DISCUSSION NOTES

MONETARY POLICY DIVISION

N°3

On the Relevance of Global Value Chains for Inflation and Monetary Policy

banco central Chile

PREFACE

The Discussion Notes (DN) seek to examine issues that are relevant for monetary policy in Chile and the world. Their goal is to present a discussion regarding the current state of the literature, highlighting the most important implications for the design of monetary policy. For that purpose, the Notes describe the different approaches set forth by frontier research, highlighting the consensus as well as debates that are still open. The DN are elaborated by economists from the Monetary Policy Division and do not necessarily reflect the official position of the Board of the Central Bank of Chile.

The third issue of the DN discusses the economic consequences of global value chains (GVC) and their growth during the last decades. It emphasizes the implications for inflation and monetary policy and the economic policy debate whose objective is to increase the resilience of GVC. The growth of GVC exposes the economy to a great variety of shocks and can therefore generate vulnerabilities, against which we must balance gains in terms of increased productivity, lower prices, and an enlarged availability of intermediate and final goods. Additionally, there are diverse factors that in the future may influence the configuration of GVC and international trade. In addition to the example of the experience during the Covid-19 pandemic, some of these factors are climate change and different geopolitical processes. Based on these elements, the DN elaborates on the discussion regarding the potential role of economic policy, whose objective is to increase the resilience of economies against disruptions in GVC, with special attention to small-open-economies as is the case of Chile.

This Discussion Note was written by Gent Bajraj, Federico Huneeus and Bernabe Lopez-Martin. The authors are especially thankful for their contributions, comments, and suggestions to Elias Albagli, Sofia Bauducco, Miguel Fuentes, Mariana Garcia, Juan Guerra, Enrique Orellana, and Juan Marcos Wlasiuk, and for the translation and edition work to Maria Consuelo Edwards. The authors are also thankful to the Board and the staff of the Monetary Policy Division of the Central Bank of Chile, for their comments during internal presentations.

CONTENTS

1. INTRODUCTION

In recent decades, global value chains (GVC) have expanded considerably across the globe, changing the organization of production, increasing the complexity of production networks across countries, and pushing international trade to unprecedented levels. This process had significant economic consequences including declines in prices of intermediate inputs of production as well as final goods, improvements in productivity, and increased availability of products in general. Simultaneously, there are important implications in terms of the synchronization of the business cycle and inflation across economies. These developments and the trends in exposure to GVC are important for monetary policy, both for their immediate effects on prices and the international transmission of shocks, as for their consequences for the transmission channels of monetary policy.

Lately, it has become evident that GVC can generate vulnerabilities and exposure to a wide variety of shocks, with sources ranging from climate change and extreme weather conditions to geopolitical conflicts, cyberattacks, trade disputes, and pandemics, among many others. Disruptions in GVC have incited an international debate regarding the desirability of implementing policies aimed at reducing exposure to GVC or increasing their resilience. The trade-offs in this discussion balance gains in efficiency of complex and just-in-time value chains while keeping dependency between countries contained. This debate is taking place in a global context in which protectionist ideas appear to be spreading. Given the current relevance of GVC in international trade flows, it is also a debate about trade openness more broadly. The importance of this debate depends, in part, on the persistence of the shocks that have initiated it, such as the pandemic and geopolitical conflicts, and new shocks that may arise in the future.

An important question in this context is whether there is room for economic policy to increase resilience to GVC disruptions. It is open to debate whether firms have the appropriate incentives to invest in supply-chain resilience, although there is clear evidence that private sector actors largely internalize the costs that disruptions represent for their operations. Research suggests that reducing the exposure to GVC would not make countries more resilient to a shock such as the Covid-19 pandemic but would instead concentrate risk on the domestic economy. More generally, the relationship between the importance of GVC and volatility is ambiguous in theory and non-significant empirically. Therefore, the potential benefits of reducing exposure to GVC are unclear at best.[1] In contrast, the potential costs in terms of productivity and welfare that would result from increasing trade costs and barriers, are significant and well substantiated. Resilience in GVC can be enhanced, among many other actions, with greater diversification and substitutability, efforts that to a large extent will be undertaken by firms. This still leaves room for the government, which can promote investment in trade and digital infrastructure, improving information gaps in supply chains, further reducing trade costs, and minimizing policy uncertainty (see e.g., IMF WEO, 2022).

1/ One caveat to consider is that this discussion centers on broad-based policies, while sensitive sectors such as medical supplies and instruments may warrant special considerations.

How much of the policy debate surrounding GVC reconfiguration is relevant for a small, open and emerging economy such as Chile. Many ingredients of this debate such as onshoring or even nearshoring are probably more relevant for countries that have the sufficient scale to implement these strategies, like the U.S. or the European Union, as shown by Freund *et al*. (2021). Implementing an onshoring strategy requires to have the sufficient expertise, capital deepening and market thickness so that it is not too costly. These characteristics are usually met by large countries. Nevertheless, there are still other policy ingredients that are relevant for small, open, and emerging economies. It might be optimal for governments to subsidize resilience strategies, that is, helping firms to diversify their input sourcing strategies.

Moreover, if the world economy shifts into an equilibrium where there are massive reconfiguration efforts carried out by many countries and multinational firms, then reconfiguring the GVC of firms in small, open and emerging economies might be very difficult. The market for search and matching will potentially be congested and prioritized for multinationals and developed countries. In such a scenario, at least until multinationals and developed economies finish reconfiguring their GVC, it might be optimal to implement subsidies for search and matching that help firms in both their input strategies and export promotion strategies.

