Review article: is war necessary for economic growth?

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Ruttan, Vernon W. *Is War Necessary for Economic Growth? Military Procurement and Technology Development.* New York: Oxford University Press, 2006.

"Is War Necessary for Economic Growth?" is a provocative title. One cannot publish such a title without expecting to be taken seriously – and being expected to provide a substantive answer. If the author succeeds in the former, he fails in the latter.

A far more precise title of the book would have been: "Is Major War, or Threat Thereof, Necessary for the Continued Post-World War II Economic Growth of the United States of America?" Even if a clear-cut answer were provided, it would apply only to the United States and readers would learn little about the broader questions of (military) technology, productivity, development, and growth. The author, Vernon W. Ruttan – Regents Professor Emeritus, Department of Applied Economics, University of Minnesota – is a well-regarded authority on agricultural economics and on technology and economic development. He is also author of a recent textbook on technology, growth, and development.[1] He writes that in that book he did not "give particular attention to the role of military and defense-related procurement as a source of commercial technology development" (p. vii), hence the production of the book under review here.

"Is War Necessary for Economic Growth?" studies the effect of military procurement on the eventual commercial development of six general-purpose technologies. Professor Ruttan claims that military procurement has been "a major source of technology development across a broad spectrum of industries that account for an important share of U.S. industrial production" (p. vii) but nowhere in the book does he provide an estimate of what that share would amount to. It is surely correct that the military dollar fully funded, co-funded, or seed-funded many technologies, some of which have found their way to the non-military sphere. But the military dollar also funded many a boondoggle. For instance, the dollars spent on the Strategic Defense Initiative (SDI, or "Star Wars"), as Professor Ruttan himself acknowledges (pp. 183-184), have yet to produce anything by way of new, general-purpose technologies. In that regard, the military dollar does not differ from the non-military government dollar, or even from the private sector dollar: some technology funding succeeds, and some fails.

Surrounded by an introduction and a conclusion, the bulk of the book consists of six case studies. They are: (1) interchangeable parts and the advent of mass production; (2) military and commercial aircraft development; (3) nuclear energy and electric power; (4) the computer, semiconductor, and software industries; (5) the Internet; and (6) the space industry. It is not clear why the origin of other candidate general-purpose technologies are not examined, e.g., the standardized container shipping "box" that revolutionized land and sea transport, biochemistry and the pharmaceutical industry, electron microscopy and materials science, or even technology that permits the United States to be a world-class agricultural production powerhouse and exporter – all of which have assisted military purposes immeasurably. They served as "spin-ins" to, instead of as "spin-offs" from, the military sector. If one wishes to examine why and how war or preparation therefore might produce general-purpose technology, should one not set this against why and how peace might accomplish the same thing?

Some of the chosen cases are puzzling. For instance, given its significant but not overwhelming share in the U.S. electricity market even today – 20 percent in 2004,[2] and a much smaller share, namely only 8 percent, of overall U.S. energy consumption[3] – it is not clear in what sense nuclear energy is in fact a general-purpose technology.

The book's standard of evidence is low. All six case studies are under-researched and rely overmuch on weakly marshaled secondary material. Elsewhere, I take exception to the author's stark assertion that "nuclear power is the most clear-cut example discussed in this book of an important general-purpose technology that in the absence of military and defense-related procurement would not have been developed at all – it would not have been developed 'anyway'" (p. 86).[4] In this review, I take a brief look at the five other cases.

