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Southwest Economy

NASA/Kennedy Space Center

Seeding Technology with Defense Dollars

The United States responded to the September 11 attacks on New York and Washington by launching a global fight against terrorism, starting with the war in Afghanistan. The new focus on national security is altering the federal government's spending priorities. After the Carter–Reagan military buildup peaked in 1986, defense spending declined as a portion of total U.S. output through 2001, largely because of the Soviet Union's demise and the end of the Cold War (*Chart 1*). Now the terrorist threat is prompting a rise in spending for defense and homeland security. The White House proposes budget authority of $427 billion in fiscal 2003, up 25 percent from 2001.

Economists distinguish between private and public goods. Private goods tend to benefit only the individual consumer. Capitalist societies rely on the private sector to produce cars, televisions, restaurant meals, accountants' services and millions of other goods. Through the interplay of supply and demand, markets determine what to produce, mobilize the necessary inputs and set prices. We pay individually, and we consume individually.

(Continued on page 2)

Insurance: A Risk to the Economy?

Most people don't appreciate insurance until they need it. Or can't get it. Last year was a difficult one for the insurance industry. An unprecedented surge of catastrophic claims left the industry reeling.[1] In response to the unexpected rise in claims and weaker investment opportunities, the insurance industry cut back coverage and sharply increased premium rates.

Insurance is a valuable financial tool that boosts economic activity. By purchasing insurance, individuals and businesses share the risk of making investments and engaging in activities that they perceive as too risky to pursue on their own. Homeowners, automobile drivers, doctors and businesses can pay regular premiums to reduce the expense of an unpredictable event.

The insurance industry is an integral part of the economy. Insurance is required for operating a business and, in most states, for purchasing a home or automobile. Increases in insurance costs are taking a bite out of corporate

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INSIDE:

Latin American Market Reforms Put to the Test

Public goods benefit the population at large, cost little more to provide to additional people and offer no effective way of excluding an individual's consumption, even if that's desired. Markets don't work well for public goods. When it's impossible to exclude anyone from the benefits, there's little incentive for individuals to pay. Not enough of the good is supplied, so citizens turn to government. Defense spending meets economists' standard for public goods, the legitimate province of government.

Trade-Offs vs. Spillovers

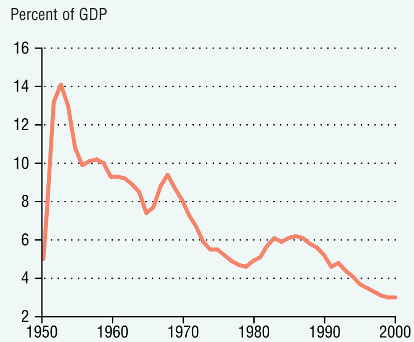
In textbooks, private and public goods are distinct and citizens must choose between one and the other—guns *or* butter. Though there doubtlessly are trade-offs, in reality the math isn't that simple, especially when it comes to defense. History tells us that military spending produces important technology spillovers in the civilian economy—a bonus beyond the benefit of national defense. The private sector, driven by the profit motive, has commercially adapted many technologies developed for military use, thus making the trade-off between guns and butter less severe than it would otherwise be.

Decades ago, military funding led to the development of many of the technologies vital to civilian aviation, including radar and the jet engine. Just about every civilian use of nuclear technology—from power plants to medical procedures—traces back to the Manhattan Project, the World War II effort to harness the atom's power. The military played a key role in developing computers and the Internet, two of the driving-force technologies of America's postindustrial economy. Now the private sector is finding uses for the satellite navigation and targeting systems developed for the military.

In the war in Afghanistan, U.S. forces have displayed a technological prowess far beyond that seen in the Gulf War a decade ago. Precision-guided munitions, global communications networks and airborne surveillance systems have been important to routing enemy combatants. Now night-vision technology is making its way from the battlefield to the highway, where it will allow drivers to see in fog or other dangerous conditions. The unmanned aircraft, or drones,

Chart 1

Defense Spending, 1950–2000



SOURCE: Historical Tables, Budget of the U.S. Government, Fiscal Year 2003, Office of Management and Budget.

that have patrolled the skies over Afghanistan may allow us to better track wind shear, microbursts and other severe-weather hazards to aviation. The Defense Advanced Research Projects Agency, the Pentagon's research arm, has dozens of projects under way for the next generation of warfare. (See the box titled "In the Pipeline.") Many of these projects may lend themselves to commercial applications. Technologies U.S. forces are using now could help drive the economy of the future.