Going forward, extreme weather events related to climate change, and policies substantiated on environmental and climate change concerns, as well as geopolitical processes are some of the main factors that could influence the configuration of GVC, while the evolution of the Covid-19 pandemic suggests that pandemics in general cannot be discarded. International events in recent years have shown that geopolitical considerations have immense consequences for international trade and suggest that, in the near future, economic policy based on geopolitical factors may diverge considerably from that based on economic arguments and welfare. These different types of events should be closely monitored given their impact on the economy and the conduct of monetary policy.

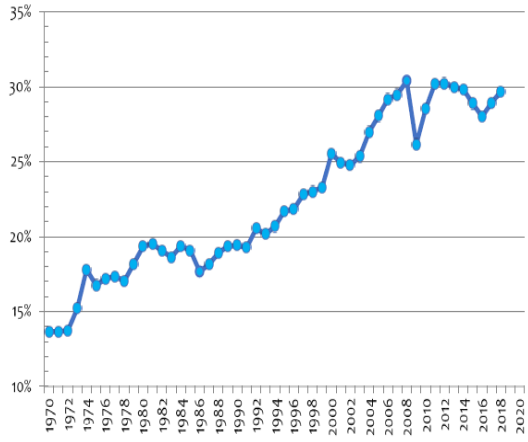
The rest of this discussion note is structured as follows. Section 2 briefly describes the evolution of GVC and international trade from a historical perspective. Section 3 discusses the impact of the growth of GVC on the behavior of prices and economic activities. In Section 4 we provide an overview of the nature of GVC disruptions and their consequences. Section 5 presents the debate on whether economic policy should be applied to improve GVC resilience or the diversification of risk. Finally, we conclude this discussion note in Section 6.

2. GLOBAL VALUE CHAINS (GVC) AND INTERNATIONAL TRADE FROM A HISTORICAL PERSPECTIVE

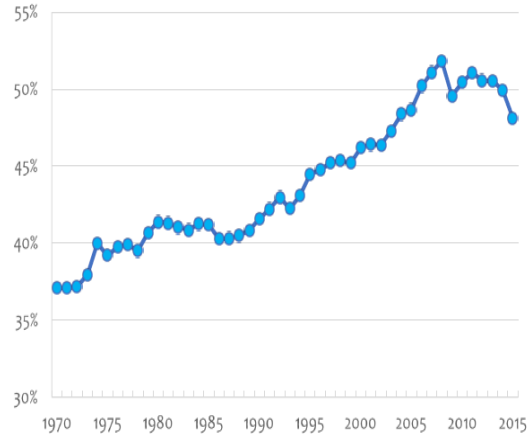
International trade has experienced a large expansion in the last half of a century. As shown in the Figure 1, world imports plus world exports relative to world GDP have grown from around 15% in 1970 to around 30% in 2020. The largest part of this expansion occurred between 1985 and 2008. This expansion of international trade has not been the same for intermediate goods and final goods. The share of GVC trade relative to world trade has grown from 37% in 1970 to around 50% in 2015. Again, the largest share of this expansion of GVC trade happened between 1985 and 2008.

FIGURE 1 WORLD TRADE AND GVC: 1970 - 2018

A. World Trade/World GDP (%)



B. GCV Trade/World Trade (%)



Sources: (a) World Bank´s World Development Indicators; (b) Borin y Mancini (2019), as reported in "World Development Report" (2020). Figure taken from Antras (2021).

What is different between GVC trade and non-GVC trade? GVC trade involves trade of intermediate goods that are used to produce final goods. Furthermore, the production of inputs can be sliced into different parts across countries. These are types of goods that can be produced in value chains that involve different countries and thus imply that, for a given final good, the value chain necessary to produce it can cross borders between countries several times. This difference between the trade of final goods and intermediate goods is crucial given that trade is measured in terms of gross flows, rather than net flows such as value added. Take for example the case of a copper wire. The raw copper can be produced in Chile and exported to China. In China, the copper can be processed into a wire and exported again back to Chile.

The value added to the copper is probably not significant, but since trade is measured in terms of gross flows, the export flow from China to Chile of the copper wire will also include the value of the exported copper from Chile to China. This example can be carried over to much more complex goods such as cellphones and airplanes, which would amplify even further this process. That is, if goods flow between countries more times given global value chains, that means that international trade will almost mechanically increase if GVC chains become more relevant because a given input will be counted several times as it crosses the border in the different steps of the chain.

This is the fundamental reason of why GVC trade is different to non-GVC trade. A corollary of this idea is that now, trade barriers between countries, such as tariffs, can have a much larger effect because a given change of these barriers will impact a given good many more times as the good crosses borders many times before reaching the final customer. This is the fundamental idea in the paper by Yi (2003), that can reconcile why a given reduction in international tariffs has had a much larger effect on international trade flows.

For GVC trade to be increasing over time, a given final good needs to have a production chain behind it crossing borders many more times than before. That is, production must be increasingly disintegrated across borders. Why has this been happening? There are several reasons behind the increase of supply chains crossing borders more times before reaching final customers. As outlined in Baldwin and Freeman (2022) and Antras (2021), there are four main reasons. First, there has been a strong technological change in information and communications (ICT). Computers, internet, and the services that surround them have become cheaper, more efficient, and more global. This has expanded the capability of producing and coordinating production in different places, and even different countries. If the headquarters of a firm is in London, it is cheaper to coordinate production of a particular input in China, relative to a century ago. Second, the costs of transport have declined both in terms of prices of airlines, ships, and land cargo. This has allowed for trade to be more dispersed across regions and countries, including value chains. Third, there were geopolitical changes and increased openness of international trade.

