

Stanford University

C I S A C

Center for International Security and Arms Control

The Center for International Security and Arms Control, part of Stanford University's Institute for International Studies, is a multidisciplinary community dedicated to research and training in the field of international security. The Center brings together scholars, policymakers, scientists, area specialists, members of the business community, and other experts to examine a wide range of international security issues. CISAC publishes its own series of working papers and reports on its work and also sponsors a series, *Studies in International Security and Arms Control*, through Stanford University Press.

Center for International Security and Arms Control
Stanford University
320 Galvez Street
Stanford, California 94305-6165
(415) 723-9625

<http://www-leland.stanford.edu/group/CISAC/>

Measuring Defense Conversion in Russian Industry

John S. Earle and Ivan Komarov

I. Introduction

The size of the defense industry in Russia has been a primary concern for policymakers and scholars interested in international security and arms control, as well as for students of Russian politics and economy more generally. For an issue attracting so much apparent interest, however, there appears to be remarkably little quantitative information available on the scope of the military production sector and, particularly, on the extent to which it has changed in recent years. Analysts of the military-industrial complex (MIC)¹ have either combined the scraps of information derivable from official reports to try to form an overall picture (e.g., Cooper (1991a and 1991b), Despres (1995), Gaddy (1994), Sapir (1994), Sanchez-Andres (1995) and most of the published literature in Russian language), or they have been limited to detailed case studies of just a few firms, eschewing any attempt to measure the sector as a whole (e.g., Bernstein (1994)). Both approaches have contributed substantially to our qualitative understanding of the organizational structure of the military industry and of recent changes in the operation of some of its enterprises. But neither provides quantitative answers to the following questions: How large is Russian defense industry? What is the magnitude of decline in military production since reforms began? What are the sources of the change? To what extent are resources being released for civilian purposes? Yet the answers have important implications for international security and for the design of foreign aid and domestic policies to assist the conversion and industrial restructuring processes.

To a certain extent, of course, the existing lack of answers can be explained by data deficiencies; as we will show, estimating these quantities requires detailed information on a large number of enterprises, which was unavailable to earlier researchers.² Yet another explanation may be the conceptual difficulty in defining the scope of the defense industry and the precise nature of conversion: in principle, a number of different approaches could be applied, but they have as yet been little investigated. Rather, researchers have focused almost exclusively on an administrative definition of the sector (subordination to the State Committee for Defense Industry—GKOP), and rarely have they drawn a distinction between a decrease in military production and actual conversion of resources to civilian uses.³

Previous research has also lacked a framework for measuring the contributions of various elements of defense industry change. It is clear that Russian industry as a whole has been shrinking, but little evidence has been available on the relative rate of shrinkage in the defense and non-defense sectors of industry, and thus on the degree to which any observed reduction in military production is merely part and parcel of general industrial decline. The process of resource reallocation within firms has received more attention, but only in a limited number of case studies, and it would be desirable to know how much an

average defense enterprise has reduced military production and the degree to which it has been able to reallocate resources to civilian purposes. While they are often recognized implicitly, no one has yet made these distinctions explicit nor attempted to measure their relative importance.⁴

This paper provides systematic answers to the questions about the size of the defense sector and the extent of demilitarization and conversion in the Russian manufacturing sector. We consider a number of alternative approaches to defining and measuring the magnitude of military production and the scope of the military-industrial complex, going beyond the purely administrative definition which has dominated previous studies. We distinguish defense *conversion* from the broader notion of *demilitarization*: any reduction in defense output is demilitarization, but, in our usage, conversion requires that the resources freed up from military uses be fruitfully redeployed in the production of civilian goods and/or services. We propose a theoretical definition, to be made precise below, of the degree of *conversion* of an asset—whether physical, human, or technological—as the ratio of its marginal productivity in the new civilian use to its implicit marginal productivity in the former military purpose (as reflected in the magnitude of past investments in the asset). While neither this theoretical quantity nor its components are directly observable, of course, we are able to construct proxy measures, relying upon the information available from a large survey of Russian manufacturing enterprises conducted in July 1994. The paper reports our estimates of both the magnitude of demilitarization in an average MIC firm and the extent to which it has involved conversion in this specific sense.

Furthermore, as we have indicated, the process of resource reallocation from military to civilian purposes involves not only the transfer of resources within firms, but also their mobility across manufacturing firms and across sectors, for instance from machine building to consumer goods. To quantify these relationships, the paper develops an accounting framework to decompose total conversion into its constituent parts: a “scale effect” related to the overall decline in Russian industry, an “intersectoral reallocation effect” related to differences in relative rates of growth/decline in the defense industry compared with other sectors of manufacturing, and an “intrafirm substitution effect” related to changes in production within firms in the MIC. Applying the framework to our enterprise survey data, we build up a range of aggregate estimates of the size of the Russian MIC and the extent to which it has demilitarized and converted, over the period 1990 to 1994.⁵

It may be worthwhile to review the problems one faces in attempting to define the content and boundaries of the MIC; these problems also suggest the sorts of caveats which should be borne in mind when interpreting the empirical results below. To start with, information about the defense industry is usually harder to obtain than other economic data in any country, due to perceptions of sensitivity for national security. This tendency holds no less in the case of Russia, and we find that enterprises in the MIC are still less likely than other firms in the survey to provide sensitive information. Fortunately, the sample is large enough so that we are still able, despite this problem, to measure a significant number of relevant variables. Other measurement problems result from the continued widespread usage by firms of Soviet accounting concepts and from the inflationary environment, although some solutions are possible.⁶ For instance, because we find much greater reliability of information concerning the employment rather than the output of MIC firms, most of our estimates below are measured in terms of the effective number of people employed in the MIC or engaged in military production, rather than the very hard-to-measure value of the output which they produce.

A more fundamental problem in measuring military production and the MIC stems from the very history of Russian economic development. The paramount objective of Soviet

industrialization was production for military purposes, implemented through a series of five-year plans stretching back to 1929 and continuing with the Second World War and subsequent cold war. The Soviet state was highly militarized, the Russian Republic most of all (Sapir (1994)), and therefore the defense and non-defense components are in some sense inextricable in current Russian industry. Military firms commonly produced consumer goods, and consumer goods manufacturers often had “dual-use” technologies which would enable them to switch to military production should it become necessary (Cooper (1990)). Any analysis of defense conversion must therefore move beyond a classification of number of firms as MIC or non-MIC, and analyze the relative proportion of military and civilian goods within firms.

Moreover, the presence of vertical supply chains, in everything from energy and mining to metalworking and transportation, implies that many firms could be solely engaged in supplying such intermediate goods and services to firms producing rifles, tanks, and airplanes; yet the supplier enterprises will not be observed to be producing “defense goods” conventionally defined. Indeed, practically everything may have some military use: even final consumer goods such as food (rations), clothing (uniforms), and “consumer” appliances (radios). And it is difficult to have product codes that are sufficiently disaggregated to identify precisely whether a good tends to be “more defense” or “more civilian.” For these reasons, we find unsatisfactory a definition based solely on the nature of the output produced. Producing guns and bombs is almost certainly a sufficient condition to be considered part of the sector, but in a broader view of the complex, it is probably not a necessary one.⁷

Nor does a purely administrative definition of the MIC appear to be adequate, despite the fact that it has been adopted in most previous attempts at quantification. While most firms producing standard defense goods were brought under subordination to the *Goskomoboronprom* (GKOP) in 1992, many were not, and the supplier organizations were almost completely excluded. The GKOP group may be of particular interest for some analyses, for instance understanding the current battles for resources and influence among various sectors of the Russian economy, and we do present results for it below. But we are also interested in a broader perspective, including other firms with military production and those with a more indirect relationship to defense, as well as looking inside firms to try to measure the strength of their orientation toward the military.