Interchangeable parts and mass production

Chapter 2 on "Interchangeable Parts and Mass Production" is only 10 pages long, and the critical part – the part that should establish how the advent of interchangeable parts and commercial mass production was an outflow of military procurement – is only 3-1/2 pages long. Professor Ruttan locates the origin of the invention and use of interchangeable parts and mass production, widely dubbed the "American System of Manufacturing," with the U.S. Ordnance Department's gun acquisition program and the Springfield and Harpers Ferry armories in the early 1800s. Interchangeable parts made use of guns in the field easier. (Instead of waiting for an armorer to repair a gun, one could just exchange the faulty part and continue the use of the gun.) Likewise, among other virtues, mass production that replaced craft-production of guns led to higher gun reliability. Yet Professor Ruttan himself notes that the key technology was brought in by civilians, Thomas Blanchard and John H. Hall. Moreover, the use of interchangeable parts can be traced back at least as far as Gutenberg's interchangeable type to print books! Economic historians Rondo Cameron and Larry Neal report on Dutch merchant shipbuilding in the 1600s using "elementary mass production techniques [and keeping] stores of interchangeable parts."[5] Later, in the 1700s, clockmakers used interchangeable parts as well, and so did the French military before none other than Thomas Jefferson became enamored with the idea of interchangeable parts and mass production and wrote back home about it. Professor Ruttan's claim, then, that "only the U.S. War Department could provide the large arms contracts that enabled private manufacturers such as North, Whitney, and Colt to make the large investments necessary to build and equip factories with the machinery to produce the interchangeable parts for gun production" (p. 30) does not sit quite well. Moreover, as weapons historian Edward C. Ezell notes, the American System "was not a simple panacea for solving the weapons-manufacturing problem. Success lay with the efficient marshaling of production capacity, whether it be based on the craftsman's skill or the machine's repetition and precision" (1986, p. 25), or, as renowned military historian Martin van Creveld notes in the introduction to his *Technology and War*, "we must begin by taking into account such mundane things as roads, vehicles, communications, timekeepers, and maps, and end by considering the most complex problems of technological management, innovation, and conceptualization" (1989, p. 2). In a word, just because the U.S. Ordnance Department placed a large order for handguns does not equate to a revolution from crafts to mass production. The industrial revolution had just got underway, and what is inconceivable is not that without the U.S. weapons order mass production with interchangeable parts would not have occurred. Instead, what is inconceivable is how mass production with interchangeable parts would not have become standard practice anyhow, especially given the pre-1800 antecedents.

The development of the commercial aircraft industry

Chapter 3 discusses the development of military and commercial aircraft. Once more, there is no question that military funding, in the United States as elsewhere, provided huge incentives. But can it really be said that there would be no commercial aircraft industry today, or a substantially less advanced one, without the military dollar? From Icarus of Greek mythology to the hot-air balloon built by the Montgolfier brothers in 1783, to Otto Lilienthal's controllable air glider flown in 1891, to the first Zeppelin or *dirigible* flight in 1900, to the Wright brothers' Kitty Hawk, North Carolina flight in 1903, people not only pursued the dream of flight but successfully advanced it.[6] So, what is there to believe that without the military, the quest would not have continued? By 1908, the third Zeppelin had made 45 flights and had traveled 4,398 km (about 2,700 m), at which point the German military became interested. As coincidence would have it, that was the same year the American military became interested in the Wright brothers' contraption. Civilians led the military, not the other way around.[7] In fact, the world's first commercial airline was founded in Germany, and by 1914, twenty-one of Zeppelin's airships had transported some 40,000 passengers, covering 200,000 km of distance. In 1924, a Zeppelin-design made an 8,050 km transatlantic flight to deliver an airship to the United States,[8] also for commercial service (it flew there for eight years under the name "ZR-3 USS Los Angeles"), and to an enthusiastic welcome by the American public and a White House reception.

The Great War resulted, in essence, in a design-competition between two engine-powered aircraft designs, the difference lying in the wing-lift (the Wright brothers) as opposed to the gas-lift design (Zeppelin). Both aircraft served in the war; both were used for reconnaissance missions and for bombing raids. About equally fast, the airship could carry many more guns and a much larger bomb load on account of its much larger lift capacity. It also sported superior range and endurance. The big problem, the one that proved to be its doom, was greater vulnerability to air defense, i.e., searchlights and gunfire.[9] If not for that, who is to say that today we would not fly in airships rather than in airplanes? Quite possibly, airplanes might be second-best technology, surviving only because of the exigencies of war.[10] Professor Ruttan notes that by "the mid-1990s it seemed clear that military contracts would no longer play a significant role in the development of the U.S. commercial airliners" (p. 58),[11] and that "it was becoming increasingly clear that technology transfer from military procurement was no longer a dynamic source of technical change in the commercial airline industry" (p. 62). Is it possible that the military dollar was no more than an unwelcome "interloper" in the civilian air flight business, an interloper that steered civilian aircraft advances off course? It is perhaps because Professor Ruttan follows the aircraft as it developed, rather than as it might have developed, that he never seriously asks what alternatives they were (he never mentions the Zeppelin, for instance). When he writes that it "is hard to avoid the conclusion that, in the interwar period, commercial aircraft would have been developed more slowly and introduced more slowly in the absence of defense-related technology development and military procurement ... [and] that the advances in aircraft design represented by the Boeing 707 and 747 would have been substantially delayed in the absence of the stimulus provided by military procurement" (p. 64), he thereby assumes that the Boeing 707 and 747 and *only* the Boeing 707 and 747 could ever have been invented for passenger air flight. The Zeppelin and the pre-World War I commercial airline based on it suggest that it could have been otherwise. Perhaps the military dollar amounted to nothing but an enormous, 80-year long (ca. 1915 to 1995) diversion of research and funding to designs that suited the military but impeded civilian advance. Although Professor Ruttan discusses path-dependence in the opening chapter, he never applies it in the case studies, much preferring to stick with the demand-induced view of technological advances.