This is a consequence of the role of international organizations set up after World War II (WWII), which pushed towards a framework for free trade with multilateral negotiations of lowering trade barriers. This was possible due to political agreements made after the specific context of WWII but also due to political alignment on the idea that international trade is beneficial. Finally, there is the political factor that promoted a "capitalist labor force." This idea is related to the fact that, from the perspective of advanced economies, it became politically viable to have more people involved in international trade and participating in the globalization process.

This factor was pushed by the fall of communism in Eastern Europe and the gradual increase of market economy practices in East and Southeast Asia. The expansion of the capacity to trade led to the expansion also of available labor for production. Offshoring tasks and producing inputs in other countries to take advantage of lower labor costs was highlighted as something beneficial and another reason for the expansion of trade. These reasons interacted with each other and, to some extent, were also complementary. For example, the political support for offshoring was possible because the costs of coordinating offshoring were declining given the ICT technology change.

Nevertheless, as pointed out previously, the expansion of both international trade and GVC trade has stalled since the Great Recession in 2008.[2] This can either be coined as a moment of de-globalization or slow-balization as the expansion of trade between 1985 and 2008 was probably not sustainable. In either case, there are structural and cyclical reasons behind the pause in the expansion of international trade. First, economic dynamism has been declining for several decades but this was amplified after the Great Recession, which led to a reduction of the dynamism of international trade. Second, the fall in global trade intensity in the past ten years also reflects China's decline in trade intensity. This, in turn, is the result of (a) China consuming more of what it produces while exporting less, and (b) its substitution of global supply chains with domestic ones. This phenomenon might continue as India and other low-income countries develop domestic consumers and supplier industries (Lund, 2020). Third, there are geopolitical shifts in the attitude towards international trade, driven by trade itself. Expansion of trade has contributed to increased polarization (Autor et al, 2020). Furthermore, constituents have become more negative in terms of willingness to support free trade and weight more the costs and unequal distributional benefits of trade (Stantcheva, 2022).

The process of polarization started to become more relevant after 2008 and was expressed in three different dimensions. First, the multilateral liberalization agenda under the umbrella of the World Trade Organization (WTO) lost strength. Second, the process of regional liberalization has been stalled to some extent (and even shows signs of retreat as was seen with Brexit). Finally, political support for the return to protectionism increased during the trade dispute between the U.S. and China. This change in attitude towards international trade will probably continue to increase as trade-induced inequality will continue to grow with the expansion of automation and digital technologies. Thus, it seems to be that the biggest threat to the expansion of trade is political and institutional rather than technological, although some of the technological changes could induce more inequality and may worsen the political factors behind deglobalization. Nevertheless, given the larger relevance of GVC trade, political barriers to trade can have a bigger effect on international trade (as aforementioned and suggested by Yi, 2003). We will come back later to the role of geopolitical changes in shaping GVC trade after the pandemic.

In terms of the effects of new technologies such as 3D printing, it is still unclear as to how they will affect trade. Some argue that the possibility of printing goods locally will shorten global supply chains, and diminish international trade. Formal evidence is scarce but recent examples show that trade could, in fact, increase (Freund *et al.*, 2022); this would be in line with previous episodes of improvements in which technology led to reductions in production costs and enhanced product quality. This is particularly the case for products that require large investments in technology and machinery, and the presence of highly specialized inputs and services.

2/ See also M. Marcel (BIS Bimonthly Meeting, 2020).

3. THE IMPACT OF THE GROWTH OF GVC ON PRICES AND ECONOMIC ACTIVITY

The literature has identified several effects of the growth of GVC during the last few decades on macroeconomic variables. In this section, we describe these effects along with the main channels and mechanisms through which they operate, highlighting some of the quantitative results found in the literature.

3.1 Prices

As GVC have risen, several economies across the world have experienced an increase in the share of imports from low wage countries. This has resulted in a downward pressure on prices due to higher competition[3] and an increased variety of products, as documented extensively. For example, Bai and Stumpner (2019) estimate that, during 2004-2015, Chinese imports led to a 0.19 percentage point annual reduction in the price index for consumer tradables in the U.S. They attribute two-thirds of the effect to lower inflation on existing goods with the rest of the effect due to the introduction of new goods and disappearance of old goods. Similarly, for the case of Chile, Prades (2021) and Peña and Prades (2022) find significant effects on domestic consumer prices, as a result of deflationary pressures due to imports from low-wage countries. There is a vast body of literature with similar findings for a number of countries.[4]

The results in the literature should be interpreted with caution. First, they are partial equilibrium analysis: in the absence of this downward pressure on prices, monetary policy would have reacted differently to manage inflation. Moreover, due to the size of the shock and availability of data, the studies have focused on the impact of Chinese imports. However, the growth of imports from low wage countries began earlier (see Section 2). Finally, due to the partial equilibrium nature of these exercises, quantifying the effect on non-tradables is not straightforward.