The complexities in defining military production and the MIC strongly suggest that it is best to avoid reliance on any single indicator. Rather, our strategy is to consider multiple definitions and measures. Associated with each definition of the scope of the sector, of course, is a different notion of conversion. The result is a range of estimates which, while less convenient than a single number, we feel is the only honest way to approach the problem. In addition to providing useful tests of the robustness of our measures, the differences in definitions are important to examine because they are often substantive: different measures may be appropriate for different purposes.

The rest of the paper is organized as follows. Section II reviews the findings of previous attempts to quantify the size of aggregate military production and of the MIC in Russia. We discuss problems of definition, unit of measurement, and source of information, and we summarize the studies’ most important results.

Section III describes our conceptual approach to defining demilitarization and conversion. First, we provide a simple model of these processes for a two-sector, three-good economy, which makes explicit the key concepts. We then lay out an accounting framework for constructing aggregate measures of the size of the military-industrial

complex and of total demilitarization, measuring the relative contributions of components attributable to overall industrial change, intersectoral shifts, and intrafirm restructuring. Although simple, the framework is also quite general, and it clarifies the relationships among factors which are critical in the broader problem of industrial restructuring in transitional economies.

Section IV describes our data, and presents four alternative approaches to defining and measuring the sector. One of these, subordination to the GKOP, is static in our data set, but for the other three measures—product types, revenue sources, and distribution methods—we have information in both 1990 and 1994, allowing us to measure the extent of change in each variable over that period. In Section V, we present our calculations of those changes, focusing on an “average MIC enterprise,” and we provide estimates of the extent of intrafirm demilitarization and conversion, whereby individual firms have shifted from defense to non-defense activities.

Section VI turns to the question of shifts within industry between the defense and non-defense sectors, and we present evidence on their differential rates of change, according to our set of alternative definitions. We apply our aggregation framework to assemble these figures together with information on the aggregate industrial sector and build up a set of estimates of “total MIC” and “total demilitarization” in Russia. Each estimate of total change is decomposed into its components, to assess the relative contribution of each. Section VII concludes the paper with a discussion of inferences concerning policies for the conversion and demilitarization of Russian industry.

II. Literature Review

In this section, we summarize the problems and the results of previous attempts to quantify the size of aggregate military production and of the military-industrial complex in Russia. As is often recognized, the analyses have suffered from definitional limitations and ambiguities, from problems in the choice of units of measurement, and from poor quality of information and unreliability of sources. For the most part, they pertain to the Soviet Union (rather than the Russian Federation) before the major reforms took place, and they are seriously out of date.

We have discussed the definitional issues in Section I above. Although not all studies report the precise definition of the MIC that is the basis for their estimates, implicitly or explicitly most of them have used a purely administrative approach: MIC is taken to be the set of enterprises that was subordinated to one of a group of ministries in the pre-reform period and came under the supervision of the State Committee for Defense Industry (*Goskomoboronprom* or GKOP) in 1992.⁸ As we have argued, however, a broader definition of the MIC may be desirable for many purposes. Anecdotal evidence indicates, and the results of our analysis will demonstrate, that a significant number of enterprises outside the GKOP boundaries are closely tied to the military, and a significant number inside engage in little or no military production, at least according to some definitions. Thus, if one is interested either in military output or in the inputs that are consumed by the military, and not just the formal grouping (which may, of course, have political relevance), more detailed information is necessary to construct a working definition of the MIC.

Other definitional problems concern the concepts of military production and conversion from military to civilian. Whether a product should be classified as military or civilian is

unclear in many cases, particularly when the available information concerns only some aggregated groups of products. To some degree this problem may be unavoidable, but there has been little attention to the robustness of results under alternative classification schemes. Considerable inconsistency and vagueness also exist with respect to the meaning of conversion: referring to the general usage of the term, Bernstein (1995) remarks that “[M]ore appropriate terms are diversification and restructuring” (p. 215).⁹ Ambiguous definitions may also interact: for instance, if the MIC is taken to be the GKOP-subordinated enterprises and if all production in the MIC is considered to be military, then any bureaucratic rearrangement of enterprises across the boundaries of the GKOP will induce a change in the observed size of the defense sector. Such rearrangements have taken place on a considerable scale, in the early 1990s as some consumer manufacturing was brought under the GKOP and more recently associated with corporatization and privatization, but it does not seem reasonable to count them as conversion.

A second set of issues concerns the choice of units of measurement. Nearly all estimates of military production and of the size of the MIC in the literature are based on either the number of employees or the number of enterprises. Some estimates of the production of some individual weapons or types of weapons (jet fighters, tanks, missiles, aircraft carriers) do of course exist, but, with one exception, we could find no estimates of the aggregate output of military and military-related production or sales. The single exception is Cooper (1991b), who reports the total gross output of the complex, as of 1988, at more than 140 billion rubles, or 16 percent of gross industrial output, of which the military component was approximately 88 billion rubles. But there are serious reasons to be skeptical of such aggregate output estimates (which may also help to explain the reticence of most researchers to examine them). The main problem here, which Cooper readily admits, is the distortion of prices, which was particularly strong in the case of military goods. According to Chapman and Wittneben (1992), for instance, during 1990–92 the prices for certain goods ranged up to a factor of 9, depending on whether the specific use was civilian or military. Within the MIC, controlled prices were similarly arbitrary. Ozhegov et al. (1992) estimate that military prices during 1992 were approximately 50 percent of the civilian due to administrative regulations. The intertemporal changes are obscured by the fact that in 1992 the prices for military goods, on average, had increased less than the prices for civilian goods, whereas in 1993 the picture was the opposite (Despres (1995)).¹⁰ Moreover, the state has run large arrears in payments to defense producers, which, in a high inflation context, has reduced the effective price received by producers and greatly obscured relative prices. Indeed, we feel that the pricing problem is insurmountable, and therefore we follow the existing literature and try to use employment measures wherever possible.

A third set of issues concerns the sources of information used in previous research. Cooper (1991a) draws upon publicly available Soviet budgetary documents, and Sapir (1994) estimates state expenditures on weapons procurement based on “unattributed documents of the Defense Intelligence Agency.” But these methods suffer not only from the dubiousness of their sources and from the pricing problem just discussed; in addition, raw materials and intermediate inputs fed into the military chain are certainly excluded here, and it seems quite likely that much military spending was hidden in other budgetary accounts.

In general, researchers have often been forced to construct estimates on the basis of very little information. Indeed, Horrigan (1992) relies on negative information: she claims with regard to the discrepancy between the sum of employment by branch and total employment reported by Goskomstat (the State Committee for Statistics) in 1985 that “it is almost certain that the data reveal employees in the VPK [MIC] sector,” and proceeds on

that assumption to analyze the pattern of such statistical discrepancies across Soviet republics! The amazing thing is that, given the general lack of information, and the importance of the subject, her approach may actually be reasonable. Most other studies, even the most careful ones, seem to be based entirely on anecdotes.¹¹ In addition to using the budgetary figures, Cooper provides his own estimates based on the “fragmentary information available,” which means random figures occasionally cited in Russian periodicals, themselves often quoting the speeches of some government officials. Despres (1995) and Sanchez-Andres (1995) also rely on Russian press reports, although the former also uses the secondary reporting in *Segodnya* (1994) on a GKOP document. Again, the use of such sources may be warranted where no better are available, but their inherent unreliability must be recognized.

Finally, most estimates of the number of employees in the MIC pertain to a different geographical-political entity in an earlier era: the USSR in the pre-reform years. They are out of date and provide no information on either demilitarization or conversion. Estimates of the recent changes can be pieced together only with other calculations of the proportion of Soviet military production that was located in Russia and various government statements on the “numbers affected” by conversion, and this is precisely what most analysts have been forced to do.