The computer industry

Chapter 5 discusses the electronic digital computer industry. (Chapter 4 on nuclear energy and electric power is discussed in Brauer, 2007). The history of computing proceeds so gradually and is so smoothly set with continuous invention and innovation that it is difficult to delineate with precision which advances count for "how much" in directing the development that has led to today's ubiquitous computing environment. It is a bit odd that Professor Ruttan would narrow the scope of his writing to the electronic digital computer, rather than say to automation which is the tack van Creveld takes and which, at once, makes clear that the quest for efficiency-enhancing technology is a quest that much transcends military objectives and applications. One fears that Professor Ruttan is setting up a strawman case.

Within the restricted view, there is no question at all that the military dollar played an influential, demand-inducing, role. But what role? Would today's computer industry either not exist or lag substantially behind the achievements made to date? Do we have to thank World War II and its 20 million dead for what pleasures modern-day computers offer? Even in this case, ambiguity enters. For example, developments in the field relied on general-purpose tinkerers and scientists such as Charles Babbage and Hermann Hollerith. The invention of the first *digital* computer is difficult to pin down, but a number of sources give pride of place to the U.S.'s Atanasoff-Berry effort and to Germany's Karl Zuse's (both with working models in 1941). This of course was made possible by the tremendous advances in physics in the early part of the century. Universities in the United States, such as Harvard, Princeton, the Massachusetts Institute of Technology, the University of Pennsylvania, the University of California (i.e., Berkeley), and others were repositories of extraordinary talent which the military dollar could hire.

The military was certainly willing and able to finance risky ventures. But this is a long way from claiming that the effort would otherwise not have been undertaken at all or that substantial delays would have occurred. Especially when put in the historical context of non-digital, non-electronic computing and automation, one could argue, I believe, that World War II just happened to come along "at the right time" to provide an important research sponsor for particular forms of computing. As for the case of aircraft, it is possible that because of the overwhelming presence of the military dollar inferior computing designs became "locked-in," inferior, that is, from the point of view of the eventual civilian general-purpose technology that would result and come to dominate today's computing environment. The dynamics of the market can skew the outcome. A large player affects the development path. Thus, if one couples Professor Ruttan's demand-induced view of technological advance with evolutionary and path-dependency views, one might agree with Rip and Kemp that "technology is not chosen because it is efficient, but becomes efficient because it is chosen."[12] The civilian market made the best of what the military let trickle out. Indeed, the subsequent civilian development of the computing industry – one might point for example to hardware and software designers' rabid adherence to open standards – can be argued to demonstrate that the military *stifled* rather than advanced technological development by keeping things under the impenetrable wrap of secrecy.

There is no space here to make a similar case for the semiconductor industry, other than to note that it, too, grew out of civilian university and commercial-based research – in this case to advance communications technology. The military was merely the most important early adopter. Professor Ruttan's demand-induced view is not wrong, but it tells only a part of the overall story and thus clouds his eventual conclusions.

The Internet

Chapter 6 – "Inventing the Internet" – underplays both American *non-military* contributions as well as *non-American* developments. As always, there is no question that the military dollar spurred research and steered developments into useable products and services, but the case that *without* the military dollar similar products and services would not have become available or only with substantial delay is not well made. Yes, the U.S. Department of Defense's Advanced Research Projects Agency (ARPA), founded in 1958, was an important contributor to the development of computer networks.[13] Professor Ruttan's presumption is that without the military there somehow would have been no or much less of a need for computer-to-computer communication. Yet even without the military, scientists will still have wanted to have their computers communicate, the better to share data and findings more easily. The underlying idea, after all, is entirely akin to telephone, electricity, road, railroad, and other networks. It is a bit outlandish to suggest that only the military dollar would have been able to create what would become the Internet, a network of computer networks. What the military dollar did do was to appropriate the early development process, channel it toward its own needs, thereby forestalling whatever civilian developments would have taken place as researchers were drawn from civilian to military applications. For example, the idea of "packet-switching" – breaking a message into parts to be distributed via a variety of net-nodes and alternative routes to the ultimate intended recipient where the parts would be reassembled – derived from security concerns that a nuclear explosion might disable a centralized communications node, thus giving rise to decentralized nodes and routing. Was this idea unique to military needs? No, not at all as the aforementioned telephone, electricity, and road networks also are decentralized. Capacity constraints at centralized computer nodes eventually would have spawned decentralized systems. That it was "only the commitment of very large financial and technical resources that were available to ARPA that assured the success of the packet switching technology" (p. 117) is then no more than an assertion.

