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# Semiconductors and Canadian National Security: Causes, Consequences, and Considerations

by Kevin Budning, Guillaume Cote and Alex Wilner

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# POLICY PERSPECTIVE

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In his March 2022 State of the Union address, U.S. President Joe Biden told a packed House of Representatives that the path to rebuilding America's economy was to reduce its reliance on foreign supply chains: "Economists call it 'increasing the productive capacity of our economy.' I call it building a better America."

The president's speech was just one of many public appeals for the United States to curb its dependence on others, while simultaneously increasing its production of critical goods. The post-pandemic economy has presented the U.S. with several unforeseen supply chain disruptions that are further contributing to inflation, especially in key manufacturing and technology sectors.

Russia's aggression against Ukraine, simmering conflict between North Korea and American allies South Korea and Japan, plus rising tensions (and the perception of it) with China over Taiwan and Hong Kong, continue to upend the Pacific and European regions. This instability has exposed vulnerabilities in the U.S. aerospace and defence sectors with respect to the flow, sourcing and importing of a wide range of critical materials and advanced components.

To curb some of these challenges, in August 2022 the U.S. Congress passed *The Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act,* which earmarked $280 billion towards boosting the research, production and manufacturing of semiconductors in the United States. Semiconductors are a critical component needed to make microelectronics (MEs). Also known as chips or microchips, MEs are comprised of microprocessors, transistors and sensors. These small pieces of technology power just about every modern device, ranging from smartphones to automobiles, to airplanes, to dishwashers, to national defence systems. If state-level funding and private investments are included, more than $1 trillion will likely be allocated towards this effort over the next 10 to 15 years.

The shift casts a cloud of uncertainty over the Canadian government, which continues to import most of its MEs from Taiwan and South Korea. The legislation also raises a major concern for Canada's defence sector, which relies on MEs to power a host of systems and platforms, including those needed to fuel artificial intelligence, machine learning, cloud computing, synthetic environments, LEO satellites, quantum and a range of other enabler technologies that are essential for Canada to interoperate with its allies.

Therefore, at a minimum, it is in Canada's best interest to ensure that the quality and supply of ME technologies remain uncompromised. Anything less risks degrading our sovereignty and our ability to defend and deter against emerging and future threats. The federal government should also work to secure a level of development access to critical field technology, or an exemption agreement with the U.S., so that it avoids falling further behind its allies and adversaries alike.

## Semiconductors and the World Economy

The history of semiconductor chips goes back to the 1950s, when they were first used in guidance computer systems for NASA spacecraft and missiles. As the computing power of these chips doubled nearly every year after, it quickly became obvious that MEs would serve a dual purpose, one for civilian and one for military use. The increased demand in chips by the 1970s, coupled with the high cost of domestic wages, resulted in the U.S. offshoring much of its manufacturing to East Asian countries such as Taiwan, South Korea and Japan. These countries became the world's largest manufacturers, with companies like Samsung, Toshiba and the Taiwan Semiconductor Manufacturing Company (TSMC) emerging as global leaders.

For more than 50 years, a complicated yet dependable trade scheme formed between the West and East. American companies that specialized in design relied on their East Asian partners to manufacture the product, with the final step of assembly landing in China. Each country had its comparative advantage, with the goal of building the cheapest and most advanced chips top of mind.

In recent years, however, the Chinese government has developed a new ecosystem that does not depend on outside sources to design, manufacture or assemble microelectronics. The move has propelled Chinese technology conglomerates, such as Huawei, and has created a degree of resiliency in the national industry, protecting the Chinese economy from supply chain chokeholds and (future) economic sanctions or trade embargoes.

The shift, along with reported cases of Chinese intellectual property theft, exacerbated the already worsening tensions between China and the United States. As the two countries progress towards a potential Cold War – one in which access to cutting-edge technology may be the deciding factor – the U.S. has acted to slow China's ascent in the information economy. Former U.S. president Donald Trump, for example, escalated trade tariffs on goods imported from China and banned U.S. sales to a host of technology companies that operated as subsidiaries of the Chinese government.

And then the COVID-19 pandemic struck. The closing of foundries, manufacturing plants, research and design facilities, laboratories, stores and couriers brought the industry to a screeching halt. In a matter of weeks, the automaker Ford was forced to stop production on 70,000 F-150 pickup trucks, Apple announced it was slashing iPhone production by 10 million units and thousands of Canadian customers were forced to wait over one year to receive their pre-ordered appliances.