Despite the problems faced by previous researchers in this field, we shall quickly summarize their results, as they do provide a useful starting point for our analysis and a point of comparison against which to check some of our figures. Estimates of the numbers employed in the Soviet MIC range from 6 million to as many as 12 million (Cooper 1991b), if those in research establishments and services related to military production are taken into account. Other estimates of the total number of employees are 7.6 million (Despres (1995)), 7.4762 million (Chapman and Wittneben (1992)), and 9 million (Ponomarev et al. (1993) and Sanchez-Andres (1995), who appear to be relying upon the same source, although they do not cite one another). If one considers only manufacturing of military products, the only estimate found gives a number of 4.7 to 5 million employees in the USSR (Cooper (1991b)). The only estimates for Russia appear in Chapman and Wittneben (1992), Gaddy (1994), Glukhikh (1994), and Vazhenin (1995). Both of the former pertain to the year 1985, and they are in approximate agreement on the percentage of total employment in the “defense complex” (Chapman and Wittneben) and “defense industry” (Gaddy)—23 to 25 percent—although the definition of employment seems to be different (“industrial productive personnel” in the former, versus “total employment” in the latter). Chapman and Wittneben estimate 5.4168 million total employees in the Russian defense complex, or 72.5 percent of the USSR defense complex employment. Vazhenin provides figures for 1988: within the MIC, 61.3 percent of all assets and 60 percent of all employees were in Russia. Glukhikh, the chairman of the GKOP, reports 4.487 million employed in enterprises under GKOP administration (1994), of which 3.6736 million are in manufacturing and 0.8135 million in science.¹² Our estimates for GKOP employment in 1990, reported below, easily fall within the range of estimates here.

Estimates of the number of companies in the MIC in the USSR in the late 1980s lie around 2,000. Ponomarev et al. (1993) and Sanchez-Andres (1995) report some 2,020 companies, consisting of 1,100 manufacturers and 920 research establishments. Cooper’s (1991b) numbers are about 2,000. For Russia, more recent estimates are available: 1,700 enterprises in 1993 (reported by Sanchez-Andres (1995)), 2,000 in 1994 (reported by Glukhikh (1994)), and 1,800 as of June 1995 (reported in *Moscow News* (1995)) supposedly subordinated to the GKOP. Zhanov (1992) reports that, as of 1991, 67 percent of Soviet military-industrial enterprises and 79 percent of research and development establishments were in Russia.

One type of information which is interesting in these analyses, and which we may also compare with our data, concerns some of the characteristics of the companies. The distribution of the MIC companies is reported to be the following. Cooper (1991a) estimated that about 400 companies within the USSR MIC in the late 1980s were “strictly civilian” (with zero military production), 1,000–1,100 were “strictly military” (with military production greater or equal to half of their output), and 500–600 companies had “mixed production” (with less than half of output being military). Those numbers correspond fairly closely to those reported by Sanchez-Andres (1995) and also, as we shall show, to those enterprises subordinated to the GKOP in our sample. Strictly military are 48 percent of the MIC companies as reported by Sanchez-Andres (in our sample this figure is 47.3), 27 percent (29.3 in our sample) are strictly civilian, and 25 percent (23.3 in our sample) have mixed production.¹³

The overall share of civilian production within the MIC was estimated at 40 percent in 1989 and 80 percent in 1992 (Ponomarev et al. (1993)); this is a dramatic change, although it is not clear whether the increase in civilian production was only relative or also absolute. In general the distinction between relative and absolute changes is rarely clearly drawn; an exception is Lomanov (1993): “[S]tructural changes in the defense industry were only in terms of a drop in military production; practically there was no increase in civilian production.” Kulichkov and Kalachanov (1994) provide the change in the share of state military orders in revenue received by MIC companies: 68.4 percent in 1989, 49.7 percent in 1990, 38.3 percent in 1991, and 25.8 percent in 1992. Glukhikh (1994) reports a 78 percent fall in military production from 1991 to 1993. For 1993, Kulichkov, Sudarikov, and Volkov (1994) estimate that military production fell by 36 percent among GKOP enterprises while civilian production fell by 14 percent, with the civilian proportion rising to 78 percent of the total. By contrast, Salo (1994) estimates a smaller 19 percent drop in military production in 1993, and the same figures for civilian production and the civilian proportion. In another article (1993), he provides exactly 100 less the figures given by Kulichkov and Kalachanov, above, for the civilian production proportion in the MIC. Regarding the latter, the figures in Fastenko and Chistova (1995) are also broadly similar: the percentage of civilian production in the MIC rose from 40 in 1989 to 80 in 1995.

Some other bits of information are also suggestive. Skibinskaya estimates 440 thousand people were laid off from the defense industry from 1989 to 1993, quite a large number given the low average layoff rate in Russia (Earle and Estrin (1996a)). Salo (1994) provides the number of employees “separated” (laid off or quit) from military production at 1.5 million in 1992 and 1 million in 1993.

According to Chapman and Wittneben (1992), as wide a range as one to five million employees in the MIC were to be “affected” as a result of conversion. Russian sources give a vague figure of more than one million employees associated with military production to be affected (Kachaykin (1993)), and Cooper’s numbers are in the same range, about 1,200,000 people (500,000 to leave the sector and 700,000 to be retrained).

As we will show below, our estimates for employment in the MIC lie in the same general range as those presented by various sources. But they also go far beyond them in several respects. First, they take into account firms that are outside GKOP subordination but which nevertheless have strong military orientation (suppliers to military producers, for example). Second, assuming the data set is representative, our estimates are likely to provide a more accurate picture of the MIC than extrapolations from Russian periodicals and official sources. Third, our estimates cover the period 1990 to 1994 and are therefore up to date, whereas almost all prior estimates pertain to the pre-reform USSR. Fourth, we

examine not only the distribution of the MIC firms, but also look inside the firms to estimate the shares of civilian and military production. Finally, we provide systematic estimates of the changes in military and civilian production, and of demilitarization and conversion.

III. Conceptual and Estimation Framework

This section describes our methodology for estimating the size of the military-industrial complex and the extent of demilitarization and conversion in Russia. We begin with a simple two-sector model, which is useful for specifying our definitions of several key concepts: MIC and non-MIC enterprises, military production, demilitarization, and conversion. We then present an aggregation and accounting framework, which serves two purposes. First, it enables us to build up estimates of the level and change in military production for the whole Russian economy from observations on individual enterprises. Our basic data source, described in Section IV below, consists of information from a large sample of industrial enterprises in Russia. But we are interested in more than just measuring the change in orientation from military to civilian production with respect to the firms in our sample; we would also like a summary measure for the extent of demilitarization in all of Russia. Second, the framework allows us to estimate the contributions of different factors to overall change. We are able to decompose and assess the relative importance of three principal elements: the aggregate decline in Russian industry (what we call the “scale effect”), the differential patterns of growth and decline in defense and non-defense firms (the “intersectoral reallocation effect”), and the changed behavior inside of defense enterprises (the “intrafirm substitution effect”).

The starting point for our analysis of demilitarization and conversion is the assumption of a simple economy with two sectors, each with a representative firm, one labeled “MIC” and the other “non-MIC.” We assume that MIC produces two outputs, a civilian good (C_1) and a military good (M), while non-MIC produces only a civilian good (C_2), which is possibly different from C_1 .¹⁴ With all prices normalized to unity, $X_{mic} = M + C_1$ is the total output of MIC firms, while $X = X_{mic} + C_2$ is total output for this economy. Although stylized, these assumptions correspond to the situation in the Soviet economy before perestroika, when MIC enterprises commonly produced civilian goods in addition to their military output, but the types of civilian goods tended to be different from those produced in non-MIC enterprises.¹⁵

M therefore represents the total military production in the economy, and dM would equal the absolute change in M , or what we might call *absolutedemilitarization*. We may also define the *military intensity* of the MIC as the proportion of all goods produced by the MIC which are military, M/X_{mic} , and *relative demilitarization* of the MIC as the change in this proportion, $d(M/X_{mic})$, and of the entire economy as $d(M/X)$.