Researchers do not stop researching just because the military does not fund their interests. Indeed, Professor Ruttan does not report alternative civilian network efforts, nor European network efforts. ARPA and ARPAnet, being of U.S. military provenance, had obvious reasons to keep close control over knowledge diffusion. In fact, the *exceptions* to knowledge sharing are interesting: for example, in 1968, the governments of the United States and Norway concluded an agreement whereby Norway would become the first non-U.S. ARPAnet node (the link become operational in 1973). The purpose concerned Norwegian seismological research, especially in the area of seismological detection – Soviet nuclear-test explosions in other words.

Professor Ruttan's concluding assessment is that "in the absence of military support ... [the] realization of the Licklider vision would have been substantially delayed," perhaps for "at least another decade" (p. 128). This may well be an incorrect assessment. Joseph Licklider's famous "man-computer symbiosis" paper was published in 1960, and ARPA hired him in October 1962. It is inconceivable that Licklider would not have pursued his man-machine interaction vision elsewhere. The military just offered a convenient avenue to do so. Moreover, when in the early to mid-1980s the U.S. National Science Foundation inherited some of ARPA's network research, resulting in NSFnet – an *open* university and research computer network – the question arises of why the U.S. government could not have placed network research with the NSF in the first place. If in the late 1950s, the funds had gone to NSF rather than ARPA, would we not now be in possession of an equally marvelous Internet? My point is that there is nothing *inevitable* about *only* the military dollar having been able to lead to computer-network research, as Professor Ruttan implies.

The space industry

The final case study, in chapter 7, concerns the space industries. The main objective is "to trace the development of weather, communication, and earth-observing satellites to their World War II and cold war origins" (p. 130). In my reading, the chapter shows just the opposite – how civilian use of space has been equally possible. Indeed, the chapter includes long sections on how Eisenhower and Kennedy insisted on some degree of separation between the military and the public-goods civilian spheres, and many examples are provided of international public cooperation and of American private sector involvement, especially in the arena of communications satellites. Only toward the very end of the chapter does Professor Ruttan make the point that without *launch vehicles* (i.e., rockets), none of this might have been possible. However, the launch vehicle part of the space industry is scarcely discussed in this chapter, so that it is not possible to assess the assertion. To the extent that the launch industry *is* discussed, what is remarkable is that in preparation for the International Geophysical Year (IGY), 1957-58 – an international *civilian* "good-will" demonstration of high-tech science for the common welfare of humankind, and expressly endorsed by Eisenhower – the United States decided that it would *not* involve agencies that worked on military space-launch vehicles. Instead, the project (called Project Vanguard) was handed to an agency that had "no involvement with the [ballistic] missile program" (p. 133), namely the Naval Research Laboratory (NRL). In 1956, the U.S. Army Ballistic Missile Agency (ABMA) snatched Wernher von Braun's rocket team that had worked to develop ICBM's since the late 1940s and pushed mischievously, despite Eisenhower's instruction of separating military and civilian rocketry, for part of the IGY spoils.[14] When the NRL's Vanguard rocket failed (6 December 1957), von Braun's Jupiter-C succeeded to put the first U.S. satellite into orbit (31 January 1958) – but only by a matter of six weeks when another Vanguard rocket achieved the same objective (17 March 1958). A critical piece of information is that von Braun's Jupiter-C was based on missile technology, whereas the pedigree of the Vanguard was not a war-technology but instead based on early weather-study rockets. The key point is that there *was* alternative, non-military technology available (even though it was formally placed with a naval research outfit) and so, again, one must question the just-so story telling: can we really believe that without the military dollar, the world would not have begun and succeeded to explore space? I am not convinced by Professor Ruttan's story.

