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The Price of De-Risking

Reshoring, Friend-Shoring, and Quality Downgrading

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The Price of De-Risking: Reshoring, Friend-Shoring, and Quality Downgrading

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ABSTRACT: This paper estimates the costs of 'de-risking' scenarios between China and OECD members at the aggregate and sectoral levels. Aggregate large-scale de-risking – reshoring by increasing reliance on domestic production and friend-shoring by reducing imports from specific foreign countries – is quantified with the IMF's GIMF model, suggesting significant permanent effects on the global economy. Returning integration to 2000 levels translates into long-term global GDP losses of 4.5 percent under reshoring and as much as 1.8 percent under friend-shoring. Friend-shoring does not necessarily deliver a boon to third countries as trade diversion benefits might be largely offset by contractions in China and OECD members. Sectoral de-risking, where all trade between rivals is eliminated in specific products, is quantified through empirical estimation of the scope for quality downgrading. The results demonstrate the potential for significant losses in input quality should there be an escalation in export bans. Losses are asymmetric against China in the specific case of semiconductors but can be significant for both sides in other sectors—including in critical areas such as environmental goods.

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1. Introduction

Amid rising geopolitical tensions and in the wake of Russia's invasion of Ukraine, concerns have grown about the global economy dividing into blocs, with large swaths of trade and other flows between countries in rival blocs severely restricted or outright eliminated. In response to these concerns, researchers around the world invested heavily in estimating the potential impact of such scenarios (for a brief survey of this literature, see Box 1 in Aiyar and others, 2023; see Aiyar, Presbitero, and Ruta, 2023, for a book-length collection of studies on fragmentation).

There are increasing signs that the global economy may be headed toward what policymakers refer to as 'de-risking', as countries aim to reshore and friend-shore supply chains in the aggregate. In addition, there are signs of policies totally undoing ties in narrow sectors to restrict access to high-quality inputs. This paper sheds light on the potential impact of these two dimensions of fragmentation by considering relations between China and OECD countries using (i) a macroeconomic model to estimate the impact of several large-scale de-risking scenarios, and (ii) empirical estimates for the scope for quality downgrading to assess the costs of spiraling export restrictions in narrow sectors.

Aggregate de-risking: The increased likelihood of de-risking in the aggregate is visible in how companies increasingly take into account geopolitical considerations in their investment decisions (IMF, 2022), including as observed in greenfield FDI and merger data (Aiyar, Malacrino and Presbitero, 2023), and in detailed data for the U.S. (Freund and others, 2023; also then covered by Alfaro and Chor, 2023). Some governments have also been explicit about their objective of pursuing a path of less integration. For instance, Germany's Strategy on China notes that "[…] de-risking is urgently needed. However, we are not pursuing a decoupling of our economies" (Federal Government of Germany, 2023).

In this paper, "de-risking" is defined as countries changing how they source goods and services along two dimensions. A "friend-shoring" dimension measures how much countries want to change between different foreign sources ("friends" vs. "rivals"), while minimizing the change to overall dependence on foreign sourcing. In other words, China and OECD members reduce imports from their rivals. A "reshoring" dimension measures how much more countries seek to rely on domestic sourcing versus foreign sourcing, beyond the already high home bias in domestic sourcing as documented in IMF (2023). That is, China and OECD members increase their reliance on domestic production and reduce their imports from all other countries, friends and rivals alike.

The model-based de-risking exercise is anchored with input-output data on how these two dimensions of integration evolved between the years 2000 and 2021 for OECD economies.

Specifically, the increased reliance of these economies on foreign suppliers in general (for the reshoring dimension) and on China in particular (for the friend-shoring dimension) is measured in 2021 compared to 2000. Then the IMF's GIMF (Global Integrated Monetary and Fiscal model) is used to simulate scenarios in which both OECD members and China undo the increased integration of the past two decades.

The model simulations reveal that such a significant 'de-risking' shock could be a sizable drag on the global economy. The formulations of reshoring and friend-shoring in this paper can be considered as an upper bound on GDP losses that occur through the trade channel given the assumption that several decades of integration are being unwound because of either reshoring or friend-shoring. Specifically, reverting integration along the reshoring margin to 2000 levels translates into long-term global GDP losses of 4.5 percent, while losses from reverting integration along the friend-shoring margin leads to losses of between 0.4 to 1.8 percent. The reshoring margin is particularly painful, with losses of over 10 percent of GDP in smaller and more open economies. While the friend-shoring margin features smaller losses, notably it does not generate a significant boon to third countries. Trade-diversion benefits are more than offset by the resulting contractions in the economies of China and OECD members as friend-shoring policies are distortionary, partially undoing the growth engine that has come from countries' current specialization patterns.

Undoing economic ties in narrow sectors: Some products within specific sectors may be subject to an even more extreme undoing of economic ties. This is the case, for example, of the semiconductor industry, where the United States has imposed complete export bans on sales of certain products to China. A key feature of these export bans is that they are designed to restrict access to the highest-quality inputs. One example is the semiconductor industry, where U.S. restrictions aim to prevent China from being able to procure logic chips with design rules under certain nanometer thresholds (see, for example, Shivakumar, Wessner, and Howell, 2022). In this case, China faces the possibility of quality downgrading in its inputs, potentially being forced to produce lower-quality outputs, such as slower artificial intelligence models.

The empirical estimates of quality differentials corroborate a large quality lead by OECD economies over China in semiconductor sectors: the median estimated Chinese product quality is about one-third lower than the median quality for the OECD. In a hypothetical situation in which China and the OECD cut off all access to each other's semiconductor products, and assuming that both parties can easily substitute each other with a good-quality product from the rest of the world, the trade-weighted drop in quality is of about 5 percent for China, but zero for the OECD. However, such a stark asymmetry does not hold in general. Performing the same exercise for the case of environmental goods, the trade-weighted average quality loss is of about 11 percent for China and as high as 5 percent for the OECD, as different economies specialize in the production

of different environmental goods. For all goods combined, both sides would see input quality drop by about 8 percent. Such magnitudes equate to potentially significant productivity losses. Estimates from the literature linking input and output quality suggest that for firms with a high-skilled labor force, such as those in high-tech sectors, these drops in input quality can result in output-quality reductions of similar proportions.

The rest of the paper is organized as follows. Section 2 defines de-risking and how the modeling exercise is calibrated. Section 3 provides a brief description of the model and presents the de-risking simulations. Section 4 presents the quality-downgrading framework and results.

2. De-risking: Definitions and Calibration

First, a note on terminology. The term 'de-risking' in this paper is used as it is currently being used by policymakers—that is, as the pursuit of the reshoring and friend-shoring of supply chains. Whether such policies would mitigate risks to supply chains ('de-risk'), however, is not clear. In the face of largely random shocks, as those from lockdowns at the height of the COVID-19 pandemic, reshoring policies seem particularly ill-equipped to increase resilience as they diminish diversification benefits brought about by international trade (Bonadio and others, 2021). Whether friend-shoring as implemented in this paper may be beneficial to mitigate risks from random shocks or from concentration in sourcing—and whether the reduction in risk is worth the cost[1]—is an open question, which should be tackled by future research.

As noted, de-risking is here defined as countries changing how they source goods and services along two dimensions. A friend-shoring dimension measures how much countries want to change between different foreign sources while minimizing the change to overall dependence on foreign sourcing. A reshoring dimension measures how much more countries seek to rely on domestic sourcing versus total foreign sourcing. Both China and OECD members are assumed to seek to reshore and friend-shore; other economies do not actively seek to reshore or friend-shore.

The concepts of reshoring and friend-shoring interact strongly with global value chain (GVC) production, making the GVC aspect of the model a critical feature to gauge the potential impact of these policies. A GVC is a production process that is integrated across sectors in a country and often across different, multiple countries. A good example of a GVC is the automobile industry, which can involve computerized equipment, other vehicle parts, and assembly of vehicles in different countries, but all in one integrated, streamlined process. The same country or sector may be present more than once in any one GVC. Reshoring and friend-

[1] For an analysis of whether government intervention is needed to achieve first-best resilience outcomes, see Grossman and others (2023).