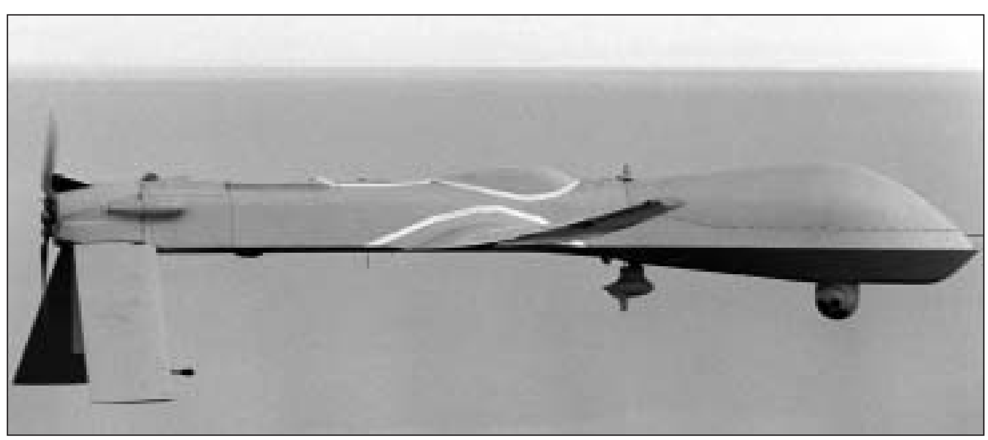
A Better Way to Find Our Way

No simple pattern exists for the technology nexus between the military and the private sector. The Global Positioning System (GPS), a system of computers and satellites that allows users to pinpoint any position on earth, was developed by the armed forces. Only later was the technology transferred to the private sector. No space-based technology would be possible, of course, without NASA, a major government program that developed the rocketry and satellite technology that made GPS possible.

GPS' roots are in the 1960s military environment, with its Cold War standoff between the United States and the Soviet Union. To get a better fix on the positions of nuclear-armed Poseidon submarines, the U.S. Navy launched seven navigational satellites into low polar orbit. The system had limited range and didn't operate quickly, so it wasn't suitable for aviation or other fast-moving military missions. In 1973, the Pentagon consolidated Navy and Air Force research projects on improving satellite-based navigation, which quickly led to a concept called Navigation by Satellite Timing and Ranging (NAVSTAR). It took 22 years and $8.1 billion to make the system fully operational.[1]

In 1983, the government decided to allow civilian access to the GPS, and the next year the first commercial product hit the market. It cost $150,000 and required two people to operate.[2] The expensive and bulky system found a ready market among surveyors. By 1991, almost 100 companies were selling GPS gear, and competition in the marketplace began to foster the same kind of rapid innovation and price cutting seen in consumer electronics. At the end of the GPS' first decade in the private sector, handheld units sold for less than $150.[3]

The armed forces use GPS technology to reduce navigational errors, allow more precise synchronization of forces and increase the accuracy of so-called smart bombs. Civilian uses are expanding each year. Today, Americans are



U.S. Department of Defense

Drones, used by the military today, may someday track weather hazards to aviation.

In the Pipeline

Corningware was originally developed by Dow Corning as a heat-resistant material for rocket nose cones. Tang and Teflon were spin-offs from NASA projects. DARPA—the Defense Advanced Research Projects Agency—is working on dozens of projects with potential commercial applications. Of course, not every project will be successful in completing its intended military mission or eventually resulting in a viable commercial product. So-called dual-use technologies tend to be difficult to foresee because no single mind can imagine the myriad possibilities.

