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Strengthening Global Supply Chains for Low-Emissions Technology: The Policy Playbook and the Trade-offs

Globalized production has risks that can have important national security implications. When individual countries dominate production in key supply-chain segments for low-emission advances, they can threaten to strategically choke off access to obtain a geopolitical advantage.There are policies for that.

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Strengthening Global Supply Chains for Low-Emissions Technology: The Policy Playbook and the Trade-offs

by Ari Van Assche

- Governments and companies are striving to lower emissions, through policies designed to encourage the adoption and manufacturing of electric vehicles, solar panels and wind turbines. Reliable supply chains are essential for that effort.
- Concerns, however, have emerged about the national security implications of the supply chains related to these emerging low-emission energy technologies. The worry is that over-concentration of production of components or critical minerals in a specific country creates a "chokepoint" where its government can control and manipulate that production activity to accomplish national strategic goals or geopolitical ambitions.
- This *Commentary* discusses these national security concerns related to low-emissions energy supply chains, and analyzes different types of public policies that governments have adopted to deal with them. It provides a playbook for policymakers and examines the downsides and unintended consequences that are related to them.
- Policies can be offensive or defensive and used in combination. The main types are: 1. *De-risking policies* that aim to reduce a country's dependence on a perceived foreign-based chokepoint; 2. *Dominance-building policies* that aim to ensure a country maintains or strengthens its control over a supply-chain stage; 3. *Onshoring policies* that aim to directly enhance the local performance of specific supply-chain stages; and 4. *Friendshoring policies*, in which governments pressure firms that operate in their jurisdiction to re-wire their global supply chains extraterritorially by cutting off ties with suppliers in chokepoint locations.
- Policymakers in Canada, as elsewhere, face a "trilemma" since it is difficult to develop policies for decarbonization that simultaneously achieve the three goals of supporting national security, promoting low-emissions energy adoption and maintaining non-discrimination between domestic and foreign firms. The author identifies trade-offs that the Canadian government needs to consider as it formulates policies related to chokepoints in low-emissions technology supply chains.

Introduction

The push toward net-zero emissions has gained considerable momentum in the past decade, with governments around the world taking actions to ensure that in the foreseeable future the amount of greenhouse gases emitted in the atmosphere does not exceed the amount removed from it. Indeed, 196 countries embraced the 2015 Paris Agreement, accounting for 98 percent of global greenhouse gas emissions. As of June 2024, 84 countries, including Canada, have incorporated net-zero emission targets into their legal or policy frameworks (Net Zero Tracker 2024). Additionally, 902 companies have included net-zero objectives in their corporate strategic plans (Net Zero Tracker 2024).

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Technological solutions like electric vehicles, wind turbines, solar panels and grid-scale stationary storage are considered central to achieving these national and corporate decarbonization goals. Electric vehicles, powered by renewable energy sources, offer a sustainable alternative to traditional internal combustion engines, significantly reducing greenhouse gas emissions. Similarly, turbines harness wind power to generate electricity, providing a renewable and abundant source of energy. Solar panels, which convert sunlight into electricity, are being widely adopted due to their efficiency and decreasing costs. Meanwhile, grid-scale stationary storage is critical for the development of a reliable low-emissions grid that can support the growing penetration rate of these emission-lowering advances.

Reflecting the criticality of these and other energy technologies in the net-zero transition, the global capacity for producing renewable electricity has risen 50 percent in 2023 compared to a year earlier (International Energy Agency 2024). By 2028, renewably electricity generation is expected to increase almost 70 percent from 2022, transforming the energy landscape and driving a global shift toward a more sustainable future.

Concerns, however, have emerged about the national security implications of the supply chains related to these emerging low-emission energy technologies. The mapping of the global supply chains of electric vehicles, solar panels and wind turbines has unveiled the dominance of several countries in key stages, leading to worries about potential geopolitical dependencies (OECD 2023). In the case of cobalt, for example, which is critical for the lithium-ion batteries used in electric vehicles, 70 percent is mined in the Democratic Republic of Congo. In the case of polysilicon, which is key for the production of solar cells, 79 percent of global capacity is in China, and half of that is concentrated in the province of Xinjiang. In these situations, there is concern that over-concentration of production in a specific country creates a "chokepoint" where its government can control and manipulate that production activity to accomplish national strategic goals or geopolitical ambitions (Farrell and Newman 2019), in the process derailing the net-zero transition.

In this *Commentary*, we discuss these national security concerns related to low-emissions energy supply chains, analyze different types of public policies that governments have adopted to deal with them and examine the downsides and unintended consequences that are related to them. We start with a discussion of chokepoints in low-emissions energy supply chains and how they matter for geopolitical power and national security. Next, we introduce a playbook for policymakers, or taxonomy of policies – both offensive and defensive – that are related to chokepoints and provide an example of each. Finally, we discuss the trade-offs that these policies generate and what the Canadian government can do to minimize the downsides.