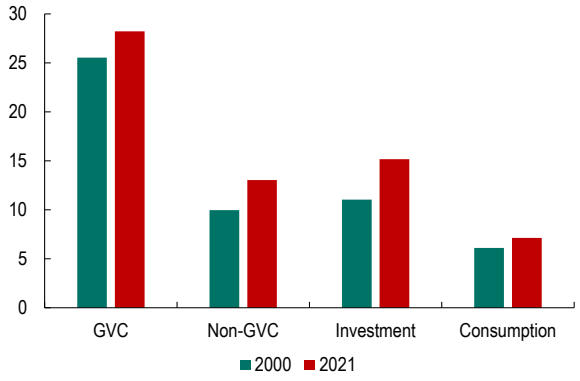
shoring could be especially detrimental to growth given the rise of GVCs globally, and especially China's insertion in GVCs, as it would reverse the efficiency gains from specialization witnessed over the last few decades.

The exercise is anchored by looking at how OECD members in aggregate have changed their integration patterns along these two dimensions since the year 2000 just before China acceded to the WTO.[2] This relies on world input-output data from Eora, and—in order to map the sectoral breakdown to be used in the simulations exercise—break down the analysis by type of tradable intermediate good (GVC and non-GVC sectors) and final demand good (consumption and investment goods).[3]

Figure 1. Reshoring and Friend-Shoring Margins

1. Foreign Sourcing as Share of Total Sourcing

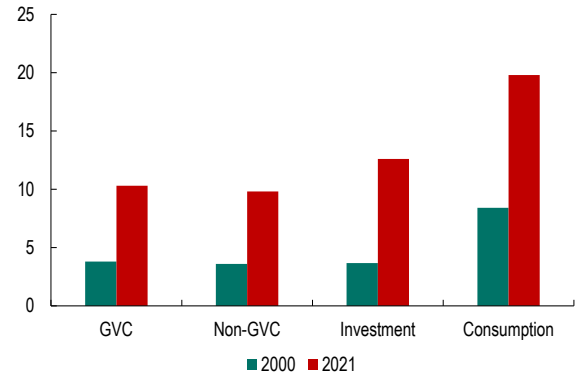
(OECD countries, percent, by type of goods and services trade)



Source: Eora Global Supply Chain database and authors' calculations.

2. Sourcing from China as Share of Foreign Sourcing

(OECD countries, percent, by type of goods and services trade)



Source: Eora Global Supply Chain database and authors' calculations..

The left panel in Figure 1 shows the results for the reshoring dimension for the years 2000 and 2021. For GVC sectors, for example, the leftmost green bar shows that OECD economies sourced around 25 percent of their purchases from foreign sources. By the year 2021, this fraction had risen to 28 percent, as shown by the leftmost red bar. Increases in foreign sourcing were of roughly similar magnitudes for non-GVC tradable intermediates and for investment goods, and somewhat smaller for consumption goods.

[2] The focus is on data for OECD economies because China's growth over the past two decades has been so large that it naturally led to China becoming more closed.

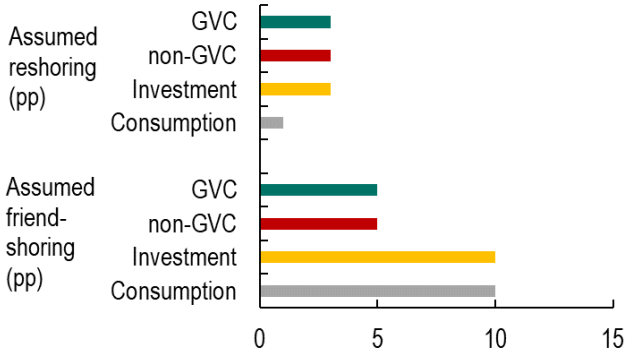
[3] See Appendix Table 1 for further details.

The right panel in Figure 1 shows the results for the friend-shoring dimension. For the OECD, this means how much it sourced in 2000 and in 2021 from China as a fraction of total foreign sourcing. As of 2000, OECD economies in aggregate purchased less than 5 percent of their GVC and non-GVC tradable intermediates and investment goods from China, while by 2021 all these ratios were at or above 10 percent. The case of consumption goods was as dramatic, with purchases from China as a share of total foreign purchases rising from just under 10 percent to nearly 20 percent.

Figure 2 shows the permanent percentage point changes implemented in the model in the long term, roughly matching the changes observed in the data shown in Figure 1. Specifically, on reshoring, the assumption is that both China and OECD economies increase the share of domestic sourcing in total sourcing by 3 percentage points for GVC and non-GVC tradable intermediates and investment goods, and by 1 percentage points for consumption goods. This translates into 2.7 percent of global GDP.[4] Along the friend-shoring margin, the assumption is that China and OECD economies shift away sourcing from each other, and in favor of others, in the long term, by 5 percentage points in the case of tradable intermediates (GVC and non-GVC) and 10 percentage points in the case of final demand goods (investment and consumption). This is equivalent to almost 1 percent of global GDP.[5] The shocks are implemented in the simulations over a period of five years under the assumption that households and firms fully understand their magnitudes and timespans as the process begins.

Figure 2. Assumed Redistributions for Reshoring and Friend-Shoring

(Percentage points by category of trade. Share of total sourcing for reshoring. Share of foreign sourcing for friend-shoring)



Sources: EORA MRIO Database; and authors' calculations.
Note: GVC = global value chain; pp = percentage point.

[4] See Appendix Table 2 for further details of the reshoring redistributions as shares of baseline global GDP and trade.

[5] See Appendix Table 3 for further details of the friend-shoring redistributions as shares of baseline global GDP and trade.

3. Model Simulations

3.1 Model

Brief Overview of the Model

To quantify the spillovers from reshoring and friend-shoring, this section uses the IMF's multi-region dynamic stochastic general equilibrium model, GIMF (Global Integrated Monetary and Fiscal Model), additionally featuring GVCs. GIMF is an annual, multi-region, micro-founded dynamic stochastic general equilibrium model (DSGE) of the global economy.[6] In this paper, GIMF comprises 10 regions: the United States, the European Union plus (EU+), the other advanced economies, China, India, Indonesia, Japan, Korea, other Southeast Asia, and the rest of the world.[7]

A share of households is modeled as finitely lived, following the framework in Blanchard (1985). These saving households choose consumption, savings, and labor supply. The remaining households are liquidity constrained, consume all their income every period and set their labor supply in proportion to that of the saving households and reinforce the short-term non-Ricardian properties of the model.

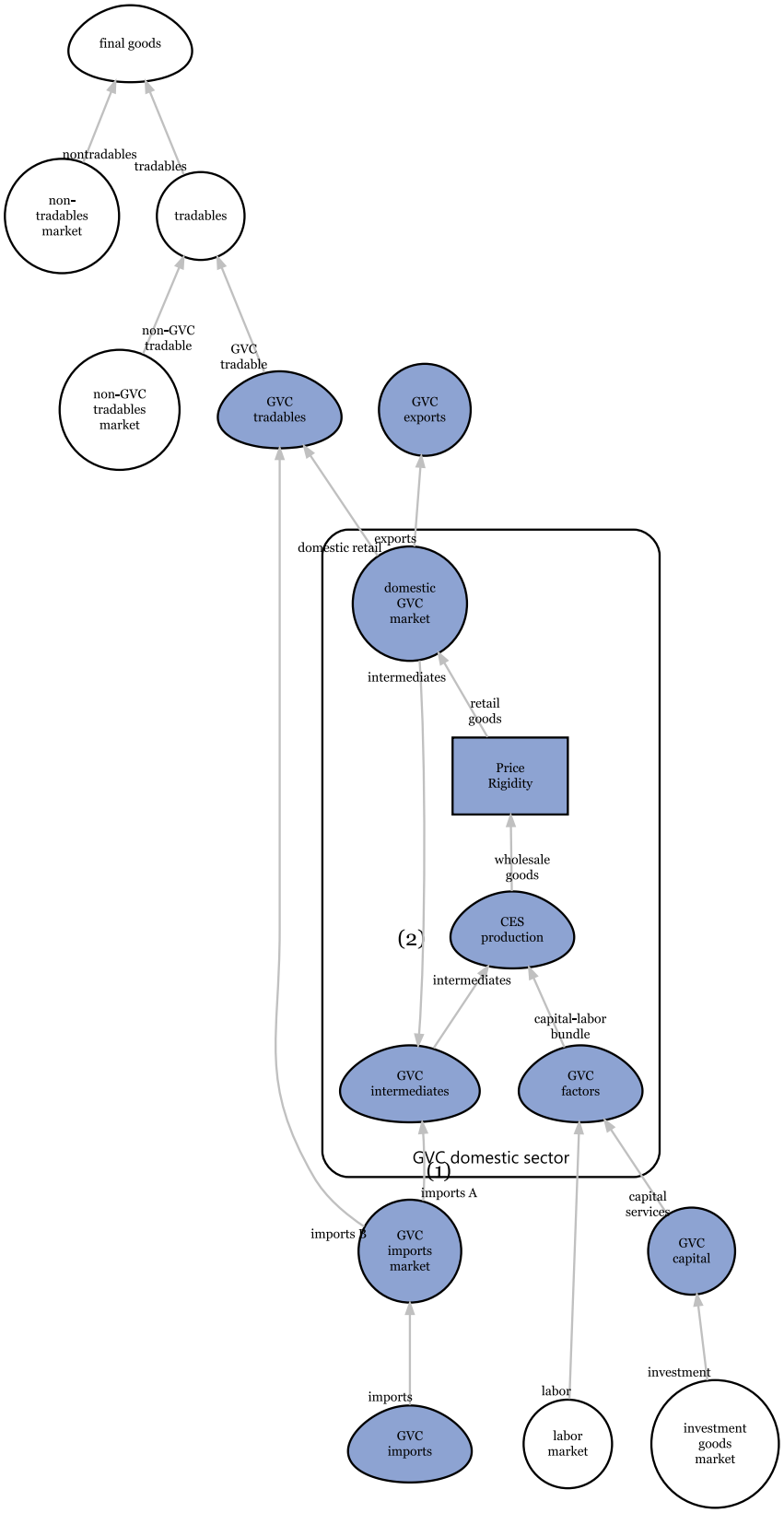
Profit-maximizing firms (owned by households) operate in monopolistically competitive markets, and produce goods in non-tradable, non-GVC tradable, and GVC tradable intermediate sectors. These three types of goods are based on sectors from the OECD Inter-Country Input-Output Database (OECD, 2021).[8] Non-tradable and domestically produced non-GVC tradable intermediate goods are produced using some combination of labor and capital.

