. SOME CONCLUDING THOUGHTS

Reviewing the situations in which defense spending may generate some benefit for the civilian economy, we see that they fall generally into two categories:

1. Situations in which defense spending produces some externality--like a technological spin-off or leftover capital--that is of value to the civilian economy.
2. Situations in which market forces fail to produce the socially optimal outcome and in which defense spending leads to a socially preferable deviation from the market-determined outcome.

The latter category deserves comment.

THE IMPORTANCE OF MARKET FAILURES

Perhaps the most basic insight of economics is that, when certain conditions are satisfied, a freely operating market will produce the set of outputs with the highest total value (with each unit of output valued at its market price) that is possible with a given set of resources. When the necessary conditions are satisfied, the prices of particular products will reflect their social values, and the market outcome will be socially optimal. Any deviation from the market-determined outcome results in a lower total value of output. Almost by definition, government intervention in economic affairs brings about deviations from market-determined outcomes. (If the market would have produced a particular result, there would be no need for the government to do anything.) Consequently, government interventions in perfectly operating markets--through regulation, taxation, or government spending--always result in some loss of output.¹

¹Clearly, regulation, taxation, and government spending can serve a variety of valuable social purposes--creating a more equitable distribution of income, for example. I do not mean to suggest that

But the conditions for the optimality of market outcomes are not always satisfied; in some circumstances, markets fail. In these cases, deviation from the market-determined outcome--perhaps brought about by government intervention--can be beneficial. Indeed, the economic justification for defense spending being a government responsibility in the first place is precisely that markets will fail to provide an optimal defense capability. This is because defense is a public good: I get the benefits of U.S. defense spending--freedom from invasion, deterrence of nuclear war, etc.--by virtue of living in the United States, whether or not I contribute to this spending. Since all residents reap similar benefits whether or not they contribute, no one has a private incentive to contribute. If the defense establishment depended on voluntary contributions, there would be very little defense. As already noted, this situation is unlikely to be ideal or optimal, and some market intervention is required to produce an adequate defense capability. In this case, the solution is for the government to intervene in the market, providing a defense capability and forcing everyone, through the tax system, to contribute.²

Consideration of the sections above will reveal that most circumstances in which defense spending results in benefits for the civilian economy arise out of some sort of market failure. Firms may fail to invest optimally in research, for example, because markets do not allow them to capture the full benefits of their efforts. Government support for R&D may be necessary because individual firms overestimate the true social risks inherent in uncertain research efforts. And so on.

these purposes are unworthy. The point here is that government intervention in perfectly operating markets will always have costs in the form of reduced output of goods and services. The broader gains that result from the intervention may outweigh these costs, but the costs will be real nonetheless.

²For a particularly nice discussion of the public-good nature of defense and the problems this can cause, see Mancur Olson, Jr., and Richard Zeckhauser, *An Economic Theory of Alliances*, The RAND Corporation, RM-4297-ISA, October 1966.

The civilian gains arising from the economies of scale generated by defense spending may be viewed as the result of a kind of market failure. The failure in this case is that in markets characterized by a downward-sloping supply curve--that is, markets characterized by economies of scale--buyers will fail to recognize the full benefit inherent in a decision to purchase an item. Because they do not take into account the positive externality generated--lower prices for other buyers--they will buy less than is socially optimal. Another way to understand this market failure is to remember that for an industry characterized by economies of scale, marginal costs will always be below average costs. In these circumstances, a firm that meets the usual condition for social optimality--that price equals marginal cost--will be selling below its average cost and incurring losses. Eventually, it will go out of business unless it can charge some high-value customer (the Defense Department, for example) for some of the uncovered average costs.

By extending somewhat the concept of market failure, we can capture even the situations in the first category noted above--situations in which defense spending produces externalities beneficial to the civilian economy. In these cases, a market failure occurs in the sense that the Defense Department for some reason cannot or will not demand compensation from civilian interests for benefits generated by defense spending. Typically, it cannot, for example, sell the rights to technologies developed in the course of defense-funded R&D.³

With market failure construed in this broader way, we can pose a relatively simple method of identifying situations in which civilian benefits can possibly result from defense spending: If we can identify a market failure, defense spending possibly (but not certainly) will produce benefits for the civilian economy. If we cannot identify such a failure, there is no reason to believe that defense spending will

³I am, perhaps, pushing the traditional concept of market failure a bit too far here. My point is not to establish a somewhat dubious terminology but to characterize as simply as possible situations in which defense spending may lead to civilian benefits.

produce any social benefit beyond its contribution to national security. A search, then, for circumstances in which defense spending might prove beneficial to the civilian economy becomes a search for market failures that might be compensated for with defense spending.