Supply Chain Chokepoints and National Security

Like many other manufacturing industries, the production process of low-emissions energy technologies is dispersed across different countries and relies on global supply chains (OECD 2023). As shown in Table 1, a typical solar photovoltaic (PV) panel, for example, relies on critical raw materials that have been mined in Asia, the Americas and Oceania. Its components are manufactured in Asia, and it is assembled in China. The global supply chains of wind turbines and electric vehicles are equally global in scope (OECD 2023).

Policymakers generally consider globalized supply chains to be beneficial for the net-zero transition for several reasons. First, they play a crucial role in enhancing the economic viability of a product, reducing the costs of low-emissions energy solutions and, therefore, promoting the shift away

Table 1: Solar PV Panel Supply-chain, by Type and Source, 2023

Supply Chain Segment		Largest Producers
Resource Extraction*	Copper	Chile (23%), Peru (12%), Congo (11%)
	Bauxite	Australia (25%), Guiea (24%), China (23%)
	Silver	Mexico (25%), China (13%), Peru (12%)
Raw Material Processing**	Copper	China (44%), Chile (7%), Congo (7%)
	Aluminum	China (59%), Australia (14%), Brazil (7%)
	Polysilicon	China (>81%)
Component Production**	Wafer	China (53%), Japan (21%), South Korea (20%)
	Cell	China (78%), Japan (16%), South Korea (4%)
Assembly**	PV module	China (80%)

* Data from US Geological Survey used to calculate geographical concentration.

** International Energy Agency (2022).

Source: Author's compilation.

from carbon-intensive incumbent technologies.[1] Indeed, global supply chains promote a fine-grained international division of labour, which occurs at the task level rather than the industry level (Timmer et al. 2019). This international division enables countries or regions to functionally specialize in those supply-chain stages in which they have a comparative advantage, directing domestic resources to their most productive use (Grossman and Rossi-Hansberg 2008). Global supply chains can also generate dynamic efficiency gains and innovation by fostering knowledge connectedness across borders (Ambos et al. 2021). For these reasons, many scholars consider global supply chains to be an important pillar of low-emissions energy technologies' efficiency.

Second, global supply chains can in many cases strengthen the resilience of the production processes of low-emissions energy technologies (Thakur-Weigold and Miroudot 2024). A desirable feature of globalized production is that it provides companies with broad access to outside supplier options that can be used to generate what some have called "flexicurity"; that is, a combination of flexibility and security (Ossa 2023). The option to switch suppliers from one country to another, for example, has been found to reduce large corporations' exchange-rate risks (Kogut and Kulatilaka 1994), labour-cost risks (Belderbos and Zou 2007) and business-cycle risks (Chung et al. 2010).

Despite these benefits, globalized production has risks that can have important national security implications. In a context of hyper-specialization, where individual countries dominate global production in key supply-chain segments, governments can threaten to strategically choke off

1 While global supply chains have a slightly different connotation than global value chains, we use the former to depict both.

access to obtain a geopolitical advantage. Following Farrell and Newman (2019), we use the term "chokepoint" to describe this power. A chokepoint emerges in a global supply chain when a single country has a monopoly power over a supply-chain stage that cannot be easily substituted. In that case, the privileged state has coercive power since it has the capacity to deny adversaries access to the output of this value-chain stage, which can also have substantial consequences for third parties.

Several recent events demonstrate the weaponization of such chokepoints. In 2019, Japan reacted to a spat with South Korea by restricting exports of high-tech chemicals that South Korean firms needed to make semiconductors and display screens (Kim 2021). Japan's global dominance in the production of these chemicals made it difficult for South Korea to source these inputs from elsewhere, thus threatening to create severe disruptions to its semiconductor industry. Another example: in 2020, the US exploited its global dominance in advanced chip design to prohibit foreign-based companies from selling advanced semiconductors and tooling that contained specific US-origin technology or software to companies on the Department of Commerce Entities List (Luo and Van Assche 2023). This move was aimed at maintaining US dominance in the advanced semiconductor industry and limiting China's ability to develop its own capabilities in advanced semiconductor manufacturing.

There is growing evidence that chokepoints are also present in the global supply chains of low-emissions energy technologies. A small number of countries control a large share of the critical mineral reserves, processing operations and manufacturing activities that are indispensable for renewable technologies and difficult to substitute (Hayes and McCullough 2018, Goldman Sachs 2023, OECD 2023, Li et al. 2024). For example, 71 percent of cobalt used in electric vehicle batteries comes from mines in the Democratic Republic of Congo. China accounts for almost 90 percent of global rare-earth element, mine-to-metal refining, including more than 60 percent of the world's cobalt, nickel and lithium. As well, around 70 percent of battery components and battery cells are made in China.