[6] See Kumhof and others (2010) and Anderson and others (2013) for a detailed exposition of the standard version of GIMF and its properties. For more details on the version of GIMF with the GVC sector see Carton and Muir (2024, forthcoming).

[7] The country composition for the aggregated regions is defined as follows. "European Union plus" comprises the European Union and Switzerland. "Other Advanced Economies" comprises Australia, Canada, Iceland, Israel, New Zealand, Norway, Taiwan POC, and the United Kingdom. "Other South-east Asia" comprises Brunei, Cambodia, Hong Kong SAR, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. "Rest of the World" is all other countries not mentioned in the text or this footnote.

[8] See Appendix Table 4 for further details, including the division of various manufacturing and service industries into the non-tradable, non-GVC tradable, and GVC tradable sectors in the model.

Figure 3. GIMF's Global Value Chain Sector



Source: Carton and Muir (2024, forthcoming).

The GVC sector is more complex than the other two sectors, as seen in Figure 3. GVC goods are used both in final goods and as inputs in the production of other GVC goods – that is, GVC goods are an input for and output of "round-about production" as in Basu (1995). The sector is intended to represent industries such as semiconductors, with chips going into the production of computers sold to consumers (a final good), or as inputs into auto-parts (another GVC good). Production in the GVC sector combines capital and labor (bundled using a Cobb-Douglas function) with already produced GVC goods, which are both imported (labeled (1)) and domestically sourced (labeled (2)). The produced output is then split between inputs into final goods or cycled back as inputs into the production of other GVC goods, both domestically and abroad.

Regions trade final goods (consumption and investment), and both non-GVC and GVC tradable intermediate goods. The flows of these goods are tracked bilaterally. Trade flows react to demand, supply and pricing (i.e., the terms of trade and bilateral real exchange rates) conditions. The model captures barriers to trade using NTBs, which have similar impacts on the decisions of importers and exporters as tariffs, but, unlike tariffs, do not generate fiscal revenues from the importing region's consumers – instead they result in deadweight losses to the exporting region's producers.

Monetary and fiscal policies are set to respond to shocks endogenously according to inflation targeting and debt-GDP ratio targeting rules respectively. Therefore, under the scenarios discussed below, monetary policy adjusts in the short term to maintain relatively stable inflation rates. Fiscal policy adjusts the level of general lumpsum transfers sent to households, both in the short term to maintain economic stability, and the medium term to maintain debt to GDP targets.

Summary of the Calibration

Each region's economy is calibrated using the OECD Inter-Country Input-Output Database for 2018 (OECD, 2021), drawing on its national accounts and fiscal ratios (Table 1). The calibration represents a steady state for each region, where every region has converged to a global real growth rate of 2 percent and global real interest rate of 2.5 percent. Some adjustments are necessary to reconcile the global data with a well-defined steady state. Therefore, countries that are far from a steady state in 2018 may have notably different steady state calibrations. For example, China's investment is much higher than needed to maintain its capital stock in the steady state; so, in the GIMF calibration, investment is lower and consumption is higher as a share of GDP than in the 2018 data. It is also assumed that all regions have net foreign asset positions of zero. This implies that in the baseline calibration, the current account is zero,

achieved by having exports equal to imports. The import to GDP ratio is usually more reflective of the 2018 data from the OECD database, and exports are adjusted accordingly.

Table 1. National Accounts Steady-State Calibration

(percent share of region's nominal GDP, unless otherwise stated)

	United States	European Union +*	Japan	Korea	Other Advanced Economies	China	India	Indonesia	Other Southeast Asia	Rest of the World
Share of Global GDP (%, US$)	24.4	18.9	5.8	2.0	8.7	16.7	3.2	1.2	2.3	16.7
Domestic Demand										
Household Consumption	65.4	54.9	55.2	50.9	58.2	51.7	56.7	56.1	58.8	60.1
Private Investment	17.3	21.1	20.8	28.9	18.5	18.5	26.8	32.1	24.3	20.3
Trade										
Aggregate Exports	11.6	20.0	18.5	42.5	28.8	17.5	20.2	21.6	61.9	22.5
Consumption	*3.6*	*6.3*	*3.7*	*7.9*	*7.2*	*5.1*	*6.3*	*6.6*	*21.0*	*5.4*
Investment	*1.6*	*3.1*	*4.0*	*7.4*	*3.3*	*3.1*	*3.3*	*1.4*	*6.9*	*1.2*
Non-GVC Tradable	*2.5*	*3.5*	*3.1*	*3.2*	*5.6*	*1.8*	*2.6*	*3.3*	*10.8*	*3.4*
GVC Tradable	*3.8*	*7.1*	*7.7*	*24.0*	*12.7*	*7.5*	*8.0*	*10.3*	*23.1*	*12.6*
Aggregate Imports	11.6	20.0	18.5	42.5	28.8	17.5	20.2	21.6	61.9	22.5
Consumption	*3.1*	*6.4*	*4.4*	*8.4*	*9.9*	*4.1*	*2.4*	*5.2*	*12.4*	*7.6*
Investment	*1.4*	*2.7*	*2.1*	*5.4*	*2.8*	*1.6*	*2.3*	*2.4*	*8.7*	*4.5*
Non-GVC Tradable	*1.7*	*3.8*	*3.1*	*6.6*	*5.3*	*2.6*	*2.9*	*3.4*	*11.3*	*3.0*
GVC Tradable	*5.5*	*7.0*	*9.0*	*22.2*	*10.9*	*9.2*	*12.6*	*10.6*	*29.5*	*7.5*

Source: OECD (2021) and authors' calculations.

Notes: * "European Union +" comprises the European Union and Switzerland.

Trade patterns are an important feature of the behavior found in the simulations discussed below. The regions that are the most open (Table 2) are other southeast Asia (61.9 percent of GDP for imports or exports) and Korea (42.5 percent of GDP for imports or exports). The least open is the United States (11.6 percent of GDP for imports or exports). In addition to trade openness, the spillovers from one region to another also depend crucially on the size of trade as a share of global GDP, which regions trade with whom and how much, and the type of goods that is traded. This is especially important for GVC tradables, as a shock through that sector may affect all countries involved in the GVC and not just the country directly hit by the shock, as captured in the model structure discussed above.

When considered as share of global GDP, United States trade is twice as large as other southeast Asia and three times that of Korea (Table 2). In fact, the region (outside of the rest of the world bloc) with the largest global trade share is China, closely followed by the United States. Larger regions such as China and the other advanced economies, and smaller ones such as Japan and Korea are large participants in the GVC tradable sectors. This means these regions will face larger impacts, all else being equal, when considering reshoring or friend-shoring, as

shocks have amplified effects on GVC tradable goods, relative to trade in final goods or non-GVC tradable goods.