WHAT MAKES DEFENSE SPENDING SPECIAL?

The preceding sections have focused on the potentially positive or negative effects of defense spending on the civilian economy. In the course of these discussions, I have generally avoided the question of whether defense spending is different in these respects from other types of government spending. Let us take up that question explicitly now.

At the most fundamental level, defense spending is really no different from any other kind of government spending regarding its effects on the civilian economy. Any kind of government spending represents a diversion of resources away from private consumption or investment. Presumably, government spending achieves some worthwhile purpose, but we cannot escape the fact that as a consequence of government spending fewer resources are left to meet private demands. Government spending on health care is as much a necessary evil as government spending on defense.

Similarly, the potential for government spending to bring benefits for the civilian economy is not limited to defense spending. In the presence of market failures, appropriate government spending can bring beneficial deviations from market-determined outcomes. In some cases, the appropriate spending may be defense related; in some cases not. The basic analysis laid out in the earlier sections of this Note applies just as well to nondefense spending as to defense spending: Look for a market failure, then ask whether a proposed program of government spending will alleviate or exacerbate the consequences of that failure.

Why, then, focus on the effects of defense spending? The answer to this question, generally, is that defense spending (or at least some kinds of defense spending) may have some characteristics that distinguish it from other kinds of government spending. Some characteristics of defense spending--like secrecy and military

specifications--may serve principally to separate defense and civilian research, development, and production activities, limiting the possibility that defense spending will have any impact on the civilian economy other than simply diverting resources from it. Others, though, are sometimes alleged to make defense spending more likely than other kinds of government spending to generate benefits for the civilian economy. I conclude by considering briefly some of these alleged characteristics.

The Volume of Defense Spending

Perhaps the most important characteristic of defense spending is also its simplest. Defense spending constitutes a large fraction of all federal government spending. To an important extent, federal government spending *is* defense spending. In fiscal year 1989, defense spending accounted for just over one-quarter of all federal outlays. This severely understates the importance of defense spending to the economy, however, because most outlays of the federal government are for transfer payments--redistributions of income from taxpayers to private interests--rather than direct purchases of goods and services. It is through purchases of goods and services, though, that government spending diverts resources from private uses and most directly affects private markets. Almost all defense-related outlays are purchases of goods and services, and during fiscal year 1989, defense spending accounted for fully three-quarters of all federal government purchases. Thus, the bulk of the total real resources claimed by the federal government was for defense uses.⁴

⁴For my purposes, the share of defense in government purchases of goods and services is a better measure of the importance of defense spending than the share of defense in total outlays. The former share probably overstates this importance somewhat, however. Some government transfer payments have quite direct consequences for the allocation of real resources in the economy. Medicare payments, for example, are counted as transfers rather than direct purchases, but they do of course result in more resources going to health care.

Preceding sections noted repeatedly the potential benefits to the civilian economy that might result from government R&D spending. Here, too, defense spending is most of the story. In 1987 (the last year for which I have figures), more than two-thirds of all R&D activity sponsored by the federal government was defense related.

Concentration in Areas of Technical Progress

It is sometimes argued that defense spending is particularly powerful as a driver of technological progress because it is concentrated in high-technology industries where technological progress is likely to be rapid. In such circumstances, the argument goes, spin-offs, leftovers, and other positive externalities associated with the R&D process are more likely. (Some critics of current defense policies seem to hold a similar view of the nature of defense spending. They argue that an overemphasis on generating technological progress, a search for revolutionary rather than evolutionary technological progress, renders much defense R&D and procurement wasteful.)