For these reasons, there has been growing concern that the net-zero transition could be derailed due to geopolitical tensions related to chokepoints in low-emissions energy supply chains. As an illustration of these tensions, a coalition of retired senior US military officials in January 2024 expressed their concern about President Biden's electric vehicle push, warning that it will increase reliance on Chinese supply chains. In their letter, the 17 said, "This trajectory will only position the U.S. to become more reliant on China for critical raw materials and manufacturing that are necessary for the rapid expansion of EV markets this administration envisions."[2]

Similarly, the May 2023 G7 Leaders' Statement on Economic Resilience and Economic Security reflects the intention of global leaders to address chokepoints in low-emissions energy supply chains: It said: "We will address non-market policies and practices designed to reinforce dependencies and will counter economic coercion. We will continue to ensure that the clearly defined, narrow set of sensitive technologies that are crucial for national security or could threaten international peace and security are appropriately controlled, without unduly impacting broader trade in technology."[3]

Discussions, however, have been less refined when analyzing the policies that governments can use to effectively tackle these chokepoints. While pundits have swiftly expressed the need to adopt policies that can lead to diversification, decoupling and de-risking, there has been far less debate about the costs and unintended consequences that are

2 See "17 retired military officials raise alarm on Biden's electric vehicle push." Fox News. Jan. 18, 2024.

3 See "G7 Leaders' Statement on Economic Resilience and Economic Security." The White House, May 20, 2023.

related to such policies. It is important to consider these downsides as there are growing signs that policies to address supply-chain risks have helped fuel geopolitical tensions and undermine the liberal international order (Luo and Van Assche 2023). In this *Commentary*, we delve into these questions by developing a new taxonomy of public policy instruments related to chokepoints and analyzing their good, bad and ugly implications. We use our discussion to highlight the existence of a supply-chain policy trilemma and the policy implications.

Policy Taxonomy

In this section, we discuss different types of public policies that governments have adopted to deal with chokepoints in low-emissions energy supply chains. In our analysis, we recognize that governments can implement chokepoint-related policies for both offensive and defensive purposes, depending on whether they intend to control a key supply chain stage or whether they are perceived to be dependent on it.

De-risking policies: We call a defensive government measure a de-risking policy if it aims to reduce its country's dependence on a perceived foreign-based chokepoint. For example, Canada's Critical Minerals Strategy is designed in part to reduce the country's dependence on foreign-mined and foreign-processed critical raw materials by, among other things, allocating $1.5 billion to support Canadian critical minerals projects related to advanced manufacturing, processing and recycling applications.[4]

Dominance-building policies: An offensive government action, in contrast, is a dominance-building policy if its aim is to ensure that a country maintains or strengthens its control over a supply-chain stage. For example, China, the world's top miner and processor of rare earths, in December 2023 banned the export of technology to make rare earth magnets, adding it to a ban on technology to extract and separate the relevant critical raw materials.[5] This action is reminiscent of China's 2010-2012 embargo of rare earth exports that was ultimately sanctioned by the World Trade Organization (WTO).[6]

Onshoring policies: We also distinguish between chokepoint measures depending on whether they aim primarily to have a local as opposed to an extra-territorial impact. Onshoring policies are government efforts to directly enhance the local performance of specific supply-chain stages within their own geographical jurisdiction (Duranton and Venables 2021). For example, Canada and the province of Quebec have pledged billions of dollars in subsidies to Northvolt to build an electric vehicle battery plant in Quebec.[7]

Friendshoring policies: These are government efforts to pressure firms that operate in their jurisdiction to re-wire their global supply chains extraterritorially by cutting off ties with suppliers in chokepoint locations. For example, the *US Uyghur Forced Labor Prevention Act* assumes that goods made in China's Xinjiang Uyghur Autonomous Region are made with forced labour and, therefore, are blocked from being imported.[8] As a result, many solar-panel manufacturers have moved away from procuring

4 See *The Canadian Critical Minerals Strategy. – Canada.ca*

5 See "China bans export of rare earths processing tech over national security." Reuters. Dec. 22, 2023.

6 See https://www.wto.org/english/tratop_e/dispu_e/cases_e/ ds431_e.htm

7 See "Canada pledges billions to Northvolt to build Quebec EV battery plant." | Financial Post. Sept. 28, 2023.

8 Canada's recent *Fighting Against Forced Labour and Child Labour in Supply Chains Act* cannot be categorized as a friendshoring policy as it, in principle, does not target specific countries that are geopolitical rivals.

Table 2: Policies Related to Chokepoints in Low-emission Energy Supply Chains

	De-risking policy	Dominance-building policy
Onshoring policy	*EU Critical Raw Materials Act*	*China's below-market financing of solar panel production*
Friendshoring policy	*US Inflation Reduction Act*	*Cobalt mining ownership*

Source: Author's compilation.

PV modules from firms with known connections to the Xinjiang region where a significant amount of polysilicon, a key PV module component, is produced.[9]

Table 2 illustrates this new taxonomy of policies related to supply-chain chokepoints as they apply to low-emissions technologies. On the horizontal dimension, the table distinguishes between *de-risking* and *dominance-building policies*. On the vertical dimension, it distinguishes between onshoring and friendshoring policies. In the next section, we will apply the new taxonomy and showcase an example of each policy in low-emissions, energy-supply chains.