The pandemic exposed a widening gap in U.S. economic and trade policy: overdependence on other countries to secure critical goods poses an immense risk to the economy and national defence. Natural disasters, war and climate change are some of the other reasons that American decision-makers have shortened U.S. supply chains. The logic in all cases is that if the U.S. is ever cut off from MEs, an adversary could eventually gain an upper hand in virtually every sector, including in national defence. Bolstering critical supply chains is a catch-all remedy.

Since entering office, Biden has doubled down on elements of Trump's policy, including banning U.S. companies from selling advanced chips to China, blocking Chinese companies from using U.S. design software and manufacturing equipment and banning its global customers from selling American equipment to China. Biden has also successfully gained bipartisan support for *The CHIPS and Science Act*, which provides enormous incentives to domestic and foreign chip manufacturers to expand their operations in the U.S. TSMC did just that, announcing a $40 billion investment in U.S.-based facilities in December 2022. Intel, Micron, Samsung, GlobalWafers and MediaTek are a few of the many other companies that have followed suit by investing billions of dollars in the U.S.

This strategic U.S. ambition will have far-reaching impacts on America's economic, industrial, scientific and defence policies. Its mandate crosses over between the U.S. Department of Defense (DoD), Department of Energy, Department of Commerce, the Defense Advanced Research Project Agency and the National Science Foundation. It will lead to the creation of novel institutions that will enhance the co-operation between industry, academia and policy stakeholders.

## Chips and Defence

The use of microelectronics in defence cannot be underestimated. According to a 2022 report, the global semiconductor market in military and aerospace is projected to reach US$10.2 billion by 2030. These chips are diverse and include components of logic, photonics and memory. SMART-T communications, secure mobile devices, modular advanced armed robot systems, the F-35 Lightning II Joint Strike Fighter, radars and intercontinental ballistic missile systems are some of the ubiquitous examples where this technology is being applied.

MEs are generally placed into two categories: commercial off-the-shelf (COTS) and application-specific integrated circuits. COTS are publicly available, reliable and trusted instruments that can be used for a wide range of military (and non-military) applications. While COTS are not necessarily designed for military purposes, integrating them into existing systems and platforms allows for greater efficiencies, lower costs and quicker developmental lifecycles.

Conversely, application-specific integrated circuits are designed for specific use. These military chips need to be durable, reliable and tolerant to both high heat and radiation. They also need to have a longer lifecycle and be compatible with legacy defence systems. Currently, they are being used for electromagnetic spectrum operations, space capabilities, radars, jammers, nuclear technology and communications. Because of the high-tech and advanced nature of these chips, DoD requires they be produced exclusively in U.S.-based foundries that are operated by leading defence contractors, such as Raytheon Technologies and Northrop Grumman. They must also be part of the Trusted Foundry Program, a 2008 initiative designed to secure the manufacturing of sensitive information technology between select defence companies and DoD.

A more heterogenous architecture that combines COTS and application-specific integrated circuits – chiplets – could soon be the norm. These single silicon dies are designed to be combined with other dies through a series of different arrangements, often in a mix-and-match process, and then mounted onto a single substrate layer. More simply, a core chip could be commercial in nature, but have app-specific chiplets for military use subsequently attached. This innovation will reduce the cost of using commercial technology, maintain restricted access to military technology, protect the chiplet's safety and integrity and speed up the time to market.

Given the inherent link between chips and defence, countries that develop and acquire the latest ME technology have a significant strategic advantage over those that do not. The reality, however, is that 90 per cent of the most sophisticated chips and 70 per cent of all chips are manufactured in Asia. The supply chain for semiconductors is so complex and involves so many countries that any disruption could have severe consequences for national defence. Should a conflict or natural disaster disrupt chip manufacturing in South Korea or Taiwan, for instance, most of the world's militaries would face a catastrophic shortage of critical technology.

## Consequences for Canada

As the U.S. solidifies its new policy, the extent to which it will affect Canada's economy, national security and defence is unclear. On the one hand, U.S. onshoring of chip manufacturing may prove beneficial. Canadians may worry less about international supply chain disruptions. It could perhaps also leverage its free trade agreement or press the fact that the two economies and defence apparatuses are inextricably tied, to acquire the MEs it needs. Canada is also home to a major supply of critical minerals – an industry the government has already taken measures to expand and secure – that are necessary to produce semiconductors. The geographic advantage and the close relationship between the two countries may further contribute to the growth of Canada's high-tech and natural resource extraction sectors, while also incentivizing foreign investment to North America more broadly.

Put simply, having the U.S. emerge as a gatekeeper of one of the most critical goods of the 21st century would suit Canada just fine.