Obviously, this is not an accurate characterization of all defense spending. Purchases of uniforms, fuels, trucks, etc., are likely to do little to encourage technological progress. It is equally obvious, though, that some other kinds of defense spending truly expand technological horizons. Whether, on the whole, defense spending is any more technology intensive (or has been during recent years) than other kinds of government spending is a question that does not appear to have been rigorously analyzed. One might wonder, for example, about the technological consequences of reallocating defense budgets to provide more health care or public transportation. Clearly, government spending aimed at expanding technological possibilities is a better bet for producing commercially valuable innovations than is spending that simply exploits existing capabilities. Defense-related R&D, no matter what its focus, is more likely to produce commercially valuable technological spin-offs than is increased government outlays for routine medical care. But government spending to advance technology is possible in the civilian sector as well as in the military sector. Whether defense

spending is or has been a better vehicle on average than other kinds of government spending for generating technological progress that will produce civilian benefits remains an open question.

Concentration in Industries Showing Economies of Scale

A related proposition is that defense spending is particularly concentrated in industries characterized by economies of scale. If this were true, and if these industries also produced civilian products that could share in the economies of scale, defense spending would be particularly effective at lowering the costs of valued civilian products.

Certainly, defense spending is important in the total demand for some industries that show economies of scale: aircraft production, speciality metals, microelectronics, for example. It is difficult to think of other kinds of government spending that offer similar potential in these or other industries. Possibly this is because no other type of government spending generates nearly the level of purchases of manufactured products that defense spending does. It is hard to imagine even very large increases in other types of government spending--likely to be concentrated in services and in less standardized products (housing, for example)--generating the kinds of economies of scale that seem to arise as a result of defense spending. This may in fact be an important distinguishing characteristic of defense spending.

The Nonmarket Nature of the Defense-Goods Market

Defense procurement is distinguished from other kinds of government procurement by the fact that for many militarily relevant products the government is either the only buyer or the obviously dominant source of demand in the market. Few customers other than the government buy sophisticated fighter aircraft, missiles, advanced munitions, or anything closely resembling them. On the supply side of the market, many important military items are produced by only one or a few firms. The Defense Department is widely (and plausibly) said to be relatively insensitive to price in making decisions about the number of units of

any system to buy. Military acquisition decisions are often driven by military "requirements," and lower prices will often not result in a decision to buy more aircraft, missiles, or tanks. The prevalence of cost-based contracting in the military acquisition process removes some of the standard incentives for cost-reducing and performance-enhancing innovation.

For all of these reasons, the markets for militarily relevant goods may not behave very much like the ideal markets of economics textbooks. These markets are likely to be rife with market failures. To the extent that these same products or closely related ones have civilian uses, the civilian markets are likely to be considerably less than perfect also. As we have seen, market failure will sometimes create a situation in which some kind of government spending will bring about a social gain. If market failures are particularly probable with respect to militarily relevant products, perhaps military spending is likely to be a particularly fruitful type of government spending.

The Prevalence of "Bet-the-Firm" Decisionmaking

Another characteristic of the market for sophisticated weapons systems is the need for potential contractors sometimes to "bet the firm" on a single contract. Sometimes major defense contracts can be so big relative to the size of the firms competing for them that success or failure in winning and fulfilling a contract can make the difference between the firm's survival or demise. In these circumstances, the risk aversion of both firm managers and potential providers of capital funds may be particularly pronounced. Managers may face the prospect of having no future in which to recoup losses. Lenders and investors may have to contemplate the complete loss of their interests if the firm goes bankrupt.⁵

⁵The rise of "dual sourcing"--procuring military equipment from more than one producer, no matter who first developed it--may reduce this "all or nothing" character of defense-spending decisions in the future.

The rub will come if the firm in question engages in both military and civilian production. The need to "bet the firm" repeatedly on defense business may discourage civilian-side risk taking by the firm or dissuade outside lenders or investors from providing capital resources even for nondefense projects. The result could be to limit the ability of the firm to develop or to produce civilian goods. In such cases, some sort of Defense Department intervention to reduce the risks associated with defense work (through subsidies for defense-related capital expenditures, through greater cost sharing, etc.) might yield benefits for the civilian economy.

While the above story is plausible, I at least have some doubts about whether the situation described here represents a serious policy problem. Overlap between defense and civilian activities (or truly "dual-use" technologies) is more likely, it would seem, at the component or subsystem level of defense spending than at the major system level. There will be no civilian demand for advanced fighter aircraft. There may, however, be civilian demand for an avionics subsystem used in the fighter. Whereas the prime contractor responsible for final delivery of the fighter may have to bet the firm on the outcome of the contract, the avionics subcontractor may not. Thus, for the firms whose activities will matter most to the civilian economy, there may be little unusual risk and consequently no reason to suspect market failure.