Table 2. Trade Patterns Steady-State Calibration

(percent share of global GDP)

	United States	European Union + *	Japan	Korea	Other Advanced Economies	China	India	Indonesia	Other Southeast Asia	Rest of the World
Share of Global GDP	24.4	18.9	5.8	2.0	8.7	16.7	3.2	1.2	2.3	16.7
Aggregate Exports	2.83	3.76	1.07	0.85	2.51	2.92	0.65	0.26	1.41	3.76
to United States	0.00	0.58	0.14	0.08	0.57	0.48	0.11	0.02	0.16	0.69
to other OECD **	1.51	1.13	0.35	0.20	0.97	1.28	0.22	0.09	0.58	1.87
to China	0.31	0.47	0.24	0.29	0.45	0.00	0.06	0.05	0.34	0.72
to remaining regions ***	1.01	1.58	0.34	0.27	0.53	1.16	0.26	0.10	0.33	0.48
GVC Tradable	*0.93*	*1.33*	*0.45*	*0.48*	*1.11*	*1.25*	*0.26*	*0.13*	*0.53*	*2.10*
to United States	*0.00*	*0.24*	*0.06*	*0.04*	*0.28*	*0.22*	*0.05*	*0.01*	*0.06*	*0.37*
to other OECD	*0.50*	*0.37*	*0.13*	*0.10*	*0.37*	*0.52*	*0.08*	*0.04*	*0.19*	*0.93*
to China	*0.11*	*0.20*	*0.12*	*0.19*	*0.25*	*0.00*	*0.02*	*0.03*	*0.15*	*0.46*
to remaining regions	*0.33*	*0.53*	*0.13*	*0.14*	*0.21*	*0.52*	*0.10*	*0.05*	*0.12*	*0.33*
Aggregate Imports	2.83	3.76	1.07	0.85	2.51	2.92	0.65	0.26	1.41	3.76
from United States	0.00	0.65	0.17	0.12	0.58	0.30	0.05	0.02	0.15	0.79
from other OECD	1.38	0.97	0.35	0.27	1.06	1.44	0.17	0.08	0.61	1.87
from China	0.48	0.56	0.23	0.17	0.31	0.00	0.10	0.06	0.33	0.68
from remaining regions	0.99	1.58	0.32	0.29	0.56	1.17	0.33	0.11	0.32	0.42
GVC Tradable	*1.33*	*1.32*	*0.52*	*0.44*	*0.95*	*1.54*	*0.41*	*0.13*	*0.67*	*1.25*
from United States	*0.00*	*0.18*	*0.06*	*0.04*	*0.22*	*0.11*	*0.03*	*0.00*	*0.05*	*0.25*
from other OECD	*0.63*	*0.31*	*0.18*	*0.13*	*0.35*	*0.76*	*0.09*	*0.04*	*0.28*	*0.60*
from China	*0.22*	*0.20*	*0.10*	*0.09*	*0.14*	*0.00*	*0.05*	*0.03*	*0.18*	*0.26*
from remaining regions	*0.49*	*0.64*	*0.18*	*0.19*	*0.24*	*0.67*	*0.24*	*0.06*	*0.16*	*0.14*

Source: OECD (2021) and authors' calculations.

Notes: * "European Union +" comprises the European Union and Switzerland.

** "OECD" is the Organization for Economic Co-operation and Development; "other OECD" comprises European Union +, Japan, Korea, and other advanced economies regions.

*** "remaining regions" comprises India, Indonesia, other southeast Asia and rest of the world regions.

Many of the elasticities in GIMF are calibrated the same across regions, including for trade and the combination of various goods to produce final goods. However, each region has a unique set of related bias parameters, which, given the elasticities, are computed based on the calibration of key steady-state ratios based on OECD (2021).

For consumption, the intertemporal elasticity of substitution is common across regions at 0.5. The share of liquidity constrained households varies based on level of financial market development, and is set at 25 percent for the United States, EU+, the other advanced economies, and China, and at 50 percent for the remaining regions. Regions with high shares of liquidity constrained households have more volatility in GDP, as they are less able to smooth their consumption under temporary shocks or implement gradual adjustments under permanent shocks.

For this paper, the most important elasticities are related to trade and combining imports and domestically produced goods to produce intermediate and final goods (Table 3). Demand for goods in the GVC tradable sector are assumed to be relatively inelastic (0.8), compared to other elasticities of demand and trade for final consumption and investment goods and tradable intermediate goods, which are usually elastic at 1.5. Final goods are a combination of non-tradable goods and a tradable goods bundle, with an elasticity of 0.5. The tradable goods bundle is assembled from GVC and non-GVC tradable intermediate goods with an elasticity of 0.95.

Table 3. Key Production and Trade Elasticities

Elasticity between =>	*Capital-Labor / GVC*	*Domestic / Imported*	*Different Regions*
Consumption	-	1.5	1.5
Investment	-	1.5	1.5
Non-GVC Tradables	-	1.5	1.5
GVC Tradables	0.5	0.8*	0.8

Source: Authors' assumptions.

Note: * Elasticity between domestic and imported when using GVC tradable goods in the production of final goods or of other GVC tradable goods.

Because the trade and use of GVC tradable goods have lower elasticities relative to final goods or non-GVC tradable goods, there will be larger movements in prices in the face of shocks for those regions more dependent on GVC goods. This is true of the real exchange rate. So, a shock that has a negative impact on GVC tradable goods in other southeast Asia, for example, will lead to a larger depreciation in the real exchange rate than in other less-GVC-dependent regions, helping offset the direct impact of the shock on exports, but amplifying the impact on imports of final goods, all else being equal.[9]

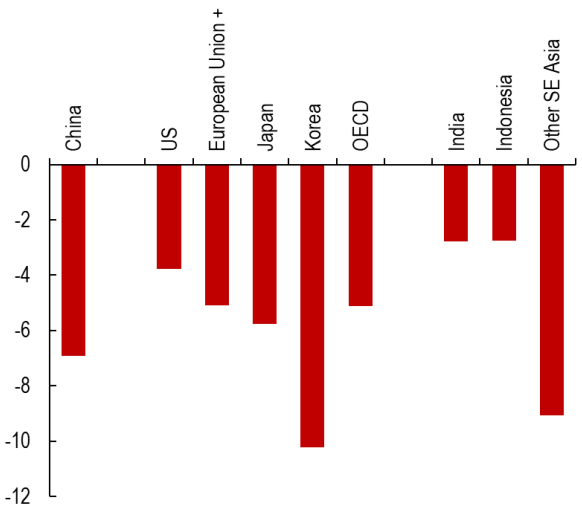
[9] To fully appreciate the significant negative impact in these simulations of the GVC sector and its elasticities in comparison to other versions of the GIMF without the GVC sector, the reader is recommended to consult Carton and Muir (2024, forthcoming).

3.2 Reshoring

The reshoring scenario, in which China and OECD members increase NTBs on all countries to reduce dependence on foreign inputs, aims to redistribute 13.3 percent of baseline global imports (equivalent to 2.7 percent of baseline global GDP, using the shocks presented in Figure 2) towards domestic sources. There is a significant global GDP loss of about 4.5 percent in the long term (Figure 4). Global imports decline by about 13.7 percent, which is in line with the magnitude of the shock itself.

Figure 4. Long-Term GDP Losses from Reshoring

(real GDP, percent deviation from baseline)



Source: Authors' calculations.

Note: European Union + = European Union plus Switzerland; SE = southeast.

The additional distortions from NTBs lead to a less-efficient resource allocation and higher input costs that are amplified through GVC linkages. China experiences a 6.9 percent GDP loss as the OECD regions are reducing their demand for their goods. For the OECD regions, losses range from 3.8 percent to 10.2 percent of GDP, with larger losses for more open economies with stronger China linkages (for example, Korea).

Reshoring is also costly for the rest of the world as they also face higher NTBs from China and OECD members. The other southeast Asia region experiences a large loss of over 9 percent of GDP in the long term because it is highly open with strong trade links with China and the OECD economies, particularly in the GVC sector in relation to China (refer back to Table 2). Therefore, the demand for its exports is falling enough to induce a large GDP contraction, with significant negative spillovers on the domestic economy. There are also significant, but smaller, losses in Indonesia and India, both of which are not as open as other southeast Asia, and with a greater proportion of their trade outside of China and the OECD.