DARPA program	Defense use	Potential commercial applications
Exoskeletons for Human Performance Augmentation	Increases the strength, speed and endurance of field soldiers, enabling them to tote more firepower, don ballistic protection and carry supplies greater distances.	Exoskeleton components can be used by people with various diabilities. Material movers can perform better and more safely.
Triangulation for Genetic Evaluation of Risks	Integrates data from multiple regions along an organism's genome to derive a unique identifier for the organism, so as to detect and classify bioengineered threats.	Detection and analysis of airborne pollutants, resulting in cleaner air, safer foods and improved water treatment.
Human Identification at a Distance	Detects, recognizes and identifies humans at a great distance from a face, fingerprint or walk.	Secure access to computer rooms, business files and banks. Help locate missing people.
Automatic Phrase Translators; Translingual Information Detection, Extraction and Summarization	Handheld translation devices that support such local languages as Pashto, Urdu and Dari; software that enables English speakers to locate and interpret critical information in multiple languages.	Translation for international travelers, supporting the tourism industry.
Evidence Extraction and Link Discovery	Discovers, extracts and links sparse evidence contained in large amounts of data; finding an information "needle" in a stack.	Improved Internet search engines for obtaining and managing information.
Global Positioning Experiments	Prevents radar jamming by using airborne, high-power GPS-like transmitters on aircraft to broadcast a signal that "burns through" jammers and restores GPS navigation.	Additional security for commercial flights, cruises, recreational boats and freighters.
BattleBoard: Command Post of the Future	Portable pen–tablet computer, about the size of a laptop screen, that uses speech and pen-based drawing and has a wireless connection to the battlefield local area network and its digital information.	Improved access to computers, cell phones and remote-control electronics. Replace current laptops at home and work, reduce carpal tunnel syndrome and aid the handicapped.
Friction Drag Reduction	Reduces the frictional drag on a moving ship's hull by 30 percent.	Reduce friction on recreational boats and freighters, improving fuel efficiency. Reduce drag on scuba divers.
Trapped Vortex Combustor	Uses high-energy, air-independent propulsion technology that produces more thrust with far less pollution.	More powerful, less polluting fuel source for commercial aircraft.
Microair Vehicle	Small air vehicle a soldier can carry and launch to gather information about the terrain ahead and enemy positions.	Enable hikers, mountain climbers and campers to be aware of the terrain, animals and people ahead.

SOURCE: Defense Advanced Research Projects Agency, "DARPA Fact File: A Compendium of DARPA Programs," Office of the Secretary of Defense, April 2002, www.darpa.mil/body/newsitems/darpa_fact.html.

driving cars with GPS that displays directions to business meetings and restaurants. Trucking companies use the technology to keep tabs on shipments. GPS readings also keep hikers from getting lost, tell golfers how far it is from fairway to flag and help anglers find their favorite fishing hole.

Picking Up the Pace

The urgency of national defense, along with the government's ability to mobilize resources, often accelerates the development of new technology. In the early 1930s, England's military asked whether radio waves could shoot down aircraft. They could not, but British physicist Sir Robert Watson-Watt found that the returning echoes provided a way of tracking planes. Without money, the invention languished. Little came of it until World War II, when massive U.S. funding made the "magic eye" a decisive weapon in winning the war.[4] The jet engine, another prewar invention, received a similar boost. After the war, of course, jet aircraft became the centerpiece of a boom in passenger traffic.

Shortly after launching the Manhattan Project, the military began research that planted the seeds of what would become the computer industry. Calculating the trajectory of shells fired from battleships and artillery required hours of mathematical computations. Among the factors that had to be considered were the type of weapon, inclination of the barrel, wind speed and direction, temperature, atmospheric pressure and humidity. To speed up the process, in June 1943 the military turned to the University of Pennsylvania's Moore School of Electrical Engineering, which had pioneered the design of an electronic calculating machine.

The result was the Electronic Numerical Integrator and Computer (ENIAC), the world's first all-electronic computer, capable of 5,000 calculations per second. The behemoth, delivered in 1946 at a cost of $486,804, weighed 30 tons and took up 1,800 square feet. An energy hog, it consumed 160 kilowatts of electrical power, enough to cause brownouts in Philadelphia.[5]

Almost immediately after the war, entrepreneurs began exploring commercial applications for computers. After a few missteps, two scientists who had worked on ENIAC found the right design in the Universal Automatic Computer (UNIVAC). A new industry came into being, but the machines were so expensive that only big corporations could buy them. It took three decades, and the development of the microprocessor, to create the personal computer.

The military also had a role in the Internet's early development. At the height of the Cold War, the military sought a decentralized communications network that could survive a nuclear attack and allow the United States to launch retaliatory strikes. In the early 1960s, the Pentagon found a potential solution in concepts being explored by a handful of researchers who envisioned connecting computers and moving massive amounts of data over a grid of open lines. The Pentagon's $1 million investment helped forge the Advanced Research Projects Agency Network, which linked four university computers in 1969.[6]

Never solely a military project, the ARPANET quickly moved to the private sector. Electronic mail started moving in 1972, and Telnet—an early commercial application for searching remote library catalogs—came two years later. The military split its network from the ARPANET in 1983. The Internet, however, didn't take off until it became easier to find information online. In 1991, Tim Berners-Lee posted the computer code for the World Wide Web, allowing users to combine words, pictures and sounds on Internet pages.[7] Netscape founder Marc Andreessen created the first web browser in 1993, and the Internet exploded. Today, 190 million computers around the world have Internet access.