3.2 Productivity

The growth of GVC has also had an impact on productivity, in particular, by the development of just-in-time production processes that promoted efficiency above resilience. Using data for 40 countries, Constantinescu *et al.* (2019) estimate that an increase by 10% in the level of GVC participation increases average productivity by 1.6%. Criscuolo and Timmis (2017) survey the literature and identify four main channels through which participation in GVC stimulates productivity: (i) firms specialize in their most productive activities while outsourcing their least productive ones (see Amiti and Wei, 2009; Grossman and Rossi-Hansberg, 2008; Schwörer, 2013; and Winkler, 2010); (ii) firms benefit from access to a larger variety of cheaper, higher quality and higher technology inputs[5]; (iii) knowledge spillovers due to interaction with frontier foreign firms (see Buera and Oberfield, 2012); and (iv) growth of more productive firms through leveraging scale economies and exit of the least productive firms due to competition from foreign firms.

3/ See Guerrieri *et al.* (2010) for a model in which foreign competition plays an important role in accounting for the behavior of inflation.

4/ See, for example, Amiti *et al.* (2018), Auer and Fischer (2010), Jaravel and Sager (2019) and de Soyres and Franco (2020) for the U.S.; Auer, Degen and Fischer (2013), Auer, Fischer and Kropf (2012), Bugamelli et al (2015) and Carluccio *et al.* (2018) for several European countries; and Andrews *et al.* (2018) for several OECD countries.

5/ For instance, using Indonesian data, Amiti and Konings (2007) estimate that a fall of 10 percentage points in input tariffs leads to a 12% productivity gain for firms that import their inputs.

3.3 Synchronization of Economic Activity and Prices, Implications for Monetary Policy

The higher the usage of inputs from one country for production in another country, the stronger is the link between economic activity in the two countries. Hence, the greater synchronization of economic activity and inflation across countries in recent decades has been, in part, attributed to the rise of GVC. For instance, di Giovanni *et al.* (2018) estimate that without direct linkages of domestic and foreign firms, the average correlation between France and their sample of partner countries would fall by one-third of the observed average correlation. Similarly, Auer *et al.* (2019) estimate that half of the global component of PPI inflation is accounted for by international input-output linkages. Moreover, they argue that PPI co-movement is amplified by input-output linkages which propagate sectoral shocks.[6]

This has implications for monetary policy. It can affect the trade-offs faced by central banks when managing inflation. For example, Auer *et al.* (2017) and Andrews *et al.* (2018) find evidence that as GVC expand, domestic inflation becomes more sensitive to the global output gap, although this is disputed by previous work by Ihrig *et al.* (2010). Relatedly, Bems *et al.* (2018) find that external factors play a considerably smaller role than domestic ones. Kohlscheen and Moessner (2022) show cross-country evidence that as the level of import penetration from a group of emerging market economies increases, the pass-through from domestic labor cost changes to core CPI inflation collapses.

Theoretical work exploring the role of production networks in general is relatively recent and, in the case of GVC, particularly scarce. In a closed-economy framework, Rubbo (2022) finds that a larger use of intermediate outputs in production networks flattens the Phillips curve. In her framework, a positive demand shock, given price rigidities, is only partially transmitted along the production chain. To the extent that price rigidities can be replaced by price setters in the network that fall outside of the orbit of domestic shocks, the same mechanism could induce a flattening of the Phillips curve. Pasten *et al.* (2020, 2021) emphasize the importance of sector heterogeneity (specially in terms of price stickiness, but also in terms of their size and industrial organization structure) in determining the real effects of nominal shocks. Exposure to GVC could add another important dimension of heterogeneity across sectors. Finally, Wei and Xie (2020) argue that as the production chain becomes longer, targeting PPI inflation increases welfare relative to targeting CPI inflation alone. These results suggest that GVC could be important for our understanding of monetary policy and its transmission mechanisms.

6/ See also Auer and Mehrotra (2014), de Soyres and Franco (2020) and de Soyres and Gaillard (2019). For a more in-depth view of the implications of GVC for a broader set of macroeconomics phenomena, see Chapter 4 of World Bank (2020).

4. THE NATURE OF GVC DISRUPTIONS AND THEIR CONSEQUENCES

The previous section described important channels through which GVC have made positive contributions to the economy in the long run. Nevertheless, different events in recent years (such as Brexit, the Covid-19 pandemic, the trade war between China and the U.S., the war between Russia and Ukraine and related bans and sanctions, among many others) have made evident the vulnerability of GVC to the risks of disruptions. In this section we discuss selected lessons derived from research analyzing some of these events that are present in the policy debates that we consider in the next section, as well as for monetary policy.[7] Additionally, we discuss the possibility that a reconfiguration of GVC will take place in the short run.

4.1. Some Lessons from GVC Disruptions and the Covid-19 Pandemic

Disruptions in GVC may be caused by a wide variety of factors: natural disasters, labor conflicts, geopolitical or political events, industrial accidents, cyber-attacks, etc. (see Baldwin and Freeman, 2022). Some of these events affect production firms directly or through the transportation of their goods, some are idiosyncratic to the firm while others are systemic in their spread. Firms and GVC are also exposed to demand shocks that range from macroeconomic crises, exchange rate volatility, financial stress, etc.[8] This diversity implies important challenges for firms connected by GVC, as well as for the design of economic policy given that the different types of disruptions vary significantly in their nature in terms of frequency, persistency, intensity, and geographical and sectorial extent, among other dimensions. Additionally, one important aspect along which the nature of GVC disruptions vary is their domestic or external origin. This plays a central role in the policy debate evaluating actions aiming at the reduction in exposition to GVC or their reconfiguration. In the proximate future, geopolitics and climate change will represent important sources for GVC disruptions.