While demilitarization may be measured in terms of output, examining conversion requires an analysis of inputs. We assume that all three products— M , C_1 , and C_2 —are outputs from conventional production functions:

$$M = M(L_m, K_m),$$

$$C_1 = C(L_{c1}, K_{c1}), \text{ and}$$

$$C_2 = C(L_{c2}, K_{c2}),$$

where subscripts denote the use to which the two factors, labor (L) and capital (K), are put. It will be convenient to measure all factors in efficiency units in order to examine the effect of reallocating them from military production to other uses, which presumably results from demand shocks, not modeled here.¹⁶ We may distinguish three types of reallocation.

First, some “military” resources, dL_m and dK_m (defined positively), may be transferred within the firm from M production to C_1 production, so that subsequently we have

$$M = M(L_m - dL_m, K_m - dK_m) \text{ and}$$

$$C_1 = C_1(L_{c1} + a_1 dL_m, K_{c1} + b_1 dK_m),$$

while C_2 remains unchanged. This we call *intrafirm reallocation* or *substitution* of production. a_1 and b_1 measure the degree of *intrafirm conversion* of the reallocated factors dL and dK , respectively: if equal to one, then the factors are fully general and may be converted to civilian use with the same productivity as in their former military use; thus, there would be complete convertibility, and total production, $M + C_1$, would be unchanged after the transfer of resources across uses. Put differently, M would fall and C_1 would rise by equal magnitudes, so that $dM + dC_1 = 0$.

If a_1 and b_1 are equal to zero, then the factors are completely specific to military production and are not convertible because they have zero marginal product elsewhere. In this case, M would decline, but C_1 would not rise, and total production would decline by dM . There would be demilitarization, but no conversion. In general, $0 \leq a_1 \leq 1$ and $0 \leq b_1 \leq 1$, so that factors may be partially converted: $|dM| > |dC_1| > 0$. Total production would decline, but by less than the amount of the decline in M .

It is often supposed that, relative to labor, capital would tend to be more like clay and less like putty, implying that $b_1 < a_1$. But many types of human capital may also be highly specific, suggesting the possibility of low a_1 as well. For instance, scientists and engineers with extensive experience in the design of high technology weapon systems, or highly skilled operators of equipment to produce those systems, may not be especially productive in civilian goods manufacturing.¹⁷

In the second type of resource reallocation, L and K may be transferred to C_2 production, so that

$$M = M(L_m - dL_m, K_m - dK_m) \text{ again, and}$$

$$C_2 = C_2(L_{c2} + a_2 dL_m, K_{c2} + b_2 dK_m),$$

while C_1 remains unchanged. This we call the *intersectoral reallocation* of resources. Similar remarks apply to a_2 and b_2 as to a_1 and b_1 , but in this case the parameters represent the *intersectoral conversion* of the factors of production. Smaller values for a_2 and b_2 imply greater asset specificity, while higher values imply less specificity. Again, we can measure the extent of demilitarization and conversion associated with a transfer of resources by the change in output: in this case of M and C_2 .

Finally, the resources may be simply lost, they may become unemployed, or they may emigrate, which would result again in

$$M = M(L_m - dL_m, K_m - dK_m),$$

while C_1 and C_2 are unchanged. This is associated with a pure decline in aggregate output with no shifting of resources, which we therefore label the *scale effect*. Note that it is equivalent to the case where a_1 , b_1 , a_2 , and b_2 are all zero. In such cases, the decline in M does not lead to increased C_1 and C_2 : again, there is demilitarization without conversion.

We apply this model in Sections V and VI below, where we use information on the production of various types of goods by a random sample of Russian industrial enterprises. From the sample alone, we can describe the behavior of an average MIC firm, including the extent to which it appears to have demilitarized and converted; this we do in Section V below. But in order to draw inferences for Russian industry as a whole, which we do in Section VI, we require an aggregation framework which permits us to construct estimates of aggregate quantities from information about a sample.

For this purpose, a slight change of notation is required. To distinguish the two levels of variables, we adopt the convention that the subscript “R” denotes estimates for all of Russia, while the lack of an R subscript implies that the information pertains to our sample. We may apply the following simple identity, using calculations from a representative enterprise sample, for the amount of all military production in Russia M_R :

$$M_R = M/X_{mic} * X_{mic}/X * X * (X_R/X),$$

where M_R = total production of military goods by MIC firms in Russia,

M/X_{mic} = average proportion of MIC firm output which is military,

X_{mic}/X = proportion of total MIC firm output in the sample,

X = output of entire sample of firms,

X_R = output of all Russian industry.

This identity shows both how an estimate of total military production can be built up from a representative sample of enterprise-level data and how the total can be decomposed into several different components. M/X_{mic} represents the allocation of resources within an average MIC enterprise between military and civilian uses, the intrafirm resource allocation.

Because MIC firms differ in size and degree of military orientation, M/X_{mic} is constructed as a weighted average.¹⁸ X_{mic}/X represents the relative size of MIC firms in the sample, the intersectoral resource allocation between the MIC and non-MIC sectors. The product of M/X_{mic} and X_{mic}/X is an estimate of the proportion of military goods in all industry, which when multiplied by X measures the magnitude of military production in all sample firms. All of these terms are estimated using the sample. Finally, X_R/X is a sampling factor which scales the estimate up to the size of Russian industry; we measure X_R from Goskomstat publications.

From this identity for total military production, we may derive total demilitarization:

$$M_R = (M/X_{mic}) + (X_{mic}/X) + X + (X_R/X) + \text{residual},$$

where Δ represents the proportionate change in the variable over the period being studied (in our case, 1990–94) and “residual” denotes a set of interaction terms (measures of which we report below only for the sake of completeness, since they are not easily interpretable). In this formula, (M/X_{mic}) represents the degree to which the relative proportion of military production in an average MIC enterprise has shifted; thus we have dubbed it the *intrafirm substitution effect*. Note that this effect may result from a decline in M or a rise in C_1 , or both; but, as discussed above, if M falls without a corresponding rise in C_1 then, according to our concepts, demilitarization without conversion has taken place.

(X_{mic}/X) stands for the relative rates of growth (or decline) of MIC firms vis-à-vis all firms in the sample, thus dubbed the *interfirm or intersectoral reallocation effect*.¹⁹ X measures overall change in output in the entire sample, and is thus a *scale effect*. Finally, (X_R/X) is the *sampling factor effect* due to any changes in the relationship between the sample and the population over the relevant period.

After a discussion of the data and our empirical definitions in the following section, we provide measures of M/X_{mic} , (M/X_{mic}) , and X_{mic} in section V. In section VI, we assemble these together with information on (X_{mic}/X) , X , and (X_R/X) to provide aggregate estimates of military production and demilitarization in Russia in the early 1990s.

IV. Data and Definitions

In this section, we briefly describe the data set and discuss alternative empirical definitions of military production and the military-industrial complex which we are able to implement using the data.

Our primary data source in this paper is a survey of 439 Russian industrial firms organized by the World Bank in June–July 1994. We describe the sampling procedure in some detail, because our calculations assume that our information comes from a representative set of firms. The complete Goskomstat database of industrial enterprises in 1991 was stratified by region and industry, and an initial sample and an alternate sample, each with 400 enterprises, were drawn. The alternate sample was used to replace enterprises from the initial sample that refused or were unable to respond (40 percent of cases), with industrial branch as the principal criterion and size as the secondary criterion for replacement. In a small fraction of cases (15 percent), no alternate firm with the relevant

characteristics was available, and a more appropriate substitute was found. The total number of valid observations from this source was finally 390 firms.²⁰

Because of the size and random selection of the sample, it has claims to be representative of all of Russian industry, which is a necessary assumption to permit the construction of aggregate estimates from enterprise data. In fact, the empirical sample does have some biases in employment composition by branch compared with official Goskomstat figures. Machine building, fuel, and energy tend to be overrepresented, while food, building materials, and ferrous metallurgy are underrepresented.²¹

Besides being the only large random sample of Russian industrial firms of which we are aware, however, the survey database is also extremely rich in variables, including several alternative measures for many important concepts. This is quite useful for our present purpose, because it allows us to examine the robustness of the results from any particular approach and because of the inherent ambiguity of the MIC and of military production. We analyze four different questions which implicate the enterprise in the defense sector: ministerial subordination, producing military products, deriving revenue from military sales to the state, and distributing military products to the state.