But on the other hand, relying on one country for any sort of goods, especially critical ones, comes with a high degree of uncertainty. Some things are out of Canada's control, such as whether the U.S. is ultimately successful at further divesting from East Asia chip production, or if enough foundries can be built to keep up with global and local demand. However, even more disruptive risks exist. A dramatic spike in the price of MEs, for instance, could add to an already burgeoning inflationary crisis. More dramatic still, the U.S. could hypothetically withhold access to its homegrown ME technologies in defence. There is also the question of why the U.S. would grant Canada preferential treatment over some of its other, arguably closer allies, such as the U.K. and Australia. As part of the trilateral Australia/United Kingdom/United States (AUKUS) security pact, it would only make sense that collaboration between these countries may be favoured in seeking to create the next generation of defence capabilities.

America's aspiring self-reliance in the supply of semiconductors may also have unique impacts on Canada's defence sector. If the price of MEs rises (as a possible result of onshoring production to the U.S.), Canada would lose some of its purchasing power and therefore its ability to procure the latest and most advanced technologies in a timely manner. This would exacerbate two perennial problems in the Canadian Armed Forces (CAF): 1) relying on aging and outdated systems and platforms that, for example, sometimes fail to communicate with our allies' kit and equipment efficiently; and 2) the cost and ability to sustain and upgrade legacy equipment.

As we have noted in a string of recent publications, Canada's growing dependence on disruptive technologies will continue as it increasingly adopts artificial intelligence, machine learning, cloud computing and other technologies into national defence. As Canada and the U.S. are working together towards NORAD modernization, these enabling technologies, all fuelled by MEs, will be central to joint defence systems, space-based capabilities, interoperability and connectivity and the increasing uses of synthetic environments. In short, MEs will enable Canada's connected battlespace (aka Joint All-Domain Command and Control (JADC2 in the U.S.)). If Canada is unable to fully contribute to NORAD's modernization as a bi-national construct, it will be pushed to the periphery from a capability, development and integration perspective. In turn, this will make the CAF a less significant military that will offer less value to strategic defence and intelligence-sharing pacts, including via NATO and the Five Eyes.

Spillover consequences for the defence industry are also likely. It is possible the attractive incentives offered by the U.S. will lure Canadian talent, including defence executives, engineers and investors to move their operations south of the border. Similarly, foreign businesses, contractors, scientists and students working in the ME space will likely choose to call the U.S., rather than Canada, their home, thus dealing a significant blow to our economy. And finally, Canada's extractive, defence and electronic industries may lack the proper policy instruments and support needed to mount a meaningful ME national strategy that would resonate with our allies. If any of these scenarios occur, Canada will be forced to surrender some of its sovereignty in exchange for increasing U.S. dependence.

## Conclusion

This article briefly outlines the history of semiconductors, the rationale behind the United States' latest decision to onshore its manufacturing, the role MEs play in the defence industry and what this all means for Canada. Although the recent U.S. legislation presents a degree of ambiguity for the Canadian economy and for national defence, it does not mean that future outcomes cannot be likewise influenced.

In many regards, the Canadian government has already started to sow the seeds for a future trilateral agreement between Canada, the U.S. and Mexico. At the January 2023 North American Leaders' Summit held in Mexico City, Prime Minister Justin Trudeau noted that "Canada has a significant role to play in the semiconductor industry. What exactly that role is, is still somewhat to be determined." It is possible Trudeau may be advocating that Canadian critical mineral companies and semiconductor foundries contribute to the U.S. chip effort – a talking point that will surely be reiterated during Biden's visit to Canada later this month.

Beyond the rhetoric, Canadian decision-makers should also consider further intertwining the two economies by incentivizing more research, development and collaboration between key Canadian and U.S. semiconductor stakeholders. Being a trusted supplier of critical minerals is certainly something significant that Canada can offer. In this area, there is a role for academia, policy and industry to coexist. Adopting a "team North America" approach to chips might be the safest way to secure a win-win-win for all.

At the same time, co-ordinating bilateral arrangements to secure an uninterrupted and unrestricted flow of critical ME technologies would provide Canada with a high degree of protection and resilience from foreign disruptions and threats working along the supply chain. Such an agreement would include domestic and international businesses – especially those working in the defence sector. While the U.S. should be top of mind, it is in Canada's interest to continue building its relationships with its European and East Asian partners who will retain an important role in the global ME ecosystem.

And finally, even while the AUKUS alliance grows stronger, Canada must continue to offer unrivalled economic, military and political value to its American partner. Above all, the relationship between the two countries is built on mutual trust. Without it, Canada's special status may one day cease to exist.

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