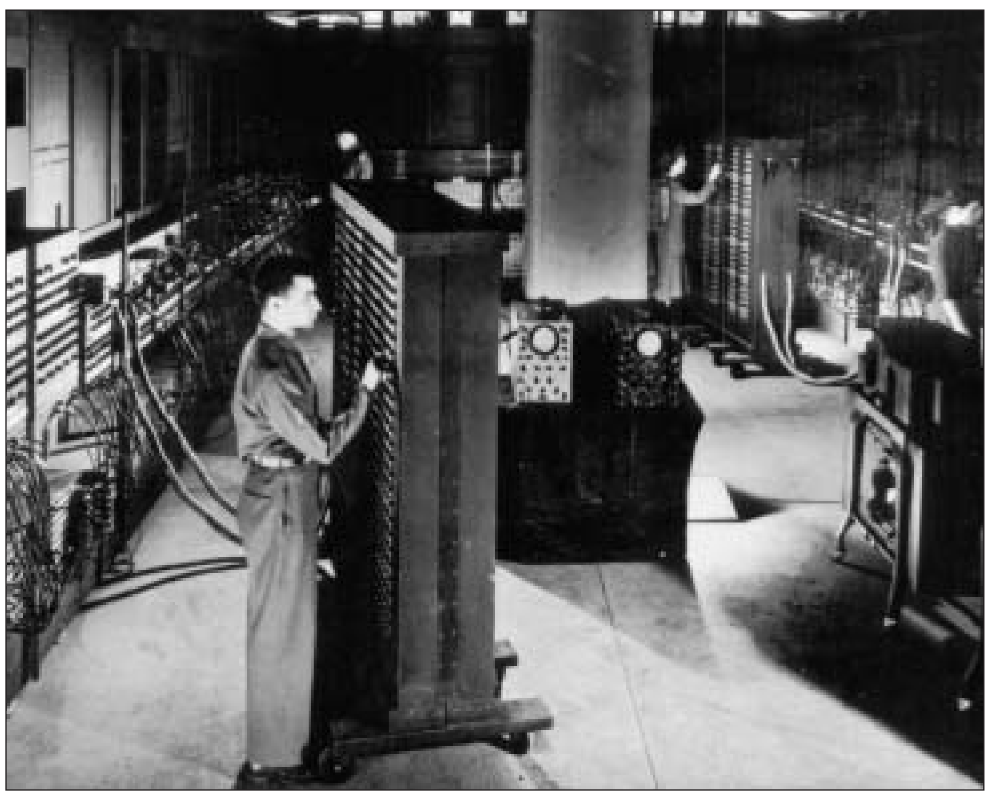
Investing in Big-Ticket Projects

Investing in basic technology can be too expensive and risky for private firms. Big commercial rewards might lie at the end of the road, but market failures can occur when companies are unable to capture (internalize) all the profit from millions spent on R&D. Massive undertakings with big technology spillovers—such as harnessing nuclear power—thus sometimes fall to the federal government. Even then, Washington often wouldn't be able to muster the political will to fund the projects if not for the priority of national defense.

The Manhattan Project is the most famous name in military research. Fearful that Nazi Germany would build an atomic weapon, the U.S. military launched its own nuclear effort on December 6, 1941, the day before Japan attacked Pearl Harbor. In December 1942, a team of scientists at the University of Chicago produced the first sustained nuclear reaction in a 20-foot-tall device, using 6 tons of uranium metal, 50 tons of uranium oxide and 400 tons of graphite.[8] Nearly three years passed before the basic technology could be adapted for military use. Scientists detonated the first atomic explosion in the New Mexico desert. Within weeks, bombs struck the Japanese cities of Hiroshima and Nagasaki, ending World War II.

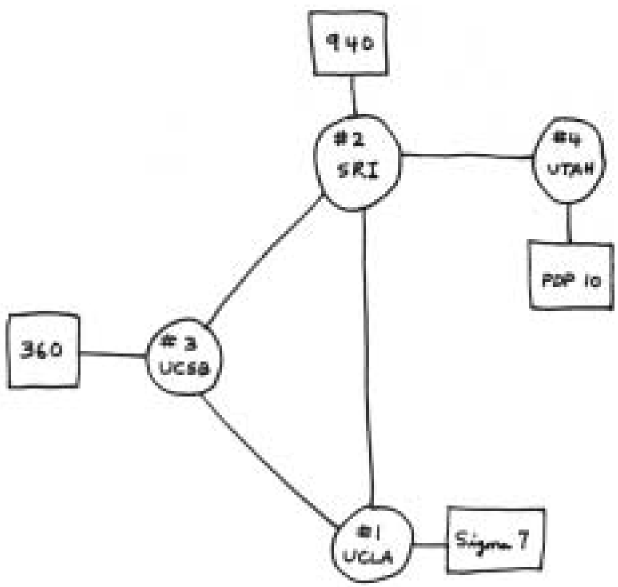
The government spent $20 billion to develop the atomic bomb and $6.2 trillion to build and maintain the nation's nuclear arsenal over the next 50 years.[9] The conversion of atomic technology to nonmilitary uses began shortly after the end of World War II, and the first commercial nuclear power plant went into operation in Shippingport, Pa., in 1957. By 2001, 103 reactors in 31 states produced 20 percent of the nation's electricity supply.[10]