Given the magnitude, extent, and persistence of the shock implied by the Covid-19 pandemic, it provides an important example for the policy debate. It is not possible to categorize this event in a stylized manner as a supply or demand shock since it represented a combination of different sectorial shocks in supply and demand, of different magnitude, that propagated within and across countries through production networks (di Giovanni *et al.*, 2022; Jiang *et al.*, 2022). Some sectors were strongly affected by supply restrictions while others were slack and reduced the number of workers and excess capacity due to lack of demand (Baqaee and Farhi, 2022). This divergence is important for economic policy given that negative demand shocks are deflationary while negative supply shocks imply stagflation.

Thus, different sectors will respond very different to policy: policies that intend to boost demand will exacerbate problems of inadequate supply and inflation in some sectors, while policies that boost supply have little impact in sectors where demand is constrained. It is reasonable then to consider that the effectiveness of monetary policy, an untargeted aggregate demand stimulus, could be moderated

7/ The academic literature has studied many other sources of disruptions, such as earthquakes and other natural disasters which, due to their exogenous nature, can be exploited as a source of identification to quantify the propagation of shocks through input-output linkages (e.g., Barrot and Sauvagnat, 2016; Carvalho *et al.*, 2021). Given the diversity in terms of sources of disruptions, it is not possible to cover all of them in this note, we select those that have provided important conclusions in terms of economic policy or have become central in recent policy debates.

8/ McKinsey (2020b) estimates that, on average, firms can expect to lose 45 percent of one year's profit over the course of a decade, where the most affected industries would be Aerospace and Automotive while Pharmaceuticals and Food and Beverage would be the least affected ones.

in this context (Baqaee and Farhi, 2022). The beginning of the recovery phase presented additional challenges. The pressure on GVC and prices mounted with the reorientation of demand towards goods and the improvement in demand that was in part attributed to the different stimulus policies that were implemented during the pandemic. At the same time, supply disruptions were not yet dissipated in production networks (see di Giovanni *et al.*, 2022; Santacreu and LaBelle, 2022).

An important issue for the policy debate is to understand the contribution of GVC in the context of the disruptions during the pandemic. It is an open question whether the renationalization of supply chains could make an economy more resilient to this type of shocks. In this direction, Bonadio *et al.* (2020) construct an international model of global supply chains and carry out different counterfactual exercises that provide several important lessons. First, they find that the average drop in GDP generated by lockdown measures would have been larger in a world without trade in inputs and final goods. The explanation is that eliminating international trade concentrates reliance on domestic inputs which were subject to disruptions due to domestic lockdowns. Second, there is heterogeneity across countries, which is explained by the severity of their lockdown policies during the pandemic. Intuitively, countries where lockdown policies were most severe benefit relatively more with the access to foreign products. Finally, even if the renationalization of all supply chains is not beneficial on average, they analyze whether doing so in specific sectors could improve resilience. They find that there is no sector in which supply chain renationalization notably improves resilience.

The trade war between China and the U.S. provides another informative example given the magnitude of the shock. This case is analyzed by Fajgelbaum and Khandelwal (2021), who document that by the late 2019, the U.S. had imposed tariffs on approximately US$ 350 billion of imports from China, while China had retaliated on US$ 100 billion exports from the U.S. An important conclusion from this research is that U.S. consumers of imported goods have borne the brunt of the tariffs through higher prices, and that the trade war has lowered aggregate real income in both the U.S. and China.[9] Another example of a politically driven disruption is given by Brexit. Broadbent *et al.* (2022) estimate that, in the long run, the GDP of U.K. will be 3.6% lower than in a no-Brexit counterfactual, given declines in productivity.

Climate change represents another central element that will shape the development and reconfiguration of GVC in the future. First, there are direct risks generated by climate change and the associated natural disasters through disruptions that affect the production and transportation of goods. Second, transportation necessary for international trade generates carbon emissions that could in turn motivate the application of new taxes and tariffs on trade aimed at reducing the impact of transportation on the environment (Dasgupta, 2021). Third, international trade in general implies the exchange of goods across countries that do not fully internalize environmental externalities generated by their production. We further explore these issues in the Box below.

9/ This work discusses the range of estimates of the pass-through of changes in tariffs to prices. This is central to the discussion because it determines the welfare losses generated by the trade war.

Box 1: Global Value Chains, Climate Change, and Biodiversity

The production of goods and their transportation give rise to different externalities because property rights related to the biosphere are either weakly defined or inadequately enforced (Dasgupta, 2021).[10] To the extent that prices of goods and their transportation do not consider these externalities, they will reduce the benefits of globalization but will also give grounds for policies that will influence the configuration of GVC.

There is a great number of examples of harmful externalities that are a direct cause of biodiversity loss. Consider a simple example examined by Dasgupta (2021): an upstream logging company exports its timber to a foreign destination. The company's private cost does not include the cost borne by inhabitants downstream, who will be subject to greater risk from floods. This is a textbook example of an externality, given the absence of property rights for downstream inhabitants who are not compensated for the damage they experience, in addition to the cost inflicted on the world's population via the carbon emissions. Additionally, this situation implies two transfers of wealth, one from the downstream inhabitants to the importer, another one from the world's population to the timber company. Many less developed economies depend on exports of primary products (coffee, tea, sugar, timber, etc.) which imply a transfer of wealth from these countries to developed economies that import these goods. The example and the discussion show how goods are underpriced and therefore provide incentives to consume more than what is optimal, particularly when considering ecologically damaging goods.