The reshoring leads to restructuring of the steady states of the economies, with the GVC sector contracting relative to the non-GVC tradable and non-tradable sectors. In China and the United States, the GVC tradable sector was initially 53.3 and 27.2 percent, respectively, of gross output, but 82.0 and 46.9 percent of the decline in gross output following the reshoring shock. Therefore, the GVC tradable sector is relatively smaller in the new steady state compared to the other sectors. Because of the strong linkages in the GVC sectors, regions that are not reshoring

also experience the same redistribution. For example, for other southeast Asia, the GVC sector was initially 51.8 percent of gross output, but contributes 63.8 percent of the fall in gross output.

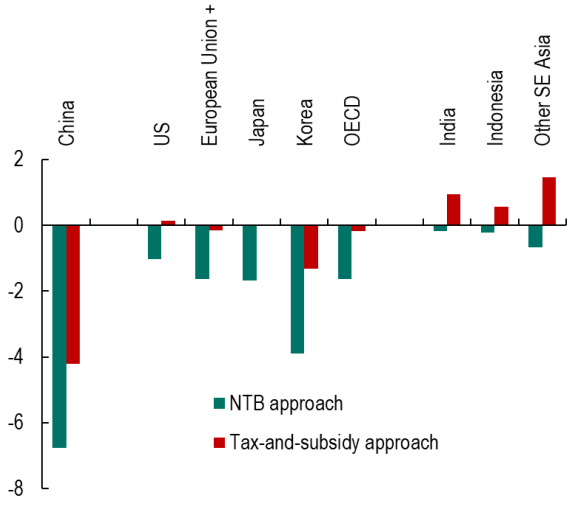
In summary, reverting the reshoring margin to 2000 levels before China acceded to the WTO, a shock of 2.7 percent of global GDP, translates into global GDP losses of 4.5 percent. These are permanent losses, borne more widely by the more open and strongly linked economies, especially through the GVC sectors. Moreover, there is an economic restructuring of all regions, where GVC tradable sectors are smaller in real terms than before the shock. These estimates underscore how de-risking can present a nontrivial drag on growth in Asia and beyond.

3.3 Friend-Shoring

The friend-shoring scenario attempts to divert 4.9 percent of global imports (using the shocks in Figure 2) towards "friendly" foreign sources. This represents 1 percent of baseline global GDP – 0.8 percent of global GDP from China (4.7 percent of its domestic GDP), and 0.2 percent of global GDP from the OECD regions (0.3 percent of their domestic GDP). Two approaches are considered to implement the scenario. Under the 'NTB approach', OECD members and China impose NTBs on each other to reduce mutual interdependence but do not restrict trade with other countries. While this seems to be the more realistic implementation given the distortive nature of friend-shoring policies that are currently being pursued, a 'tax-and-subsidy approach' is also considered, where the OECD and China tax one another's exports (using tariffs, for example) but then subsidize the rest of the regions' exports (based on their baseline export shares) using the accumulated tax revenues to encourage their exports to replace the goods lost from the restrictions. In the case of China, they are subsidizing India, Indonesia, other southeast Asia and the rest of the world

Figure 5. Long-Term GDP Changes from Friend-Shoring

(real GDP, percent deviation from baseline)



Source: Authors' calculations.
Note: European Union + = European Union plus Switzerland; SE = southeast.

region. In the case of any OECD region, they are subsidizing all other regions in the world outside of China.[10]

The NTB Approach

Global GDP declines by 1.8 percent under the NTB approach (Figure 5, green bars) as global imports decrease by 6.2 percent. The economic losses are largest for China (6.8 percent of GDP relative to the baseline in the long term; equivalent to a 1.2 percent decrease in global GDP) because of reduced demand for Chinese goods by key trading partners and amplification through GVCs as higher input costs cascade through the supply chain.

GDP losses relative to the baseline are not as large for OECD countries, but still, the extent of losses depending on the countries' dependence on Chinese inputs, which become more costly. Korea observes the largest losses of close to 4 percent of GDP, while the United States sees losses of about 1 percent of GDP.

The economic effects are small for the rest of the world, with two offsetting forces as play. Higher NTBs between China and OECD members result in trade being diverted to other countries, increasing demand for their exports, which rise above the baseline in the short term. However, the large economic losses in China and OECD members notably lower their demand from the rest of the world, dampening the positive effects from trade diversion. Therefore, GDP and exports in the rest of world decline marginally in the long term (in the range of –0.2 to -0.7 percent for GDP relative to the baseline).

As in the case of reshoring, there is a restructuring of the economies. In absolute terms, there is less restructuring than under reshoring as the shock, and the consequent GDP loss, is smaller. The GVC tradable sector still shrinks in each economy relative to the non-GVC tradable and non-tradable sectors.

The Tax-and-Subsidy Approach

Global GDP declines by 0.4 percent under the tax-and-subsidy (Figure 5, red bars) while global imports decline by 1.1 percent. Once again, the economic losses are the largest for China (4.2 percent of GDP relative to the baseline in the long term; equivalent to a 0.7 percent decrease in global GDP) because of reduced demand for Chinese goods by key trading partners and amplification through GVCs as higher input costs cascade through the supply chain. Most of the

[10] As the friend-shoring scenario explores the impact of substituting one source of foreign sourcing for another, the taxes raised from rivals are assumed to subsidize other foreign producers (friends), rather than used domestically. Allowing for non-neutral fiscal policy or domestic use of tax revenue would make the tax-and-subsidy results less comparable to the other scenarios in the paper.

OECD regions, except for the United States, suffer small GDP losses because of the cross-subsidization among OECD members. The United States actually gains marginally in the long term by 0.1 percent of GDP, both because other OECD economies subsidize exports out of the United States and because of the standard result that the optimal tariff tends to be larger in larger economies as they are able to affect their terms of trade to their benefit.

For the rest of the world, the use of subsidies by both China and OECD members encourages trade diversion more than just taxing their opponents alone. Gains range from 1.5 percent of GDP for other southeast Asia (the most open region with strong trade links to both the OECD regions and China, especially for its GVC goods), relative to the baseline, down to 0.6 percent of GDP for Indonesia (a less open region).

As in the other friend-shoring scenario, in absolute terms, there is less restructuring than under reshoring. But the restructuring now differs depending on whether a region is imposing friend-shoring measures (China and the OECD regions) or solely a recipient of subsidies to encourage new exports. The OECD regions and China still have the GVC sector contracting relative to the other two sectors. But the other regions see their GVC tradable sectors expand, because demand for the GVC goods, relative to the baseline steady state, have increased at a rate faster than real GDP. For example, in Indonesia, real GDP is only 0.6 percent higher, but the GVC sector is 1.4 percent higher. The equivalent values for other southeast Asia are 1.4 percent and 2.7 percent respectively.

Summary

Going back to 2000 levels of trade associated with friend-shoring translates into a significant shock of almost 1 percent of global GDP, leading to global GDP losses of 1.8 percent for the NTB approach and 0.4 percent for the tax-and-subsidy approach. While friend-shoring is less damaging than reshoring, it still has significant negative impacts, especially in China and the OECD regions. Notably, it does not yield significant benefits even to third countries, with gains even in the best-case scenario, that of other southeast Asia, limited to 1.5 percent of baseline real GDP (equivalent to 0.2 percent of global GDP) in the long term. The economies restructure less than under reshoring. It can even be the case that the GVC sector expands in some regions when friend-shoring is expansionary under the tax and subsidy approach.

4. Quality Downgrading

To assess the potential cost of extreme fragmentation in specific sectors, this section follows the approach in Khandelwal (2010) and uses detailed bilateral U.S. trade data to estimate quality at the country-product level (a variety). In particular, quality is inferred based on market shares conditional on price: for example, if two countries sell a product at the same price but have

different market shares, then the approach will infer that the country with higher market share has the higher quality good.

4.1 Approach and Data

As in Khandelwal (2010, equation (15)), the below equation is estimated separately for each industry (NAICS 6-digit) (industry subscript is suppressed for simplicity):

$$ln(s_{cht}) - ln(s_{0t}) = \lambda_{1,ch} + \lambda_{2,t} + \alpha\ p_{cht} + \sigma\ ln(ns_{cht}) + \gamma \ln(pop_{ct}) + \lambda_{3,cht},$$

where *c* indexes country, *h* indexes products at the Harmonized System classification (HS) 10-digit level, and *t* index time. s_{cht} is the market share of a variety *ch* (the HS 10-digit product from a specific country) at time t in the given industry, s_{0t} is the market share of the domestic industry, $\lambda_{1,ch}$ is a variety-specific fixed effect, $\lambda_{2,t}$ is a time fixed effect, p_{cht} is the price (unit values inclusive of cost of insurance and freight and tariff duties) for a variety at time *t*, ns_{cht} is the market share of the variety within the HS 10-digit product nest, pop_{ct} is the population of the country producing the variety, and $\lambda_{3,cht}$ is an unobserved variety-time error. The derivation of this demand equation can be found in Khandelwal (2010).