Although nuclear power has fallen from favor in the United States, other uses of the technology continue to expand. Industrial companies use imaging technology to inspect metal parts and welds for defects. Irradiators sterilize food. Atomic gauges monitor and control the thickness of sheet metal, textiles, paper, plastics and other materials. Medicine makes use of the atom. X rays, CT scans and MRIs help diagnose problems



John W. Mauchly Papers, Rare Book & Manuscript Library, University of Pennsylvania

ENIAC—the Electronic Numerical Integrator and Computer—was the result of a military project but ultimately gave rise to today's personal computers.



This sketch shows the ARPANET as it existed in 1969. The four-node network has evolved into today's 190 million-node Internet.

with internal organs and bones. Without surgery, doctors can diagnose heart disease, detect tumors and monitor transplants for rejection. Each year, Americans receive 10 million to 12 million nuclear medicine and therapeutic procedures.

Sometimes, Guns Help Make Butter

In the mid-1950s, President Eisenhower warned of the emergence of a military–industrial complex that could warp American democracy. Government investigators periodically turn a spotlight on wasteful spending—$7,600 coffeemakers and $400 hammers, for example. Even when defense spending is managed well, many critics consider it wasteful, arguing that money spent on bombers and battleships drains the economy of human and natural resources the private sector uses more productively.

Viewing military spending as just threatening, wasteful or inefficient ignores important long-term potential benefits for the economy.

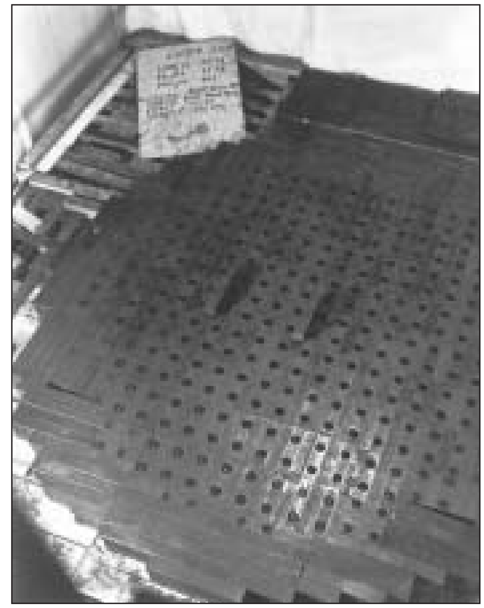
The Pentagon and other government agencies do play a role in directing and funding technology. But the market, with its powerful profit incentive, can take what government does and make a lot more out of it—creating new industries and jobs and adding to economic growth. For example, U.S. GPS producers employ more than 23,000 people and will ship $4.7 billion in equipment this year.[11] The computer industry, descended from ENIAC, has produced a huge economic impact, with sales of 30 million units a year. Even after the dot.com downturn of the past two years, the Internet business will grow into a mainstay of the future. Taken together, computers and the Internet are part of a vibrant, expanding information technology sector with annual output of $800 billion (8 percent of GDP) and employment of 5.6 million workers.

Guns or butter? The classical dilemma suggests a trade-off in which increased military spending saps the commercial sector. It's not always that way. Over the years, military research has made important contributions to the civilian economy, many of them rarely acknowledged. Military spin-offs touch our everyday lives with such innovations as Corningware, air bags, photochromic glasses, the HMMWV and even a two-week tick repellant that's sprayed on clothing.

Every year the private sector creates thousands of new and improved products without government assistance. So we might have gotten the benefits of the GPS, computers, the Internet and other military spin-offs without the Pentagon's research and development. Companies or universities might have stepped forward with the funding. Private consortiums might have formed to internalize the technology spillovers and get the projects under way. But that didn't happen. What did happen isn't so bad, though, because the private sector took what government had done and found a way to bring it to market.

—W. Michael Cox

Cox is a senior vice president and chief economist at the Federal Reserve Bank of Dallas.



Argonne National Labs

The first controlled nuclear reaction occurred at CP-1 (Chicago Pile 1), on an old squash court under the University of Chicago's Stagg Field. The 1942 feat marked the start of the Atomic Age.

Notes

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