Previous studies of the size of the MIC have almost exclusively used subordination to some ministry or combination of ministries as the defining criterion for what constitutes a MIC firm, and it seems that it is commonplace to equate MIC with subordination to the GKOP.²² We adopt this interpretation for the answers to the question concerning whether the firm “belongs to the MIC.” As shown in the column of Table 1 labeled “GKOP,” 64 out of 428 firms, or 15 percent, responded “yes.”

Table 1

GKOP and Broad MIC

No. of Observations	GKOP	Broad MIC
MIC	64	126
Non-MIC	364	94
Unclassified	11	219
Total	439	439

Note: The table shows the number of firms classified as part of the MIC according to two definitions. “GKOP” pertains to enterprises subordinated to the *Goskomoboronprom* in 1994, while “broad MIC” additionally includes all firms reporting production of military goods, revenue from sales of military goods, or distribution of military goods to the state in 1990.

As we argued in the introduction, however, subordination to the GKOP is likely to be an overly narrow definition of MIC. Many other firms are closely tied to the military because of the types of products they produce or because they sell either to other defense firms or to the military directly. It seems to us desirable to include such firms in a broader definition of MIC.²³

First, we use information on the types of products that the firm produces. Our data set provides the Russian Industrial Classification (OKONH) and 1990 and 1994 percentages in total output for the three main products of each firm in 1994. We have identified seven categories of industrial products dominated by military firms in 1990: instruments and computers, aircraft, defense, shipbuilding, radio, communication means, and electronics.²⁴ We define the variable MILPROD as the percentage of output in these military categories; thus, it is a measure of M/X_{mic} .²⁵ According to one definition, any firm listing a military product among its three main products (MILPROD > 0 in tables reported in subsequent sections) is included in MIC. A more restrictive definition of MIC, which emphasizes the firms most closely tied to defense production, includes firms with military production greater than 50 percent of their total in 1990 (MILPROD90 > 50).

Another way to define MIC can be derived from information concerning the various sources of revenue received by the firm in 1990. One category that the firms could specify was “military goods sold to the state”; MILREV is defined as the percentage of revenue in this category.²⁶ MILREV may include goods not counted as military under MILPROD, perhaps because the product classification is too highly aggregated to identify them as military (for instance, some kinds of chemicals or machine building). According to one of our definitions of MIC, any firm receiving any of its revenue from military sales in 1990 (MILREV > 0) is MIC. Analogously to MILPROD, we also specified a group of big military revenue-makers, where MILREV > 50 in 1990.

The last method for classifying a firm as MIC uses information on how it distributes its products. One of the possible distribution methods is “delivery to the state for military purposes”; MILDIS is defined as the percentage of production so distributed.²⁷ MILDIS may include goods included in neither MILPROD nor MILREV, because the goods themselves are not guns and ammunition, but are used by the military (uniforms, food, inputs to production, etc.). Analogously to MILPROD and MILREV, we defined two types of MIC based on this information: (1) if a firm distributed military products to the state in 1990 (MILDIS > 0), and (2) if a firm distributed more than 50 percent of its total production as military products to the state (MILDIS > 50).

We also use all of our concepts—GKOP, MILPROD, MILREV, and MILDIS—to identify the broadest notion of the MIC in Russia.²⁸ A firm is defined as “broad MIC” if it meets any of the following four conditions:

- a) subordinated to GKOP,
- b) any military production (MILPROD > 0),
- c) any military revenue (MILREV > 0), or
- d) any military distribution of products (MILDIS > 0).

Table 1 shows that when MIC is defined in this broader fashion, the number of firms increases to 126. Conditional upon the assumption of no bias in the pattern of missing values, this would imply that MIC accounts for 57 percent of the total number of industrial enterprises in the Russian economy!

Table 2 shows a four-way cross-tabulation of the four definitions we use to construct broad MIC. It is apparent that the definition of MIC depends greatly on the definitional criterion one applies. Because each criterion involves looking at the problem from a somewhat different angle, each provides a somewhat different measure.²⁹ In particular, it is clear that the conventional approach of equating MIC with GKOP subordination makes a very strong assumption, albeit one which previous researchers have not been able to test. These results show that military production, defined in three different ways, extends beyond the enterprises included in most discussions of the MIC.

Finally, our definition of the amount of military production (M) is drawn directly from the variables we have just described. We measure the proportion of military goods in total output of the firm, M/X_{mic} , in three alternative ways. The first is the percentage of output in all seven military branches (MILPROD). The second is the percentage of revenue which the firm derives from sales of military products (MILREV). The third is percentage of sales of military products distributed to the state (MILDIS). From any of these, M for any given firm can be recovered by multiplying by the corresponding X_{mic} .

As discussed in Section III, however, we are interested in estimating M/X_{mic} , what we called the “military intensity” of production, for an average MIC firm, to have a sense of the central tendencies in the importance of military production and in $d(M/X_{mic})$, the relative demilitarization. For this purpose, it is necessary to weight firms according to their relative size, which we have chosen to measure as the number of individuals employed in the firm. Employment is of course an input measure, and our results can therefore be interpreted as the level and changes in uses of labor for military and non-military purposes.³⁰

We use employment as the weighting variable because output (or sales) measures have at least three deficiencies. First, prices in 1990 were rather arbitrary, and thus the comparisons of the value of output across firms would be inadequate.³¹ Second, changes in the price level and in relative prices were so rapid and volatile that to be able to make comparisons over time, it would be necessary to have precise deflators for different products, the accuracy of which is highly questionable. This problem is particularly vexing in the MIC, where there are massive delays in payments by the state for defense goods (Despres (1995)); which price should one use: the price which was contractually agreed, or that actually realized after inflation eroded its real value? Third, and perhaps not unrelated to these problems, the incidence of missing values is much higher for the output and sales variables than it is for employment in our data set.³²

V. Measuring Demilitarization and Conversion

In this section, we report our measures of the size and change of military production for enterprises in our data set, under the set of three alternative measures of military production (M)—MILPROD, MILREV, MILDIS—and eight alternative definitions of the MIC—

GKOP, broad MIC, MILPROD>0, MILPROD>50, MILREV>0, MILREV>50, MILDIS>0, MILDIS>50—which we explained in the previous section. For each measure of M, we use four definitions of MIC: GKOP, broad MIC, and the two categories corresponding to M, for instance MILPROD>0 and MILPROD>50 when M is MILPROD. Tables 3, 4, and 5 display the results for MILPROD, MILREV, and MILDIS, respectively.

We report M/X_{mic} (what we called the military intensity), C_1/X_{mic} , and their changes from 1990 to 1994, also showing more disaggregated results for types of M and C_1 , for an average MIC enterprise in the data set. Figures for 1994 are expressed as a percentage of the total for 1990, where the change in the total is measured as employment change (for the reasons given in the previous section). Thus, we measure demilitarization for an average firm as the result of both a fall in employment and in the proportion of production, revenue sources, and distribution methods which is military in nature ($MILPROD/X_{mic}$, $MILREV/X_{mic}$ and $MILDIS/X_{mic}$ respectively).