The examples of de-risking policies come from the US and the European Union (EU), as these regions have expressed national security concerns related to chokepoints in low-emissions energy supply chains. The examples of dominance-building policies come from China, as this country has become a dominant player in the supply chains of low-emissions energy technologies. Through case studies below, we discuss the logic for each of the policies and some of the critiques they have received.

Case 1: The European Union's *Critical Raw Materials Act*

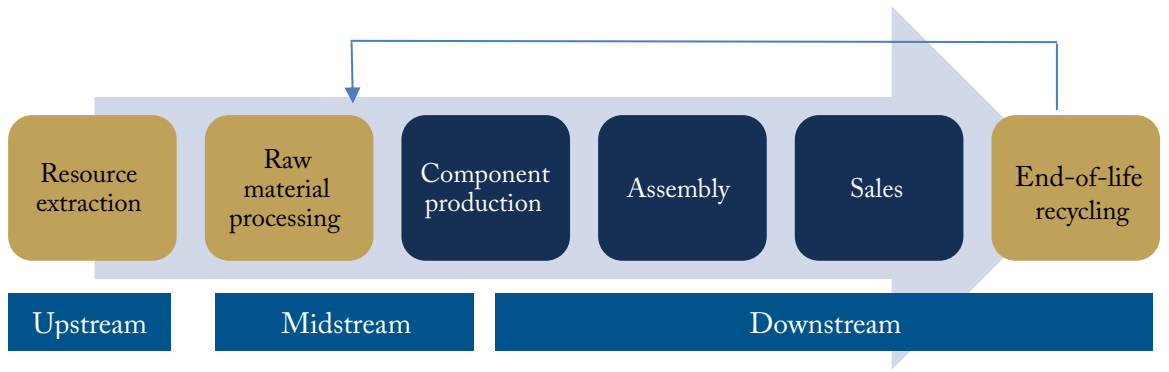
The EU's 2023 provisional agreement on the *Critical Raw Material Act* (CRMA) is an example of an onshoring policy for de-risking. The CRMA is intended to ensure the EU has a sustainable and secure supply of critical raw materials. Critical raw materials are defined as those having high economic importance along with high risk associated with their supply.[10] The CRMA list includes 34 critical materials, 17 of which are designated strategic because of their importance for achieving low emissions, the transition to digital technologies and/or global market imbalances.

For example, rare-earth metals are deemed a strategic critical material since they are heavily used in the production of magnets for wind turbines. The CRMA sets out four main sourcing targets related to the EU's annual consumption of strategic raw materials to be achieved by 2030:[11]

- 10 percent from domestic extraction (mining);
- 40 percent from domestic processing;
- 15 percent from domestic recycling; and
- 35 percent from a diversified external supply, of

9 See "*Uyghur Forced Labor Prevention Act*: What it means for the solar supply chain." Available at: solarpowerworldonline.com.
10 See Critical Raw Materials. European Commission. Available at europa.eu.
11 Ibid.

Figure 1: The EU CRMA Targets: De-risking through Onshoring at Every Stage of Low-emission Energy Supply Chains



Source: Author's compilation.

> which no single country's supply share should exceed 65 percent of any strategic raw material.

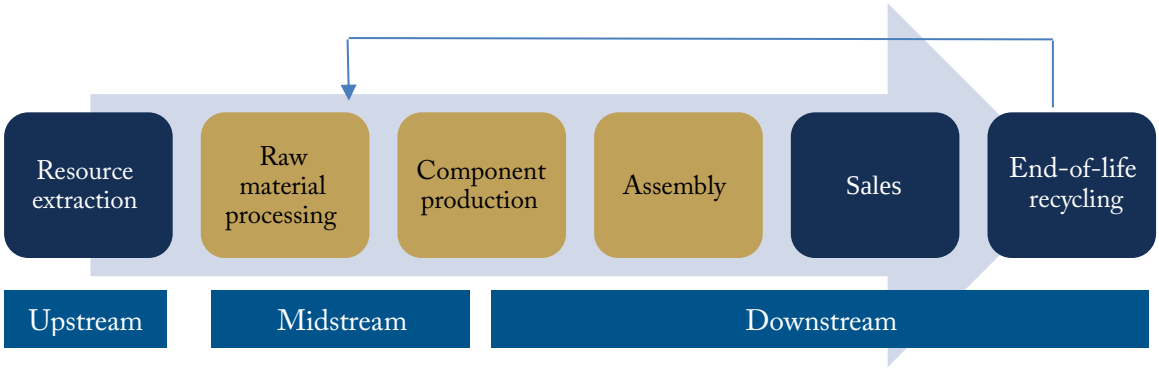
The CRMA is a *de-risking policy* as its primary aim is to reduce the EU's dependence on third countries for the critical raw materials needed to engineer its net-zero transition. We illustrate this in Figure 1 by depicting in gold the supply chain stages that the EU aims to defend, while leaving in dark blue the supply chain stages that are not targeted. Indeed, the CRMA explanatory memorandum states:

> The EU relies almost exclusively on imports for many critical raw materials. Suppliers of those imports are often highly concentrated in a small number of third countries, both at the extraction and processing stage. For example, the EU sources 97% of its magnesium in China. Heavy rare earth elements, used in permanent magnets, are exclusively refined in China. 63% of the world's cobalt, used in batteries, is extracted in the Democratic Republic of Congo, while 60% is refined in China. This concentration exposes the EU to significant supply risks. There are precedents of countries leveraging their strong position as suppliers of CRMs against buyer countries, for instance through export restrictions. (European Commission 2023.)

The CRMA is mainly an *onshoring policy*, even though it does have some friendshoring elements. Indeed, the Act's primary goals are to: (i) strengthen the EU capacity to extract and process raw materials; (ii) diversify supply chains by setting limits on the amount of raw materials that can be sourced or processed from a single country; (iii) develop new low-emissions energy technologies that are less dependent on critical raw materials that have limited and concentrated supply; and (iv) increase the supply of critical raw materials through end-of-life-recycling. In other words, the CRMA aims to increase the domestic supply of the EU's annual strategic raw material consumption by increasing local extraction, processing and recycling. The only element that relates to friendshoring is the goal of diversifying external supply so that no single country's share of any strategic raw material exceeds 65 percent.

While the CRMA's opportunities and challenges will depend on how the proposed targets are measured and implemented, the Act

Figure 2: The *US Inflation Reduction Act*: De-risking the EV Supply Chain by Friendshoring Component Production and Assembly



Source: Author's compilation.

does raise several concerns. First, to reach the domestic capacity and diversification benchmarks in critical raw materials extraction, processing and recycling, there is the concern that additional non-tariff measures will be implemented that discriminate against firms based on their ownership or nationality. In addition to concerns that the CRMA may not be compliant with WTO rules, the Act may lead to changes in trade dynamics and potential tensions between the EU and non-EU countries that dominate the extraction and processing of certain strategic raw materials.

Second, the adoption of minimum thresholds for domestic activity and potential geopolitical tensions may increase the price of critical raw materials used in low-emissions energy technologies. This may reduce market incentives for a net-zero transition by reducing the attractiveness of low-emissions energy technologies relative to their carbon-intensive counterparts, slowing down efforts to spur decarbonization.

Case 2: The *US Inflation Reduction Act* and Rules of Origin for Electric Vehicles

The US *Inflation Reduction Act*'s rules of origin for electric vehicles is a *friendshoring policy* for *de-risking*. The 2022 Act is landmark legislation that offers large tax credits of up to US$7,500 to American consumers for purchasing electric vehicles. Its goal is to subsidize buyers sufficiently so that they purchase electric vehicles instead of traditional cars with internal combustion engines, a demand-pull strategy that exists elsewhere around the globe (OECD 2023).

The Act is a defensive *de-risking policy* aimed at reducing chokepoints in raw-material processing, component production and assembly of electrical vehicle cars (see the supply chain stages in gold in Figure 2). To reduce the high US dependence on these supply chains stages from China, the Act has tightened the eligibility criteria for receiving the tax credit (Bown 2023). To qualify for it, the final

assembly of electric vehicles needs to take place in North America.

Second, the electric vehicle needs to meet critical-materials sourcing requirements. That is, it needs to meet minimum thresholds of lithium, cobalt and nickel extraction or processing in the US or a country with which the US has a free trade agreement. In 2023, this minimum threshold was 40 percent of the value of sourced materials, but this is slated to increase by 10 percentage points a year until reaching 80 percent in 2027.

Third, the electric vehicle needs to meet battery component requirements. In 2023, 50 percent of battery content needed to be produced in North America and this will increase incrementally by 10 percentage points a year until reaching 100 percent in 2028. Finally, starting in 2025, a vehicle's battery may not contain any critical raw materials sourced from a foreign entity of concern, which includes China, Russia and Iran.

The rules-of-origin details suggest that the Act is a *friendshoring policy* (even though it does include some onshoring elements). It is important to note that this is different from its original intent. While it was drafted to be an American onshoring bill, Canada and Mexico lobbied successfully to be included as partners to the Canada-US-Mexico [Free Trade] Agreement (CUSMA). Other allies then advocated successfully to further broaden the text to include other free trade agreement partners. In its final form, the Act's primary aim is not to directly benefit US-based firms in electric-vehicle supply chains. Rather, it mainly aims to reduce dependence on countries like China by incentivizing investment in the US, North America and countries with a free trade agreement with the US.