Quality for variety *ch* at time *t* is defined in terms of the estimated fixed effects and the residual and is given by:

$$\lambda_{cht} \equiv \hat{\lambda}_{1,ch} + \hat{\lambda}_{2,t} + \hat{\lambda}_{3,cht}.$$

The estimated quality will intuitively be higher if a variety (country-HS 10-digit product) captures a larger share of an industries demand conditional on price, the producing country's population, and the varieties share within a nest (HS 10-digit product).[11]

In what follows, the estimated quality at the country-product-year level is normalized between 0 and 1, with 1 indicating that the country has the highest quality for that product in a given year.

Khandelwal (2010) estimates qualities for the period 1989-2001. Here qualities are estimated for the period 2002-2018. U.S. HS 10-digit trade data are from USA Trade Online.[12] The same trims to the trade data are performed as in the original paper. Population data are from

[11] Adding population to the estimating demand equation controls for hidden varieties as the HS 10-digit market shares are likely to be aggregations of even more detailed product categories with larger countries more likely to produce and export more sub-varieties. Adding nest shares to the equation allows for correlation in preferences across varieties within a HS 10-digit product. See Khandelwal (2010) for more details.

[12]The sample only includes manufacturing industries. Commodities are excluded as they tend to be homogenous and are not well suited for quality estimation in this framework.

the World Bank World Development Indicators, and industry-level domestic shares are from the NBER domestic shipments data. Price is endogenous and is instrumented using variety-specific unit transportation costs (available in the trade dataset), exchange rates (from the World Economic Outlook database), and oil prices (from Haver). ns_{cht} is instrumented with the number of varieties within the product and the number of varieties exported by this partner.

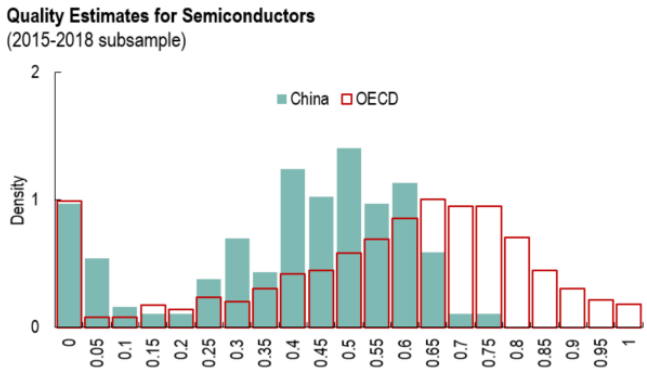
When estimating quality for the OECD as a whole, for each product the 90th percentile of quality across all OECD economies is used. To calculate the potential quality losses should China and OECD members restrict access to each other's products, it is assumed that both sets of economies can substitute towards inputs from the rest of the world with quality in the 75th percentile across all non-China, non-OECD economies. Specifically, let $j\epsilon\{CHN, OECD\}$, with $k = \{CHN, OECD\} - \{j\}$ (e.g. k is China when j is OECD members), q denote the normalized quality (location in ladder) for a given variety *(ch* subscript is suppressed for simplicity), and subscript $ROWp75$ denote the 75th percentile of non-China non-OECD, then the percent loss in quality for j is calculated as:

$$loss_j = \frac{1(q_k > q_j)[1(q_j > q_{ROWp75}) \times (q_k - q_j) + 1(q_j \leq q_{ROWp75}) \times 1(q_k > q_{ROWp75}) \times (q_k - q_{ROWp75})]}{q_k}$$

4.2 Results

As a starting point, Figure 6 plots the histogram of normalized quality at the product level for China and OECD members in semiconductor sectors, focusing on the more part of the sample (2015-18).[13] The results show that the median estimated Chinese product quality is about one-third lower than the median quality for OECD members. In a hypothetical situation in which China and the OECD cut off all access to each other's semiconductor products and assuming (as explained in the previous subsection) that both parties can easily substitute each other with a good-quality product from the rest of

Figure 6. Quality Estimates for Semiconductor Sectors

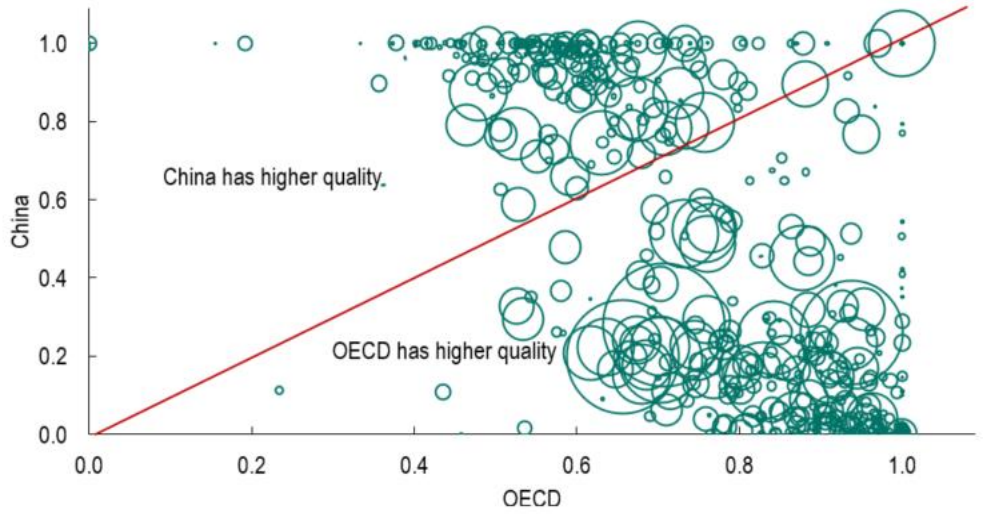


Sources: USA Trade Online and IMF staff calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

[13] These are NAICS codes including the term "semiconductor", namely NAICS industries 333242, 333994, 334413, 334419, 334515, 335999, and 423690.

the world, the trade-weighted drop in quality is of about 5 percent for China and zero for the OECD.

Figure 7. Quality Estimates for Environmental Goods
(2015-18 average; bubble size proportional to total U.S. import values)



Sources: USA Trade Online and IMF staff calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

Note: Each bubble in the figure represents an environmental good. The position of each bubble is a function of the estimated export quality for that good by the OECD (measured on the horizontal axis) and China (measured on the vertical axis). The size of the bubble is proportional to the total value of imports of that good by the United States.

The case of semiconductor industries thus features a stark asymmetry between China and OECD economies, with the former having potentially more to lose (in a static sense) from loss of access to inputs. Such an asymmetry, however, does not hold in general. Figure 7 shows the normalized quality estimates for environmental goods, as defined at the HS 6-digit level by the IMF's climate change indicators' dashboard.[14] Specifically, each bubble in Figure 7 corresponds to a product, with the export quality of the OECD measured along the horizontal axis, and the quality of China measured on the vertical axis. The size of the bubble is proportional to total U.S. imports of that product. OECD economies tend to have higher quality, and on China's side the dispersion of qualities is higher (with the lowest quality in some products). That said, there are products where China is at the quality frontier, implying potential losses for the OECD in a scenario of escalating export bans. In a hypothetical situation in which China and the OECD cut off all access to each other's environmental products, and assuming again that both parties can

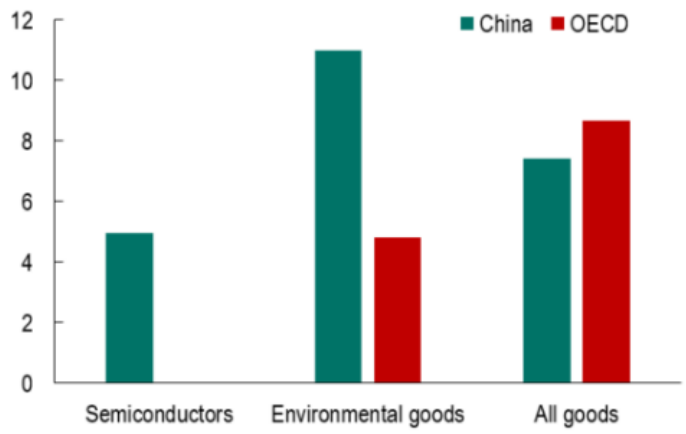
[14] Environmental goods include both goods connected to environmental protection—such as goods related to pollution management and resource management—and adapted goods—which are goods that have been specifically modified to be more 'environmentally friendly' or 'cleaner.'

easily substitute each other with a good-quality product from the rest of the world, the trade-weighted drop in quality is of about 11 percent for China and 5 percent for the OECD.