All three tables show significant production of civilian goods by MIC firms. For GKOP, the figure of 50 percent is in the rough order of magnitude reported by other analysts (e.g., Cooper (1991a), and Despres (1995)) working with published data. Results do depend significantly on definition, however, and firms in broad MIC tend to produce more civilian goods, while the biggest military producers, where MILPROD, MILREV, or MILDIS > 50, have the highest military intensity: 80 to 90 percent in 1990.

By any definition, however, military production is falling. It has fallen most in defense goods, radio equipment, and electronics, and risen slightly in instruments and computers. The range of the overall fall in military production is from 15.4 percent to 39.9 percent for MILPROD (Table 3), from 18 to 55.1 percent for MILREV (Table 4), and from 22.4 to 51.6 percent for MILDIS (Table 5), depending on the definition of MIC. Roughly speaking, the broader the definition, the less decline in MIC. The largest declines have occurred in the biggest producers, the ones with more than 50 percent of production, revenue sources, or distribution methods that are tied up with the military. The sample as a whole has shrunk 16–19 percent, whereas MIC firms have shrunk more, in the range of 21–38 percent (according to the definition of MIC).

The change in civilian production, however, is remarkable. Civilian production has in general changed little, falling slightly everywhere but in the big military producers. In the vocabulary of Section III, M has declined dramatically, but C_1 in most cases has not risen. Put differently, the total fall percentage in MIC employment is approximately equal to the decline in military production. This implies that whereas one can speak of substantial demilitarization, it does not seem that the freed-up resources have been transferred internally to civilian uses where their marginal product is high. Rather, either the resources are draining out of the firms, or their marginal product is close to zero in their new internal uses. Only the big military producers seem to be engaging in some conversion, but even there the decline in M is between three and five times the rise in C_1 .

In conclusion, we find rough consistency across our measures of military production and MIC. Military production in MIC firms is down by about 25 percent; in the biggest military producers, the decline is significantly greater, on the order of 40 to 50 percent. But civilian production has also fallen or grown very little in most MIC firms, so that it appears that there has been little transfer of military-specific capital to civilian uses. Inside Russian enterprises, there appears to have been substantial demilitarization, but very little conversion.

VI. Aggregate Estimates of Military Production and Demilitarization

The previous section reported our measurements of military intensity and demilitarization for an average MIC enterprise in a sample of firms. In this section, we employ our aggregation framework to build up estimates of the total quantity and change in military production from the enterprise-level information. We decompose the total change into several significant components, including the intrafirm and the intersectoral reallocation of resources, and overall industrial decline.

Table 6 and the accompanying charts show our measurements of the aggregation/decomposition framework of Section III, using the three definitions of military production—MILPROD, MILREV, and MILDIS—and the eight definitions of the MIC—GKOP, broad MIC, MILPROD>0, MILPROD>50, MILREV>0, MILREV>50, MILDIS>0, and MILDIS>50—which we analyzed in the previous section. We find that the percentage of military production, revenue, and distribution methods in the total (M/X_{mic}) has changed significantly, although we saw in the last section that this was due to a steeper decline in M than in C_1 ; both have declined in all but a few firms (which tended to be the ones with the highest military shares). The size of the decline in M is about 15 percent for MILPROD, but 40 to 50 percent for MILREV and for MILDIS.

X_{mic}/X , the proportion of MIC in the total sample (as measured by employment), also has declined, ranging from about 10 percent (in the case of MILPROD) to about 20 percent (in the case of MILREV and MILDIS). However, both non-MIC and MIC production have declined, so that, again, the decline in the percentage of industry accounted for by MIC is due only to a more rapid decline in the military than in the civilian sector.

X , total industrial employment as measured in the survey data, has declined quite significantly, by 15 to 19 percent, although here the differences across measures only reflect differences in the samples available for analysis with each. The decline in total employment reflects the official statistics on decline (19 percent) quite closely, as there is little change in X_R/X .

Charts 1–3 tell the same story graphically. The complete bar measures total industrial employment in Russia according to the Goskomstat: 22.81 million in 1990 and 18.58 million in 1994. Using the methodology developed in this paper, we have decomposed these totals (and the change) into the components—shown on each bar from top to bottom—attributable to civilian production outside the MIC (C_2), military production in the MIC (M), and civilian production in the MIC (C_1). All twelve estimates show a large fall in C_2 and a still sharper drop in M . Only three of the twelve—the three pertaining to the enterprises with the strongest military orientation—show any increase in C_2 , and those increases are very slight, much smaller than the drops in M for the same set of firms. Even if some firms are managing to accomplish some conversion, we estimate that aggregate conversion is negligible.³³

VII. Discussion

This paper has used detailed enterprise data from a large sample survey to try to provide answers to some of the outstanding quantitative questions about the Russian military-industrial complex. We have found that military production has fallen sharply in MIC

enterprises, on the order of 25 percent, from 1990 to 1994. At the same time, civilian production has been roughly constant in those firms. The military intensity of MIC production has fallen, but largely as a result of military decline, not civilian production increase. This implies that there is little or no intrafirm conversion taking place; rather, the resources freed up from military production have flowed out of the firm.

Where have the resources gone? We have demonstrated that the proportion of MIC firms in all of industry has fallen, but both MIC and non-MIC industrial firms have declined dramatically, only the former somewhat more rapidly than the latter. This implies that there has been little intersectoral conversion: the freed-up resources are not being productively used in industry. Rather, there has been a large general decline in Russian industry, and military production and MIC decline appear to be only a part, if a particularly rapid part, of this larger process.

The military resources have therefore flowed out of industry, and out of our field of observation. Perhaps they have become unemployed, perhaps they have gone abroad, or perhaps they have become employed in the service sector. According to the definition of conversion which we have proposed in this paper, however, we would argue that none of these should be regarded as meaningful conversion. Neither unemployment nor emigration is of much use to the Russian economy, and it seems unlikely that the types of service-sector employment that are available would utilize the specific skills of military labor and capital. Although the service sector is not included in our database, and information concerning it tends to be much less reliable than industrial data, it is well known that employment in education and research, the fields where one might expect the highly skilled scientists and engineers of the MIC to find productive employment, is rapidly declining. Rather, the growth sectors are retail trade and business services, not areas where military resources are likely to have an especially high marginal product.³⁴ While it is possible that a nascent "high tech" sector is presently being founded, in small start-up companies, upon the resources formally employed in defense (see, e.g., Sedaitis (1995)), there is no evidence that a substantial increase in civilian production is as yet attributable to such a phenomenon.

Thus, we seem to be observing demilitarization of the Russian economy without conversion in any meaningful sense. The questions we have not addressed, but on which we would offer some speculations, are whether this process is inevitable, desirable, and irreversible. Concerning the inevitability of the lack of conversion, it may be that military-specific capital and skills simply have few civilian uses; we do not know whether this is necessarily the case, but we can say that those uses do not appear to have been discovered in Russia. Thus, the huge investments in Soviet defense appear to be sunk and unrecoverable; the degree of asset specificity is too high for them to be converted to other uses.

If we conclude that conversion is essentially impossible, then whether demilitarization is desirable depends on the weights attached to Russian defense production in one's social welfare function: from an American point of view, the reduction of Russian military power may be desirable (as long as the military resources do not flow to still less desirable countries), but perhaps not from Russia's. Certainly there are a few Russian politicians who do not think so. At least in the short run, demilitarization without conversion implies a loss of military strength without a compensating economic gain. Moreover, the cold war equilibrium has been upset, perhaps worsening the situation from the point of view of some third world countries insofar as the United States may have become freer to intervene in their domestic affairs.