Despite its implementation, the *Inflation Reduction Act* also faces similar downsides to the EU's CRMA. First, its discriminatory nature has triggered discontent among European and Asian leaders, among others, worried that the Act will crowd out investment in their own electric vehicle sectors.[12] For example, the EU has raised concerns that the Act violates WTO rules.[13] Second, it has been widely established that the use of administrative measures such as rules of origin to reconfigure global supply chains away from cheaper suppliers increases prices (Augier et al. 2005). This, therefore, may hamper the net-zero transition by discouraging low-emissions energy adoption.

Case 3: China's Below-market Financing of Solar PV Panels

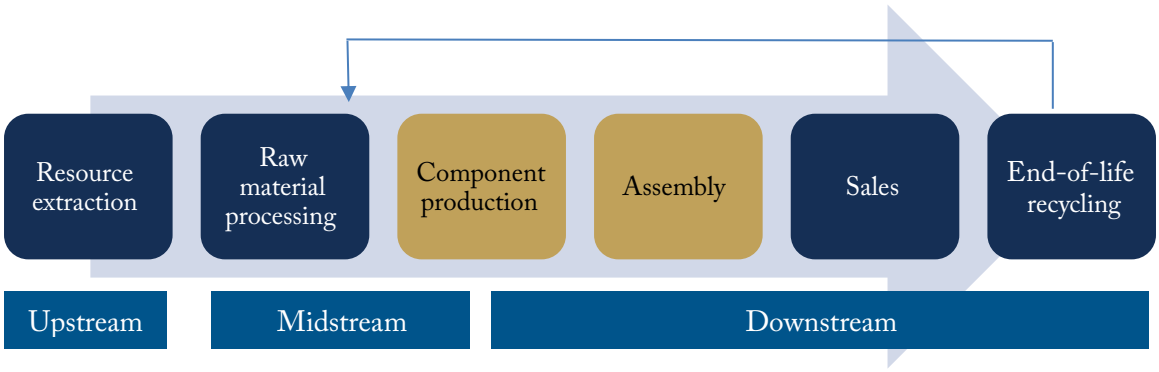
Countries that are globally competitive in a specific supply chain stage may develop proactive dominance-building policies to maintain or strengthen their control over a potential chokepoint. China's use of below-market financing in the solar PV panel industry is an example of an onshoring policy for dominance-building. This supply-side push policy takes the form of both below-market borrowings, where governments provide support through debt financing, or below-market equity; i.e., providing equity finance on terms that are inconsistent with market principles (OECD 2021). In both cases, these below-market financing tools serve to lower Chinese companies' capital costs, thus providing them with a competitive advantage in both local and global markets. Below-market financing is considered an important feature that has helped develop China's dominance in the solar PV panel sector (Lam et al. 2018).

In such situations, below-market financing can be seen as a *dominance-building policy*, as it promotes China's global dominance in the production of components and assembly of solar PV panels. In Figure 3, we have identified the supply-chain stages in which China wants to strengthen its dominance in gold. As Table 1 shows, China has developed

12 "Europe's troubled relationship with the *Inflation Reduction Act*, explained." Vox. July 23, 2023.

13 "EU Is Assessing If US Inflation Act in Breach of WTO Rules." Bloomberg. Sept. 10, 2022.

Figure 3: Below-market Financing Targets the Component Production and Assembly Stage of Solar PV Panel Supply Chains



Source: Author's compilation.

into the world's leading producer in all categories of solar component production and assembly (International Energy Agency 2022). In 2021, China's share in global production for PV modules, cells and wafers was 80 percent, 78 percent and 53 percent, respectively.

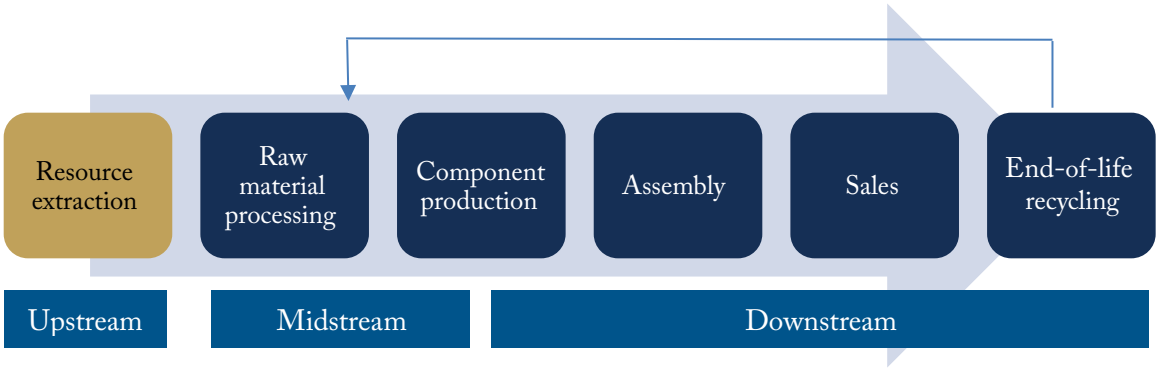
China's below-market financing of solar panel production is also an *onshoring policy*. A 2021 OECD report has shown that below-market borrowings (and not so much below-market equity) are a prevalent feature in the global solar PV industry. The Chinese government has used below-market financing to increase domestic production capacity for solar panels, thus supporting domestic self-reliance and boosting global competitiveness.