A central issue is that of carbon emissions generated by the transportation of goods. According to the Environmental Protection Agency, in the U.S. transportation represents 27% of greenhouse gas emissions, the largest sector in this regard, and above electricity generation (25%) and industry (24%). In turn, the shipping industry is responsible for around 940 million tons of CO2 annually, which represents at least 2.5% of total world CO2 emissions (United Kingdom Research and Innovation, UKRI). Externalities, including those represented by carbon emissions, are textbook examples that justify policy intervention, when property rights cannot be clearly defined and enforced. Different policies, including taxes (for example, on emissions generated by international trade), tariffs and non-tariff barriers, and policies aiming at the substitution of certain goods (especially those that are ecologically most damaging), are potentially a factor that will have an impact on the configuration of international trade and GVC in the future.

In addition to policies, climate change itself directly imposes a variety of risks faced by firms that affect production of goods and their transportation. Although an exhaustive characterization of these risks is obviously outside the scope of this Box, several useful examples provide an appreciation of their importance (for more details see McKinsey, 2020a; Dasgupta, 2021; IPCC, 2022).

10/ This first part of this Box briefly discusses the implications of production and transportation, and human activities in general, for the environment, based to a large extent on Dasgupta (2021) (Chapters 7 and 17, and Boxes 7.1 and 13.5). The second part of this Box provides a very brief overview and examples of different disruptions that are generated by climate change and is based on IPCC report on Climate Change UN (2022) and McKinsey (2020a).

A specific example is given by rare earths, which are critical in industries in general based on electronics (including aerospace and defense, electric vehicles, drones, medical appliances, etc.). This is a case describing the vulnerability of GVC that are based on highly specialized commodities. The production of rare earths is highly concentrated geographically. It is estimated that for the year 2030 an increased likelihood of extreme rainfall, which is sufficient to trigger mine and road closures, will doble in southeastern China, which could potentially reduce global production by 20 percent in a disaster year. Thailand suffered the worst flooding in 50 years in 2011[11], which lasted between 30 and 60 days in different regions and resulted in losses totaling US$ 40 to 50 billion. The episode reduced industrial output by 50 percent and severely disrupted global electronics, automotive and food supply chains. This type of events could become more frequent: it is expected that extreme weather events and sea level rise will affect coastal and low elevation cities that represent over 11% of the global population, potentially increasing to beyond 1 billion people by 2050. These areas are key for transportation, production, innovation and GVC in general.

Countries with high hurricane hazard contributed to approximately 45 percent of global value of traded goods in recent years. Countries like Taiwan and Japan, for example could see the risk of a disruptive hurricane increase from 1 percent per annum to 2 percent by the year 2040. This is particularly sensitive for semiconductor manufacturing hubs in this region. Droughts, in addition to floods, also generate impacts on supply chains across the world, which have directly affected transportation in waterways such as the Danube (affecting Germany's production of chemicals and pharmaceuticals), the Panama Canal, and the Mississippi River (the latter affected by both droughts and floods). Agriculture and fishing represent two additional sectors that will be vulnerable to climate change in coming years and are vital given the welfare costs that are generated by disruptions to these industries.

There is a variety of actions and strategies that participants in global supply chains can carry out to adapt to these developments and to increase resiliency against these risks, including contingency plan agreements with suppliers, increases in inventories, diversification of sources of intermediate inputs, investment in infrastructure to protect supply chain assets, and the allocation of risk by using financial and contractual mechanisms, among many others. However, these actions do not fully eliminate risks generated by climate change, they are costly, and will still influence the configuration of GVC in the future.

11/ Studies do not suggest a link between the Thai floods in 2011 to climate change, but these events are expected to become more frequent, and show how extreme weather can affect supply chains.

4.2. Reconfiguration of GVC

An important question is whether the recent disruptions in GVC will lead to significant changes in the geography of worldwide production networks. Surveys show that executives are expecting changes.[12] However, because firms incur large costs when they implement their global sourcing strategies, their location decisions tend to be sticky. Hence, even in the case of an affirmative answer, it may be too soon for this process to be reflected in the data.

Antras (2020) argues that the bulk of the collapse in trade in the early phases of the pandemic was in the intensive rather than the extensive margin. Given the large sunk costs incurred by firms, to the extent that economic agents perceive COVID-19 as a temporary shock, a major reconfiguration of GVC is unlikely. Moreover, while the author acknowledges that the pace of globalization has slowed down relative to recent decades, he argues that the slowdown is a natural process as the growth explosions in trade openness experienced during 1986-2008 were unsustainable. In any case, recent evidence suggests that, rather than reshoring, nearshoring or friend-shoring, firms adjust to large disruption effects by shifting sourcing strategies towards developed economies, to take advantage of scale (Freund *et al.*, 2020).

On the other hand, there are other factors which could push towards a reconfiguration of GVC. Countries could decide to sever ties for political factors. The geopolitical factors behind potential reconfiguration of global supply chains have gained momentum given the war that Russia has waged against Ukraine. This conflict has the potential of making multinationals and countries rethink their sourcing and selling strategies, thus conditioning more their economic ties with other countries by weighting in more the political context that underlies those ties. The trade war between China and the U.S. is another recent example for the geopolitical dimension as key in terms of reconfiguration of global supply chains. Countries and multinationals could implement strategies of friend-shoring, that is, focus on economic ties for sourcing inputs from countries in which there are good political relationships.