Finally, whether the demilitarization process could be reversed is self-evidently a matter of great concern to scholars and policymakers in the field of international security and arms control. Military capital and skills are rapidly atrophying from the Russian MIC, becoming unemployed, or flowing into drastically different uses, and they are also depreciating in value and gradually losing their usefulness in military production. But because they are not, by and large, finding valuable applications in the non-military sector, they are likely to be more available to participate in remilitarization than if substantial conversion had taken place: the skilled weapons designers or technicians now selling miscellaneous goods in kiosks would be happy to return to their former jobs, should state funding resume. If the political situation should change, demilitarization would probably be much more easily reversed than conversion would have been.

Much of the original enthusiasm for conversion was based on the hope that it would help the Russian transition significantly and bolster popular support for reforms. Bernstein and Perry (1993) even argued that “the efficient use of a considerable portion of the assets from the military-industrial complex remains necessary if the economic reforms are to succeed.” The unfortunate converse of that proposition is that the lack of success with conversion has disastrous implications for the Russian reforms, potentially leading to political backlash and remilitarization.

Notes

¹ This paper uses the terms “defense industry” and “military-industrial complex” interchangeably. Our usage differs from most authors’ in not always conforming to the set of firms subordinated to the State Committee for Defense Industry; indeed, it is part of our purpose to consider a variety of possible definitions. More precise distinctions are drawn when we present alternative empirical definitions of the sector, in Section IV of the paper.

² The need for enterprise data with widespread sectoral coverage is particularly critical if one wishes to consider elements of the MIC not subordinated to the State Committee for Defense Industry (*Goskomoboronprom* or GKOP), as we discuss below.

³ Bernstein (1995) is an exception, recognizing that “[D]efense conversion in Russia is in many ways a misnomer” (p. 201).

⁴ The work of Despres (1995) has most closely examined military and civilian proportions within an administratively defined MIC.

⁵ We should emphasize that our data pertain to manufacturing firms, and thus we cannot directly observe the destination of resources which flow outside of manufacturing. We shall argue, however, that few of the flows to non-manufacturing uses which have taken place qualify as conversion.

⁶ Despres (1995) discusses problems with price deflators in the MIC.

⁷ At the other extreme, large in magnitude and important in consequence as the defense sector may be relative to all Russian industry, some part of industry is certainly civilian, and we are therefore reluctant to equate defense conversion with industrial restructuring overall. One of the advantages of our decomposition is that we are able to assess the degree to which the decline in defense output is simply part and parcel of industrial decline in Russia more generally, as distinct from sector-specific phenomena.

⁸ There are eight “main departments” of the GKOP into which many defense enterprises were folded: ammunition and special chemicals, armament, shipbuilding, electronics, radio, aviation, missile and space equipment, and communication means (Hudin (1994)).

⁹ “Conversion” is also sometimes used only in reference to changes which are instigated by governmental programs “from above,” although this seems overly restrictive, excluding as it does changes initiated by the enterprise “from below.”

¹⁰ For a heroic attempt to recalculate the value of Soviet military production in world prices, see Ozhegov et al. (1991), or the summary in Despres (1995).

¹¹ A dismaying proportion of the published research in this area cites no clear, traceable sources, or even cites none whatsoever.

¹² He also mentions that salaries in GKOP firms were on average 1.5 times lower than the average in all industry.

¹³ Numbers of establishments and employees for specific departments of the GKOP can be found in Birukov (1995) for aviation, Lapygin (1995) for electronics, Maslennikov (1995) for shipbuilding, Kryshalev et al. (1995) for radio, and Kij (1995) for communication means.

¹⁴ Here we take these definitions as given in order to illustrate our conceptual approach; in the following sections we explore alternative ways of measuring the variables.

¹⁵ Despres (1995). Our data also show that C_1 products tend to differ from C_2 products; see below. Although the presence of dual-use technology implies that non-MIC firms may have had some capability to produce military goods also, this fact is not very relevant in the context of the drastic demilitarization which has taken place; thus we omit it from the model.

¹⁶ Sapir (1994) contains a discussion of shocks to the defense sector in Russia. Given a set of exogenous shocks, the size and direction of resource reallocation clearly depend on such factors as the complementarities among inputs in different uses (for instance, the economies of scope associated with producing M and C_1). Our focus in this paper, however, is on definition and measurement of the level and change in military production, rather than its behavioral causes, a subject which we plan to address in future research.

¹⁷ There seems to be some reason to believe that skill specificities are even higher in the MIC than the rest of Russian industry. According to Zavyalov (1994), most workers are at moderately high grade (half work at qualification level 4) and have long tenure in the MIC (75 percent have worked in the MIC for more than ten years).

¹⁸ The focus in this paper is on measuring the amount of demilitarization and conversion that has taken place; therefore we do not investigate the deviations from average behavior of MIC enterprises. Our data analysis demonstrates wide variation in MIC firm behavior, however, and we intend to investigate potential determinants of this behavior, including ownership change, government subsidies, and other variables, in future research.

¹⁹ The intersectoral reallocation effect is related to Bernstein's (1994) notion of "passive conversion," whereby employees of defense enterprises quit to work in non-defense companies. Our definition is broader, however, including any flow of resources (of any type and for any reason—voluntary or involuntary) from MIC firms to non-MIC firms.

²⁰ In addition, the data set includes 49 firms selected from lists of new private (*de novo*) firms maintained by local statistical offices. Many of these firms did not exist in 1991, which means they will be excluded from our analysis of changes from 1990 to 1994. In any case, they are very small, with an average employment of 98 in 1994 (compared to a mean of over 2000 in the state and privatized companies). Thus, their weight in total industry is negligible.

²¹ While it might be desirable to re-weight the sample to make it fully representative *ex post facto*, unfortunately the Goskomstat provides sectoral employment figures only at a very high level of aggregation.

²² This usage appears to be standard among analysts of the Soviet and Russian MIC. See, e.g., Cooper (1991b), Despres (1995), Pertsevaya (1995), and Sanchez-Andres (1995).

²³ Moreover, firms subordinated to the GKOP also produce significant quantities of consumer goods, as has been pointed out by Cooper (1991a) and as we demonstrate for our data set. Thus, GKOP subordination is not a very clear or convincing dividing line if one is interested in the demilitarization in all of Russian industry, not only in the somewhat military collection of firms administratively under the control of the GKOP.

²⁴ Obviously, there are any number of places where one could in principle draw the line. We adopted a convention that a product category is considered to be military if more than half of the firms that have that category as their principal product (providing the highest percentage of revenue) are subordinated to the GKOP. The OKONH category of "defense" refers primarily to conventional military weapons.

²⁵ In constructing these estimates, we faced a serious problem in treating missing values. Only the firms which have at least one non-missing product are selected. If a firm does not report making a product, it is set to zero. Percentages of output of three main 1994 products in a number of cases do not sum up to 100 (especially in 1990) and the residuals (100-the sum) in these cases were ignored on the grounds that all we know about the firm's

output is the sum of the three percentages. We adjust the firm size weight (explained below) downward accordingly.

²⁶ Other sources of revenue which firms could specify include the following: intermediate inputs, investment goods, consumer durable goods, consumer non-durable goods, non-military goods for the state, other products, trade, services, leasing, financial transactions, and other services. MILREV, and all these variables, were recoded to missing for all firms which did not provide the breakdown of revenue (at least 90 percent).

²⁷ Other distribution methods are use of enterprise resellers, use of non-enterprise resellers, non-military sales to the state, direct sales, non-state, and other. MILDIS has a missing value if we do not have information on this question.

²⁸ Perhaps still broader definitions of the Russian MIC could be conceived, such as the complete industrial sector (results for which we also present below), or including some firms producing services (for which we have no information).

²⁹ The definitions could be combined to provide an overall index of the “militariness” of an enterprise, as a continuous variable, but we investigate the implications of positing alternative sets of categories instead.

³⁰ Where the sum of all products was less than 100, we weight by the sum times employment, thus including in our analysis only the part of the firms about which we have information.