Figure 8 summarizes the results of the hypothetical exercise in narrow sectors such as semiconductors and environmental goods, and also in a scenario where trade in all goods is restricted. In the latter case, the trade-weighted losses in normalized quality are of similar magnitudes for both sets of economies (around 8 percent).

Figure 8. Quality Downgrading from Loss of Access to Others' Inputs

(percent, accounting for rest-of-world sourcing)



Sources: USA Trade Online and IMF staff calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

There are at least three important limitations of the summary gauges in Figure 8 as measures of potential quality losses from export restrictions. First, they omit the fact that different products have different elasticities of substitution. For any economy, being behind the quality frontier will be more costly in the scenarios considered if the product being restricted has a low elasticity of substitution. Second, they refer to losses in input quality, but are silent on the effects on output quality. For firms with a high-skilled labor force, such as those in high-tech sectors, estimates from the literature suggest that drops in input quality can result in output-quality reductions of similar proportions (Bas and Paunov, 2021, Table 6). Third, the estimates do not account for R&D dynamics over time, with potential development of domestic higher quality inputs if access to foreign inputs are cut off. A structural dynamic model, however, would allow one to estimate more precisely the effect of restrictions across a wider set of sectors, also potentially accounting appropriately for different elasticities of substitution and dynamic effects. This is clearly an area where future research can be very helpful.

5. Conclusion

This paper explores the potential economic impact of 'de-risking' of relations between China and OECD countries, either at the macroeconomic level based on aggregate trade policy, or within specific sectors based on restricting access to high-quality inputs.

The aggregate macroeconomic impacts are quantified using an Asia-centered version of the IMF's macro model GIMF which has an additional GVC sector. Three de-risking scenarios are considered where integration is reversed based on moving from average 2021 OECD data back to that of 2000: i) reshoring where countries increase domestic relative to foreign sourcing, reducing reliance on foreign countries, friends and rivals alike; ii). friend-shoring where countries do not change aggregate foreign sourcing but attempt to change the source of foreign sourcing away from rivals towards friends by imposing NTBs on rivals, iii) friend-shoring where countries have the same objective as the other friend-shoring scenario, but achieved by actively subsidizing their friends based on how much they tax their rivals.

The model simulations reveal that the de-risking scenarios are sizable drags on the global economy. Reshoring translates into long-term global GDP losses of 4.5 percent, while losses from friend-shoring leads to global losses of 1.8 percent when NTBs are used and 0.4 percent under the tax-and-subsidize scenario. While friend-shoring features smaller losses, it does not generate a significant boon to third countries, as trade diversion benefits are more than offset by the resulting contractions in the economies of China and OECD members, as friend-shoring policies are still highly distortionary.

For specific sectors, the methodology of Khandelwal (2010) is used to quantify the decline in input quality for China and OECD members from implementing export bans on each other. Results indicate that the semiconductor industry stands out, with a trade-weighted drop in quality of about 5 percent for China, but zero for the OECD. However, such a stark asymmetry does not hold in general. For the case of environmental goods, the trade-weighted average quality loss is of about 11 percent for China and as high as 5 percent for the OECD. For all goods combined, both sides would see input quality drop by about 8 percent.

De-risking between OECD members and China can have large negative effects at both the aggregate and sectoral levels, as demonstrated by the illustrative exercises in this paper. This underscores the need to prevent any further slide from the current fault lines in global cooperation into broader-based de-risking.

Appendix

Appendix Table 1. Eora Sectoral Mapping

Non-Tradables Sector Name	Non-GVC Tradables Sector Name	GVC Tradables Sector Name
Recycling	Agriculture	Mining and Quarrying
Electricity, Gas and Water	Fishing	Textiles and Wearing Apparel
Construction	Food and Beverages	Wood and Paper
Maintenance and Repair	Hotels and Restaurants	Petroleum, Chemical and Non-Metallic Mineral Products
Wholesale Trade	Transport	
Retail Trade	Financial Intermediation and Business Activities	Metal Products
Post and Telecommunications		Electrical and Machinery
Public Administration		Transport Equipment
Education, Health and Other Services		Other Manufacturing
Private Households		Re-export and Re-import
Others		

Sources: Eora Global Supply Chain Database; MRIO; authors' classifications.

This paper uses Eora's multi-region input-output table, which covers 189 countries and 26 sectors for the years 1990-2021 (Lenzen and others, 2012 and 2013). Several indicators, such as trade in intermediates or in final demand goods by origin, are extracted directly from the raw database. Value-added indicators, including backward and forward GVC trade, were constructed using Stata's *icio* command (Belotti and others, 2021).

Appendix Table 2. Redistributions for Reshoring

	United States	European Union + *	Japan	Korea	Other Advanced Economies	China	Global
Percent of Domestic and Foreign Sourcing by Sector							
Consumption	-1	-1	-1	-1	-1	-1	…
Investment	-3	-3	-3	-3	-3	-3	…
Non-GVC Tradables	-3	-3	-3	-3	-3	-3	…
GVC Tradables	-3	-3	-3	-3	-3	-3	…
Percent of Foreign Sourcing (Imports) by Sector							
Consumption	-20.7	-9.2	-12.3	-7.1	-5.6	-13.2	…
Investment	-43.6	-30.0	-43.5	-12.6	-35.2	-57.5	…
Non-GVC Tradables	-25.7	-20.4	-17.8	-7.0	-14.4	-26.3	…
GVC Tradables	-16.8	-31.0	-24.3	-5.5	-11.5	-15.0	…
Percent Share of Global GDP							
Consumption	-0.15	-0.11	-0.03	-0.01	-0.05	-0.09	-0.4
Investment	-0.15	-0.15	-0.05	-0.01	-0.09	-0.15	-0.6
Non-GVC Tradables	-0.11	-0.15	-0.03	-0.01	-0.07	-0.12	-0.5
GVC Tradables	-0.22	-0.41	-0.13	-0.02	-0.11	-0.23	-1.1
Gross	-0.64	-0.82	-0.24	-0.06	-0.31	-0.59	-2.7
Percent Share of Global Imports							
Consumption	-2.8	-2.0	-0.6	-0.2	-0.9	-1.6	-8.0
Investment	-5.7	-5.8	-2.0	-0.5	-3.3	-5.7	-23.0
Non-GVC Tradables	-3.3	-4.6	-1.0	-0.3	-2.0	-3.6	-14.7
GVC Tradables	-2.6	-4.8	-1.5	-0.3	-1.3	-2.7	-13.1
Gross	-3.2	-4.1	-1.2	-0.3	-1.5	-2.9	-13.3

Sources: Eora Global Supply Chain Database, OECD (2021), and authors' calculations.
Note: * "European Union +" comprises the European Union and Switzerland

The first section of Appendix Table 2 reports the shocks as they are quantified in Figure 2 in the main text, a percent of total sourcing by sector (final and tradable goods). Each following section presents the same shocks but using different methods of measuring them, based on the steady-state data used for the model simulations.