The OECD (2021) also found that below-market borrowings are correlated with two features that may help explain the large geographical concentration of midstream and downstream stages in Chinese solar PV panel supply chains. First, below-market financing is correlated with larger investments in fixed assets, which suggests that it can help solar companies expand their domestic manufacturing capacity. Second, capacity increases are negatively correlated with solar-panel prices, suggesting that they can encourage significant scale economies (see also Kavlak et al. 2018, Brandt and Wang 2019).

Meanwhile, in some respects China's below-market financing of solar panel manufacturing can be considered a boon for net-zero transition as it reduces the sticker price of solar PV panels globally. Between 2006 and 2013, state subsidies contributed to the rapid increase of China's global share of PV cell production from 14 percent to 60 percent, which went hand-in-hand with a steep drop in the global average price per watt of PV capacity. Prices have continued to fall since then, and China remains the dominant producer.

At the same time, the policy is likely in violation of the WTO Agreement on Subsidies and Countervailing Measures if it can be shown that the subsidy has caused material injury to domestic producers of similar goods. And it creates geopolitical tensions that can generate some of the de-risking countermeasures by other countries that

Figure 4: China's Growing Ownership Influence Over Global Cobalt Extraction



Source: Author's compilation.

we have discussed above, potentially increasing national security concerns and dampening low-emissions energy adoption.

Case 4: China's Growing Control of Global Cobalt Mines

China's efforts to grow its ownership influence in global cobalt mining can in some respect be seen as a pro-active *friendshoring policy for dominance-building*, even though it can also be interpreted as a *defensive de-risking policy*. In the past 25 years, China has used foreign direct investment to increase its ownership influence over global cobalt mining, especially in the Democratic Republic of Congo. China currently controls (owns or finances) 15 of the 19 cobalt-producing mines in Congo, which account for half of Congo's recent cobalt mining production. Because of this vast presence in Congo, Chinese firms own about one-quarter of global cobalt mine production (Gulley et al. 2019).

These Chinese initiatives can be seen as a pro-active *dominance-building policy* as they also strengthen China's ability to dominate the processing stage of the cobalt supply chain, a task in which it controls more than 60 percent of global capacity (OECD 2023). In Figure 4, we depict this by highlighting resource extraction in gold.

It is important to note, however, that China's actions to increase the ownership of cobalt mines in the Democratic Republic of the Congo can also be seen as a *de-risking policy* in that it aims to mitigate China's own high dependence on foreign strategic raw materials for its own energy security (Gulley et al. 2019).

While the influence of China's growing ownership influence over global cobalt mining on cobalt prices is unclear, there are several concerns related to its policies. Most noticeably, they have helped feed concerns about chokepoints in critical material supply chains, which have led to defensive de-risking policies across the globe.

Discussion and Recommendations

Our study has developed a framework and discussed several recent examples to guide our thinking about chokepoints in low-emissions energy supply

chains. We have provided a taxonomy, or playbook, of public policies, that governments have adopted related to perceived chokepoints along two dimensions. First, we have shown that governments can adopt defensive de-risking policies to mitigate over-dependence on specific countries, but that they can also adopt proactive dominance-building policies to strengthen their control over a specific supply-chain stage.

Second, we have discussed how governments can implement onshoring policies to increase domestic capacity in a supply-chain stage, but that they can also put in place friendshoring policies to replace suppliers in countries that control perceived chokepoints. For each type of policy, we have provided an example, discussed its logic and analyzed the downsides and unintended consequences.

Recommendations

Our analysis shows that policymakers face numerous trade-offs as they aim to develop secure and efficient low-emissions energy supply chains for the net-zero transition. In OECD (2021), I presented this as a policy trilemma where it is difficult for a country to develop policies for decarbonization that simultaneously achieve the three goals of supporting national security, promoting low-emissions energy adoption and maintaining non-discrimination between domestic and foreign firms (see Figure 5).