Nevertheless, there are arguments in the opposite direction as pointed out by Kleinman *et al.* (2020). The authors argue that as a country becomes more economically dependent on its trade partner, it realigns politically towards that trade partner. This view resonates with the strategy of expansion of globalization in the postwar period with the creation of General Agreement on Tariffs and Trade (GATT) and then the WTO. The limitation of this argument is that, in a deeply interconnected global economy, one needs multilateral institutions that can help in transitioning from strong bilateral economic relationships to strong political relationships. And, as has been observed, the multilateral system of international institutions is going through a major reevaluation and transformation. Thus, the capacity of these institutions to continue to expand economic and political integration is limited unless they are successful in their transformation process. Additionally, as demonstrated by recent events discussed in this section, trade does not always preclude conflicts, which may lead to economic policy based on geopolitical factors that diverges considerably from that based on economic logic and welfare considerations.

12/ A survey shows that 22% of 1,181 executives of firms based in the U.S., U.K., France, Germany, and Italy are considering moving production sites in the medium and long term (Dib and Azouz, 2020).

Finally, another factor that could lead to a reconfiguration of GVC is that governments could choose to impose regulations to correct for environment related externalities (see the discussion in the Box above). But this process is challenging, it involves a political agreement within countries that is not easy to achieve given the distributional impacts of such regulations. Additionally, as mentioned previously, it requires strong multilateral institutions to align incentives and facilitate agreements. Nevertheless, the urgency of environmental problems might be a reason to force countries to agree on international regulations and bring a new momentum for multilateral alignment.

For a country such as Chile, the role of environmental and geopolitical forces in affecting GVC strategies of firms and the government do not work in the same way. On one hand, given the comparative advantage of Chile in natural resources and renewable energy sources, environmental concerns could be a source of some specific opportunities. If countries start to demand cleaner energies, countries such as Chile might benefit if they implement successful strategies for promoting exports of green hydrogen, for example. Other developed countries and multinationals might reconfigure their GVC, in part towards Chile, to take advantage of this opportunity. In contrast, geopolitical factors do not represent an opportunity for a country such as Chile. Quite the opposite, international political conflicts between trade partners of Chile would probably hurt the economy negatively without much option for responding in the short term. Thus, it seems that environmental factors might benefit countries with the comparative advantages that Chile has, in some dimensions, whereas geopolitical factors would probably hurt such a country.

There is another area where potentially a country such as Chile might benefit from supply chain restructuring. This has to do with the expansion of high skill tradable services. In the last decade Chile has developed capacities in the area of computing and digital services. If the world economy shifts into an equilibrium of recurrent environmental and geopolitical conflicts, it might be that reconfiguring GVC will become a recurrent process for which firms will need to develop comparative advantages. If this is the case, then high-skill tradable services, that have significantly gained from the expansion of GVC, will benefit even further in this new world order. Countries such as Chile and India that have developed comparative advantages in this area might benefit from this new equilibrium of permanent restructuring of GVC.

5. THE POLICY DEBATE

The previous section has described different sources of risk faced by GVC. As recent events have shown, disruptions can generate significant costs for the economy, and this has fostered a debate on whether economic policy should be applied to improve GVC resilience or the diversification of risks. In various policy circles the narrative has tended towards highlighting risks rather than rewards (Baldwin and Freeman, 2022). In this section we examine the central arguments and ideas in this debate.

A standard approach in economics to the question of the desirability of policy intervention centers on the existence of market failures or externalities and, in general, the inability of private firms to fully incorporate the social costs and benefits of their actions. In the previous section, we described how research has forcefully argued that there is a case for policy intervention with regards to the impact of production and transportation of goods on climate change and the environment. In this section, we focus on the discussion related to the risks represented by disruptions in GVC. As argued by Grossman *et al.* (2021) or Jiang *et al.* (2022), firms may have inadequate incentives to invest in supply-chain resilience if they do not fully capture the surplus from the provision of their goods to the market. However, as they point out, it may also be the case that firms over-invest in resilience. For example, this may occur if firms aim to benefit when rivals are affected by their own disruptions, and therefore capitalize on these extraordinary profit opportunities.[13]

Firms implement a large variety of strategies and actions to manage risks in their supply chains given the costs that disruptions imply for their operations (see for example, McKinsey, 2020b). Baldwin and Freeman (2022) describe how this problem is the focus of substantial work in areas such as operations research, international business, logistics and supply chain management, and management in general. Specific actions and strategies depend on the vast heterogeneities in the context faced by firms, but they aim to promote resilience by increasing flexibility and/or redundancy in the supply chain, to foster interchangeability of inputs and production arrangements, to augment cooperation and share information among participants in the GVC (making logistic systems more visible and flexible by boosting control of information on warehousing, inventory, and transportation), boosting inventories and keeping cash buffers, to diversify distribution channels (including wholesalers, retailers, distributors, and direct online sales), among many others.[14] In general, private actors have a clear interest in taking measures to avoid disruptions to their production processes (Grossman *et al.*, 2022). Nevertheless, there is still limited research analyzing optimal government policies to promote resilience.[15]

13/ Jiang *et al.* (2022) discuss the problem of a multinational corporation in the presence of uncertainty. In this problem, inefficiencies in the pricing system break the first welfare theorem and lead to an inefficient outcome of the decentralized equilibrium (suppliers might not choose the best allocation of resources when aggregate shocks are present).

14/ In the case of disruption risks generated by climate change, adaptation measures include (for details, see McKinsey, 2020a): investments to increase protection of supply chain assets, redesign of supply chain operations, reduction of exposure by creating alternatives, allocation of risk by using financial and contractual mechanism, among others.