Appendix Table 3. Redistributions for Friend-Shoring

	United States	European Union + *	Japan	Korea	Other Advanced Economies	China	Global
Percent of Foreign Sourcing (Imports) by Sector							
Consumption	-10	-10	-10	-10	-10	-10	…
Investment	-10	-10	-10	-10	-10	-10	…
Non-GVC Tradables	-5	-5	-5	-5	-5	-5	…
GVC Tradables	-5	-5	-5	-5	-5	-5	…
Percent of Domestic and Foreign Sourcing by Sector							
Consumption	-0.5	-1.1	-0.8	-1.4	-1.8	-0.8	…
Investment	-0.7	-1.0	-0.7	-2.4	-0.9	-0.5	…
Non-GVC Tradables	-0.6	-0.7	-0.8	-2.2	-1.0	-0.6	…
GVC Tradables	-0.9	-0.5	-0.6	-2.7	-1.3	-1.0	…
Percent Share of Global GDP							
Consumption	-0.07	-0.12	-0.03	-0.02	-0.09	-0.07	-0.39
Investment	-0.03	-0.05	-0.01	-0.01	-0.02	-0.03	-0.16
Non-GVC Tradables	-0.02	-0.04	-0.01	-0.01	-0.02	-0.02	-0.12
GVC Tradables	-0.07	-0.07	-0.03	-0.02	-0.05	-0.08	-0.31
Total	-0.20	-0.27	-0.07	-0.06	-0.18	-0.19	-0.97
Percent Share of Global Imports							
Consumption	-1.3	-2.1	-0.5	-0.3	-1.5	-1.2	-7.0
Investment	-1.3	-1.9	-0.5	-0.4	-0.9	-1.0	-6.0
Non-GVC Tradables	-0.6	-1.1	-0.3	-0.2	-0.7	-0.7	-3.6
GVC Tradables	-0.8	-0.8	-0.3	-0.3	-0.6	-0.9	-3.6
Total	-1.0	-1.4	-0.4	-0.3	-0.9	-1.0	-4.9

Sources: Eora Global Supply Chain Database, OECD (2021), and authors' calculations.
Note: * "European Union +" comprises the European Union and Switzerland

The first section of Appendix Table 3 reports the shocks as they are quantified in Figure 2 in the main text, a percent of foreign sourcing (import share) by sector (final and tradable goods). Each following section presents the same shocks but using different methods of measuring them, based on the steady-state data used for the model simulations.

Appendix Table 4. Definition of GIMF's Intermediate Production Sectors

Non-Tradables		Non-GVC Tradables		GVC Tradables	
Code	**Sector Name**	**Code**	**Sector Name**	**Code**	**Sector Name**
D35	Electricity and natural gas	D01T02	Agriculture, hunting, forestry	D05T06	Mining (energy)
D36T39	Water	D03	Fishing	D07T08	Mining (non-energy)
D41T43	Construction	D09	Mining (support)	D13T15	Textiles, leather and footwear
D45T47	Wholesale and retail trade	D10T12	Food	D16	Wood and wood products
D53	Postal services	D23	Other non-metallic products	D17T18	Paper products and printing
D61	Telecommunications	D49	Land transport	D19	Coke and refined oil products
D68	Real estate	D52	Warehousing	D20	Chemicals
D77T82	Administration	D55T56	Hotels and restaurants	D21	Pharmaceutical products
D84	Public administration	D58T60	Publishing and broadcasting	D22	Rubber and plastics
D85	Education	D64T66	Finance and insurance	D24	Basic metals
D86T88	Health			D25	Fabricated metal products
D90T93	Arts			D26	Computers and electronics
D94T96	Other services			D27	Electrical equipment
D97T98	Households as employers			D28	Other machinery
				D29	Motor vehicles
				D30	Other transport equipment
				D31T33	Repair
				D50	Water transport
				D51	Air transport
				D62T63	Information Technology
				D69T75	Professional

Source: OECD (2021) and authors' classifications.

References

Aiyar, Shekhar, Jiaqian Chen, Christian H Ebeke, Roberto Garcia-Saltos, Tryggvi Gudmundsson, Anna Ilyina, Alvar Kangur, Tansaya Kunaratskul, Sergio Rodriguez, Michele Ruta, Tatjana Schulze, Gabriel Soderberg, and Juan Trevino. 2023. "Geoeconomic Fragmentation and the Future of Multilateralism." IMF Staff Discussion Note 2023/001, International Monetary Fund, Washington, DC.

Aiyar, Shekhar, Andrea Presbitero and Michele Ruta (eds). 2023. *Geoeconomic Fragmentation: The Economic Risks from a Fractured World Economy*. CEPR Press, Paris and London. https://cepr.org/publications/books-and-reports/geoeconomic-fragmentation-economic-risks-fractured-world-economy.

Aiyar, Shekhar, Davide Malacrino, and Andrea Presbitero. 2023. "Investing in Friends: The Role of Geopolitical Alignment in FDI Flows," CEPR Discussion Paper No. 18434, CEPR Press, Paris and London. https://cepr.org/publications/dp18434.

Alfaro, Laura, and Davin Chor. 2023. "Global Supply Chains: The Looming 'Great Reallocation.'" Paper presented at the Jackson Hole Economic Symposium, Jackson Hole, Wyoming, August 24.

Anderson, Derek, Benjamin Hunt, Mika Kortelainen, Michael Kumhof, Douglas Laxton, Dirk Muir, Susanna Mursula, and Stephen Snudden. 2013. "Getting to Know GIMF: The Simulation Properties of the Global Integrated Monetary and Fiscal Model." IMF Working Paper 2013/55, International Monetary Fund, Washington, DC.

Bas, Maria, and Caroline Paunov. 2021. "Input Quality and Skills Are Complementary and Increase Output Quality: Causal Evidence from Ecuador's Trade Liberalization." *Journal of International Economics* 151 (June): 102668. https://doi.org/10.1016/j.jdeveco.2021.102668.

Basu, Susanto. 1995. "Intermediate Goods and Business Cycles: Implications for Productivity and Welfare." *American Economic Review* 85(3): 512-31.

Belotti, Federico, Alessandro Borin, and Michele Mancini. 2021. "icio: Economic Analysis with Intercountry Input–Output Tables." *The Stata Journal* 21(3).

Blanchard, Olivier. 1985. "Debts, Deficits and Finite Horizons." *Journal of Political Economy* 93(21): 223-47.

Bonadio, Barthélémy, Zhen Huo, Andrei A. Levchenko, and Nitya Pandalai-Nayar. 2021. "Global Supply Chains in the Pandemic." *Journal of International Economics* 133 (November): 103354. https://doi.org/10.1016/j.jinteco.2021.103534.

Carton, Benjamin and Dirk Muir. 2024. "GIMF-GVC: Introducing Global Value Chains into the Global Integrated Monetary and Fiscal Model and Their Impacts." IMF Working Paper (forthcoming), International Monetary Fund, Washington, DC.

Federal Government of Germany. 2023. *Strategy on China*. Federal Foreign Office of Germany, Berlin.

Freund, Caroline, Aaditya Mattoo, Alen Mulabdic, and Michele Ruta. 2023. "Is US Trade Policy Reshaping Global Supply Chains?*"* IMF Conference on Fragmentation, May 2023.

Grossman, Gene M., Elhanan Helpman, and Alejandro Sabal. 2023. "Resilience in Vertical Supply Chains." NBER Working Paper 31379.

International Monetary Fund (IMF). 2022. "Asia and the Growing Risk of Geoeconomic Fragmentation," Chapter 3 in International Monetary Fund, *Asia and Pacific Regional Economic Outlook: Asia Sails into Headwinds from Rate Hikes, War, and China Slowdown*, October 2022, Washington, DC.

_____. 2023. "Geoeconomic Fragmentation and Foreign Direct Investment," Chapter 4 in International Monetary Fund, *World Economic Outlook: A Rocky Recovery*, April 2023, Washington, DC.

Khandelwal, Amit. 2010. "The Long and Short (of) Quality Ladders." *The Review of Economic Studies* 77 (4): 1450–76.

Kumhof, Michael, Douglas Laxton, Dirk Muir, and Susanna Mursula. 2010. "The Global Integrated Monetary and Fiscal Model (GIMF)—Theoretical Structure." IMF Working Paper 2010/34, International Monetary Fund, Washington, DC.

Lenzen, Manfred, Keiichiro Kanemoto, Daniel Moran, and Arne Geschke. 2012. "Mapping the Structure of the World Economy." *Environmental Science and Technology* 46 (15): 8374–81. https://doi.org/10.1021/es300171x.

_____. 2013. "Building Eora: A Global Multiregional Input-Output Database at High Country and Sector Resolution." *Economic Systems Research* 25 (1): 20–49. https://doi.org/10.1080/09535314.2013.769938.

Organization for Economic Cooperation and Development (OECD). 2021. "OECD Inter-Country Input-Output Database." Organization for Economic Cooperation and Development. Paris. http://oe.cd/icio.

Shivakumar, Sujai, Charles Wessner, and Thomas Howell. 2022. "A Seismic Shift: The New US Semiconductor Export Controls and the Implications for US Firms, Allies, and the Innovation Ecosystem." Center for Strategic and International Studies, November 2022. https://www.csis.org/analysis/seismic-shift-new-us-semiconductor-export-controls-and-implications-us-firms-allies-and.

PUBLICATIONS

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