³¹ Of course, it is also to some extent an inadequate indicator of the allocation inside of firms, but we have no measure of input usage to produce different outputs of the firm (and even the best cost accounting in the West is not always able to separate costs of producing different outputs).

³² The employment measure, of course, suffers from the drawback that employees may remain officially registered at an enterprise, even if they are only part-time, on fixed contracts, or on unpaid leave. However, our constructed measure of labor input which takes into account these factors is very highly correlated with the number employed. Thus, it would provide very similar results. We comment further on this issue below.

³³ The fact that the MIC is heterogeneous in the sense that some enterprises are able to convert, while others are not, suggests that it may be fruitful to investigate the determinants (including policies such as privatization and “conversion programs”) of this variation, a project on which we hope to report at some future date.

³⁴ According to *Russian Economic Trends* (1995), from 1992 to 1994 employment in education declined by 1.8 percent, and in science by a massive 20.5 percent. Meanwhile, employment in trade increased 14.2 percent. The rate of increase in finance and insurance was enormous—50.8 percent—but the proportion of employment in that sector was still only 1.1 percent of total employment in 1994, not enough to absorb many of the displaced workers from the MIC.

References

Bernstein, D. (editor), *Defense Industry Restructuring in Russia: Case Studies and Analysis*, Center for International Security and Arms Control, Stanford University, 1994.

Bernstein, D., "Spin-offs and Start-ups in Russia: A Key Element of Industrial Restructuring," in McFaul and Perlmutter (editors), 1995.

Bernstein, D., and W. Perry, "Defense Conversion in Russia: A Strategic Imperative," in *Stanford Journal of International Affairs* 2, Issue 2, Summer 1993.

Birukov, Yu.A., "Konversiya i Investicii," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1995.

Chapman, M., and K. Wittneben, "American Business Involvement in Defense Conversion in the Former Soviet Union: Opportunities, Constraints, and Recommendations," American Committee on U.S.-C.I.S. Relations, December 1992.

Cooper, J., "The Soviet Military Has a Finger in Every Pie," in *The Bulletin of the Atomic Scientists* 46, no. 10, pp. 22–25, December 1990.

Cooper, J., "Military Cuts and Conversion in the Defense Industry," in *Soviet Economy* 7, no. 2, pp. 121–142, 1991a.

Cooper, J., *The Soviet Defence Industry: Conversion and Economic Reform*, The Royal Institute of International Affairs and Council on Foreign Relations, New York, 1991b.

Despres, L., "Financing the Conversion of the Military-Industrial Complex in Russia: Problems of Data," in *Communist Economies and Economic Transformation* 7, no. 3, 1995.

Earle, J.S., and S. Estrin, "Privatization Versus Competition: Changing the Behavior of Russian Enterprises," IIASA Working Paper 96-049, 1996a.

Fastenko, O.V., and V.E. Chistova, "K Voprosy o Situacii v Oboronnoj Promyshlennosti," *Voprosy Ekonomiki i Konversii*, Vyp. 2, 1995.

Gaddy, C., "Economic Performance and Policies in the Defense Industrial Regions of Russia," in McFaul and Perlmutter (editors), 1995.

Government of the Russian Federation, *Russian Economic Trends* 4, No. 2, 1995.

Glukhikh, V., "Oboronnaya Promyshlennost' Rossii: Situaciya i Zadachi v 1994 g.," *Konversiya*, No. 4, 1994.

Horrigan, B., "How Many People Worked in the Soviet Defense Industry?" in *RFE/RL Research Report* 1:33, August 21, 1992.

Hudin, A.A., "Nizhegorodskaya Mezhdunarodnaya Vystavka-Yarmarka 'Vooruzhenie. Voennaya Tekhnika. Konversiya-93.' Ekonomicheskie Problemy Oboronnykh Predpriyatij," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1994.

Kachaykin, V.M. "Social'no-Politicheskie Problemy Konversii Oboronnoho Kompleksa Rossiskoj Federacii," Avtoreferat, Moscow, 1993.

Kij, A.A., "Konversiya. Investicii. Proekty," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1995.

Kryshchalev, V.K., V.M. Shenn, and S.V. Shitov, "Radiopromyshlennost' v Usloviyakh Konversii. Problemy i Vozmozhnosti," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1995.

Kulichkov, E.N., and V.D. Kalachanov, "Analiz Proizvodstvenno-Hozyajstvennoj Deyatel'nosti Predpriyatij Oboronnykh Otrasley Promyshlennosti v Usloviyakh Konversii Voennogo Proizvodstva," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1994.

Kulichkov, E.N., Yu.N. Sudarikov, and A.G. Volkov, "Ob Otdel'nykh Aktual'nykh Problemakh Voennogo Proizvodstva, Konversii Oboronnoj Promyshlennosti i Mobilizatsionnoj Podgotovki Narodnogo Khaziyajstva," *Voprosy Ekonomiki i Konversii*, Vyp. 3, 1994.

Lapygin, A.V., "Sostoyanie i Perspektivy Elektronnoj Promyshlennosti," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1995.

Lomanov, G., "Yeltsin Reshil Stabilizirovat' Bedstvennoe Polozhenie Oboronki," *Moskovskie Novosti*, No. 46, November 14, 1993.

Maslennikov, G.A., "Konversiya v Sudostroitel'noj Promyshlennosti," *Voprosy Ekonomiki i Konversii*, Vyp. 1, 1995.

McFaul, M., and T. Perlmutter (editors), *Privatization, Conversion, and Enterprise Reform in Russia*. Boulder, Co: Westview Press, 1995.

Ozhegov, A., E. Rogovsky, and I. Yaremenko, "Conversion of the Defense Industry and Transformation of the Economy of the USSR," *Problems of Economics*, October 1991, translated from *Kommunist*, 1991:1.

Pertsevaya, L., "Privatization, Defense Conversion Work Hand in Hand," *Moscow News* No. 22, June 9–15, 1995.

Ponomarev, et al., *Konversiya v Rossii*, 1993.

Salo, V.V., "O Gosudarstvennom Regulirovanii Konversii v Rossii," *Konversiya*, No. 9, 1993.

Salo, V.V., "Ob Osnovnykh Problemakh Konversii v Oboronnykh Otrasyakh Promyshlennosti i Putyakh ikh Resheniya v usloviyakh Perekhoda k Rynochnoj Ekonomike," *Voprosy Ekonomiki i Konversii*, Vyp. 3, 1994.

Sanchez-Andres, A., "The First Stage of Privatization of Russian Military Industry," *Communist Economies and Economic Transformation* 7, No. 3, 1995.

Sapir, J., "Conversion of Russian Defense Industries: A Macroeconomic and Regional Perspective," in McFaul and Perlmutter (editors), 1995.

Sedaitis, J. (editor), *Commercializing High Technology: East and West*, Stanford University Center for International Security and Arms Control, January 1996.

Segodnya, "Razreshenie na privatizatsiyu poluchil 8% predpriyatii, proizvodnyashchikh boepripasy i spetskhimiyu. Itogi raboty Goskomoboronproma za Yanvar'–Dekabr' 1993 goda," February 1, 1994.

Skibinskaya, I., "V Shtate Connecticut to je Konversiya," *Moskovskie Novosti*, No. 12, March 21, 1993.

Vazhenin, P.G., *Ekonomicheskie Problemy Rossii i Puti ikh Resheniya*, Moscow, 1995.

Zavyalov, A.B., "Social'no-ekonomicheskie Problemy Sohraneniya Kadrovogo Potenciala Oboronnoho Kompleksa Rossii v Usloviyah Rynochnyh Otnoshehij," in *Voprosy Ekonomiki i Konversii*, Vyp. 4, 1994.

Zhbanov, Yu.P., "O Khode Konversii v Rossii," *Konversiya*, No. 12, 1992.