To understand this policy trilemma, consider first the trade-off between efficiency and national security. The Canadian government needs to acknowledge that efforts to develop onshore capacity or promote friendshoring can generate important cost increases that disincentivize low-emissions energy technology adoption and reduce the competitiveness of downstream firms. The Canadian government's current mulling over whether or not to impose tariffs on Chinese electric vehicle cars reflects this trade-off.[14]

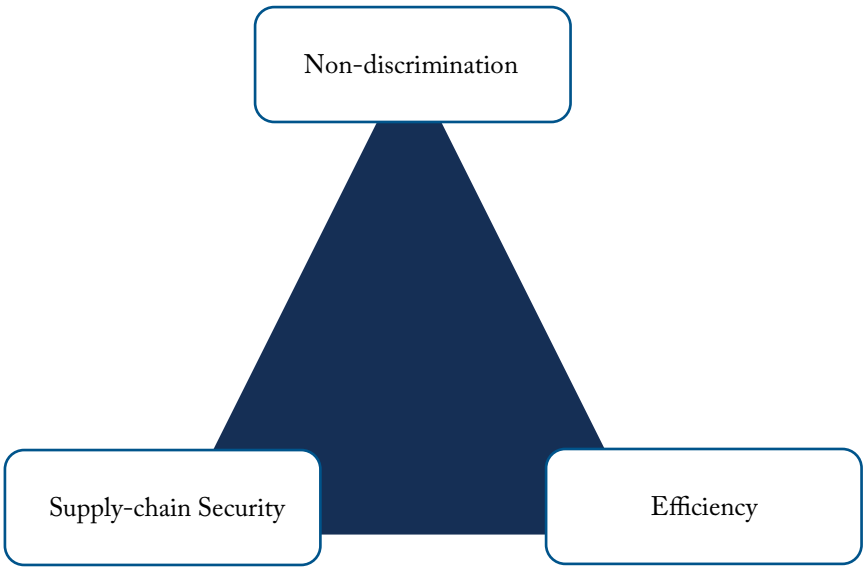
Second, governments need to consider the trade-off between non-discrimination and national security: onshoring and friendshoring policies are by design discriminatory since their ultimate goal is to reconfigure global supply chains away from countries that control potential chokepoints. As we have seen recently, discriminatory policies all too often violate WTO rules and can lead to international tensions and retaliation policies that can further endanger the efficiency and resiliency of low-emissions energy supply chains and can also generate subsidy races. Given these trade-offs, it is very difficult for a government – facing what economists call an impossible trinity – to develop policies that achieve all three goals.

The existence of the supply-chain policy trilemma raises several critical policy issues that the Canadian government should consider as it aims to address perceived chokepoints in strategic industries. First, de-risking policies have multiple harmful side effects since they reduce the economic efficiency of global supply chains, drive up geopolitical tensions and undermine global institutions. As a consequence, the Canadian government should rely only on de-risking policies sporadically and narrowly. The burden lies on Ottawa to provide concrete evidence that a chokepoint exists and that there are resulting important national security implications. This is to avoid the impression that the Canadian government might be using supply-chain policies to assert control over the sourcing strategies of private firms for their own benefit.

The Canadian government should also engage with the business community to understand better

14 See "Canada mulls Chinese EV tariff following U.S. move but is not committing to it." *The Canadian Press*. May 26, 2024. Available at https://www.thestar.com/politics/federal/canada-mulls-chinese-ev-tariff-following-u-s-move-but-is-not-committing-to-it/article_a3f97959-7d14-57ec-8866-7a7ebfddac67.html.

Figure 5: Low-emission Energy Technology Supply-chain Policy Trilemma



Source: Author's compilation.

the cost and risk implications of de-risking policies. As we have explained above, global supply chains have in many cases strengthened the resilience of production processes by providing companies with broad access to outside supplier options across the globe. The Canadian government needs to ensure that de-risking policies do not lead to an unproductive harnessing of firms' sourcing options at a cost of flexicurity.

Finally, in the limited cases where chokepoints are a real concern, the Canadian government should explore ways how to, as much as possible, avoid conflict and encourage collaboration with other countries in the development of de-risking policies. Several principles should be considered in this regard. First, friendshoring policies are generally less harmful than onshoring policies because they reduce the scope of international tensions and since they may even promote strategic cooperation.

Second, plurilateral/multilateral initiatives are generally less harmful than unilateral policy actions. Such joint initiatives may include efforts to facilitate trade in low-emissions energy supply chains, joint measures to promote R&D and end-of-life-recycling as well as joint efforts to combat unfair trade practices. They may also include plurilateral or multilateral engagements to support resource-rich countries to play bigger roles in the middle and downstream of low-emissions energy supply chains. And they can include agreements to promote social and environmental standards in low-emissions energy technology supply chains, making them both resilient and inclusive.

CONCLUSION

In this *Commentary*, we have discussed the policy community's rising national security concerns with

chokepoints in low-emissions technology supply chains. We have highlighted how these chokepoints have become a central feature in current geopolitical tensions and have discussed the importance of successfully addressing chokepoint-related concerns in our efforts to achieve a net-zero transition.

To structure our thinking of chokepoints, we have developed a taxonomy of policies along two dimensions. First, countries can develop either defensive de-risking policies to reduce their exposure to chokepoints or offensive dominance-building policies to strengthen their control over a chokepoint. Second, countries can develop either onshoring or friendshoring policies to reduce their dependence on a chokepoint. We have used examples for each type of policy combination to identify trade-offs that the Canadian government needs to consider as it formulates policies related to chokepoints in low-emissions technology supply chains.

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