15/ Grossman *et al.* (2021) is an example of recent research in this direction. They find that, in a specific theoretical framework under and under certain assumptions, a subsidy for diversification can dominate policies that promote reshoring or offshoring. They suggest various extensions for future research and consider that their setting suggest a way to understand these issues and provides a proof-of-concept to the debate.

The Covid-19 pandemic provides an important case study for the debate. As previously discussed, research suggests that reducing exposure to GVC would not make countries more resilient to this type of shock but would instead concentrate risk to the domestic economy (Bonadio *et al.*, 2020; WEO IMF, 2022). Furthermore, the behavior of trade during subsequent waves of the pandemic indicated adaptability and resilience of GVC in general (WEO IMF, 2022), even if perhaps stimulated to some extent by countercyclical economic policy across the globe (Fuentes, 2022). Previously, the so-called Great Trade Collapse associated with the Global Financial Crisis had displayed the steepest and deepest trade reduction since the Great Depression, and studies have shown that GVC contributed to attenuate the collapse.[16]

More generally, D'Aguanno *et al.* (2021) show that the relationship between the importance of GVC and volatility is ambiguous in theory and non-significant empirically. In contrast, the potential costs in terms of productivity and welfare in general (as discussed in previous sections) that would be generated by increasing trade costs and barriers are significant and well substantiated. Resilience in GVC can be enhanced with greater diversification across countries away from domestic sourcing of inputs and with greater substitutability in input sourcing, an effort that to a large extent will be undertaken by firms as private sector actors (IMF WEO, 2022). This still leaves room for the role of government which can promote investment in trade and digital infrastructure, improving information gaps in supply chains, further reducing trade costs, and minimizing policy uncertainty (IMF WEO, 2022). One caveat to consider is that this discussion has centered on broad-based policies, sensitive sectors such as medical supplies and instruments may warrant special considerations.

How much of the policy debate surrounding GVC reconfiguration is relevant for a small, open and emerging economy such as the one of Chile? Many ingredients of this debate such as onshoring or even nearshoring are probably more relevant for countries that have the sufficient scale to implement these strategies, like the U.S. or the European Union, as shown by Freund *et al.* (2021). As a response to natural disasters, firms were able to reconfigure their GVC but only towards large and/or developed economies. Implementing an onshoring strategy requires to have the sufficient expertise, capital deepening, market thickness so that it is not too costly. These characteristics are usually met by large countries.

Nevertheless, there are still other policy ingredients that are relevant for small, open, and emerging economies. It might be optimal for governments to subsidize resilience strategies, that is, helping firms to diversify their input sourcing strategies. Moreover, if the world economy shifts into an equilibrium where there are massive reconfiguration efforts carried out by many countries and multinational firms, then reconfiguring the GVC of firms in small, open and emerging economies might be very difficult. The market for search and matching will potentially be congested and prioritized for multinationals and developed countries. In such a scenario, at least until multinationals and developed economies finish reconfiguring their GVC, it might be optimal to implement subsidies for search and matching that help firms in both their input strategies and export promotion strategies.

What are the distributional impacts of this policy debate? There are two dimensions in answering this question: between and within countries. Regarding the first one, as suggested by Freund *et al.* (2021), global strategies of reconfiguring global value chains might increase income inequality between countries if the reconfiguration benefits large and developed economies. This might be the case given the market size and agglomeration effects present in these countries that would help them in adjusting to new GVC strategies. Within countries, though, it is more unclear who would benefit and lose from a GVC reconfiguration. On one hand, tradable services with high skill content such as digital services might become relatively less relevant if GVC become expensive.

16/ For further discussion and references see Baldwin and Freeman (2022).

Given the evidence that workers in these areas are the ones that have gained the most from the expansion of international trade the last decades (Eckert *et al.* 2020), reconfiguration of GVC might reduce inequality. But, if reconfiguration requires more of these high skill tradable services because the logistics of a more unstable global order of GVCs are more challenging (as mentioned in the previous section for countries such as Chile and India), then income inequality might further increase. Taken together, it is not clear whether a global reconfiguration of GVC would increase or reduce inequality. Nevertheless, given the overall positive correlation between international trade and inequality (Antras *et al.* 2017) and given the importance of GVCs for aggregate trade flows, if GVCs flows are reduced, this might also reduce inequality. The potential impact on inequality will have to be accompanied by a policy discussion on the mitigation of the impact on losers from GVC reconfiguration. This, in order to take care of potential new waves of protectionism that might be generated as a response to GVC reconfiguration. But all these conjectures will have to be studied as this process is still in its early stages.

6. CONCLUSIONS

Global value chains have experienced rapid growth in recent decades, and they have made important positive contributions to the economy. However, as different events in recent years have shown, they are subject to different sources of risks. Arguments in favor of broadly reducing exposure to GVC, and international trade, in order to moderate the exposure to these risks do not seem well founded. As a broad-based policy to reduce the exposure to GVC, costs are large and benefits are unclear at best, although some specific and critical sectors may require special analysis, and search and matching policies to adjust GVC might be useful for small, open and emerging economies.

Going forward, geopolitical events and the process of climate change could be some of the main factors shaping GVC, while the persistence of the Covid-19 pandemic warns against dismissing the possibility of future pandemics. With respect to monetary policy, in the short run central banks should closely monitor international events that could generate disruptions to GVC, given their first order impact on prices and productivity. In the longer run, reconfigurations of GVC have the potential of affecting the transmission and effectiveness of monetary policy, although more research is required in this area.

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