Conclusion

Even if one grants Professor Ruttan's major point, that military funding and procurement were the key to the eventual commercial success of certain general-purpose technologies, the book tells us little about the economics involved. Just what makes spin-off possible and successful? Although there are frequent references about how civilians either brought critical ideas to the military or of how civilians harnessed such ideas from the military, the book is essentially silent on concepts such as network economies or the economics of (open) standards with which the question of successful technology transfer from the military to the civilian sector might have been explored. Even Alan Milward's now 30-year old chapter on "war, technology, and economic change" has a more nuanced discussion of the issues than the book under review offers.[15]

Professor Ruttan does not argue that creating spin-offs from the military sector is necessarily an "efficient way to advance commercial technology development" (p. 162). That is not the question he pursues. Instead, he asks: Is major war, or threat thereof, necessary to create general-purpose technologies to advance future U.S. economic growth? His opinion is that "it may" (p. 185), on no more argument than that he is doubtful that the U.S. private sector can mobilize the resources necessary to develop future general-purpose technologies. He also believes that the "U.S. [defense] industrial base is losing its capacity to respond" even if there were a massive publicly financed injection of resources (p. 185). Further, even if the defense industrial base could respond, he still remains "skeptical" (p. 185) that viable new general-purpose technologies could result. He raises the question, for example, of the *general*-purpose use of stealth aircraft technology (p. 62). It's all argued as if the future United States were a case study to fit Olson's (1982) thesis in *The Rise and Decline of Nations*. Once more, perhaps Professor Ruttan is correct – it is just very hard to press as much of a conclusion as he does from the evidence presented.

The statement in the concluding chapter that "I have yet to identify a recent comprehensive analysis of the changing structure of the defense industrial base or of the policy implications for defense procurement" (p. 176) is puzzling. The author does not specify what he means by "comprehensive analysis," but the book's almost total lack of reference to the now fairly well developed defense economics literature –

complete with its own journals (*Defence and Peace Economics*, as well as *this* journal, and others), professional association, annual conferences, at least one textbook, a 3-volume reader, and two volumes in Elsevier's celebrated *Handbook* series (1995 and 2007) – suggests that he has not looked in the right place to inform himself.

All-in-all, this is a disappointing book on a great topic.

Notes

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1. Ruttan (2001).

2. See www.eia.doe.gov/fuelelectric.html [accessed 1 September 2006].

3. See CEA (2006).

4. Brauer (2007).

5. Cameron and Neal (2003, p. 115).

6. Note that the common American claim, repeated by Professor Ruttan, that the Wright brothers were the first to succeed with a "heavier-than-air self-powered flying machine" (p. 34) is incorrect. The *Luftschiff Zeppelin 1* (LZ1) also was a rigid, heavier than air structure (an aluminum body lifted by hydrogen gas) and, using a Daimler internal-combustion engine, also was self-powered. What distinguished the Wright brothers' machine was wing-lift as opposed to gas-lift.

7. The same was true for the balloon. A civilian invention, it was used for instance both in the American Civil War in the 1860s and in the French-German War of 1870/71.

8. In 1917, a military Zeppelin made a transcontinental non-stop flight from Germany to German East Africa (Tanzania), covering 6,757 km in 95 hours, a long-distance record at the time.

9. See Wikipedia (2006).

10. Much the same story can be told for jet-engine development, originally stemming from the work of Frank Whittle of the U.K. (a patent was granted in 1932) and of Hans von Ohain in Germany who did similar work in 1935, with the first jet engine airplane flying as the Heinkel He-178 three days before the outbreak of World War II. Curiously, Professor Ruttan tells some of this story, even that the American military was slow to switch from propeller-driven airplanes until American bombers got beat by Soviet jet-engine fighters in the Korean war in the early 1950s. The real story here is not the military as hero of technology advancement but the military as technological Luddite!

11. To be sure, no longer playing a "significant role" safe for the issue of cross-subsidization between military and civilian divisions, both at Boeing and at Airbus (EADS).

12. Cited in Carrillo-Hermosila and Unruh (2006, p. 711). The reference to Rip and Kemp is (Rip and Kemp, 1998, p. 353).

13. ARPA was renamed DARPA in 1972 (Defense Advanced Research Projects Agency) but regained its original designation as ARPA again in 1993. Professor Ruttan misses that ARPA then was *again* renamed, in 1996, to DARPA (see http://www.darpa.mil/body/arpa_darpa.html; accessed 20 September 2006).

14. One annoyance in this, as in the nuclear-energy chapter, is that Professor Ruttan consistently misspells names. Just as chemist Fritz Strassman should be Fritz Strassmann, so rocket scientist Werner von Braun should be Wernher von Braun.

15. Milward (1977).

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