BATModel

better agri-food trade modelling for policy analysis

EU-China Decoupling by the numbers: Mapping the realignment of global value chains

David Cui (Wageningen Economic Research), Ilaria Fusacchia (University of Basilicata), Luca Salvatici (Roma Tre University)

The BATModel project (Grant Agreement No.: 861932) has received funding from the European union' Horizon 2020 Research and Innovation Programme. The views and opinions expressed in this report does not represent the official position of the European Commission and is entirely the responsibility of the authors.

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SUMMARY

Intensified fragmentation and geographical dispersion have made Global Value Chains (GVCs) ever more complex and more interdependent, and, in turn, more vulnerable. In recent years, GVCs have faced severe shocks due to the combined impact of COVID-19, trade frictions, and geopolitical tensions.

The EU economy is both a major importer and exporter on the international stage. Ensuring an open and fair-trading system is of key importance for the prosperity and future growth of the EU industry and to the benefit of European consumers and citizens. Despite severe disruptions in production, transport and people's mobility, most value and supply chains have shown remarkable resilience. Still, the crisis has also highlighted that while the EU gains resilience from open and integrated world markets in global value chains, disruptions in these GVCs can affect specific essential products and inputs that are particularly critical for society and the EU economy.

One of the key lessons of the crisis is that there is a need to get a better grip and understanding of where Europe's current and possible future strategic dependencies lie. Empirical evidence shows that while the number of dependent products has shown no clear pattern since the mid-1990s in terms of sectoral composition, the map of the EU dependencies, based on the top country of origin for each dependent product, shows a clear shift in the origin toward China. This calls into question the potential for supplier diversification. Such patterns suggest that it is not the underlying structure of dependencies that has changed but the perceived risks associated with them because of the concentration of imports of dependent products from a source country, China, that is now considered less aligned geopolitically to the EU.

The EU is worried China is increasing its industrial capacity, particularly in renewable energy products, at a time when China's domestic demand is weak and other trading partners, such as the US, are limiting access to their markets. This leaves Europe as an important target for an overflow of China's exports. Valdis Dombrovskis, the EU trade commissioner, told the Financial Times that Chinese overcapacity was "a cause for concern", and European business claims that the EU trade deficit is at least partially explained by China's state subsidies and barriers to foreign companies.

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In this work, we investigate how tensions between highly interdependent economies will impact trade, income and GVCs. Specifically, we analyze the role of complex supply chain linkages in determining how demand for value-added (e.g. remuneration of primary factors) responds to changes in international relative prices. We rely on a set-up featuring General Equilibrium (GE), GVC module and, importantly, differentiating demand for goods according to their use for final or intermediate consumption. The decoupling has indeed a direct impact on the targeted products, but GVCs, along with GE effects, trigger additional consequences worth investigating. In particular, by tracing the impact of decoupling along the GVCs, we assess to what extent the EU's exports are affected due to reduced competitiveness led by vertical linkages, and we find a loss of EU competitiveness in all markets as production costs increase in industries using Chinese imported goods as inputs. By the same token, restricting Chinese exports to the EU market that contain previously exported EU intermediate inputs also hurts the EU value added. These are the effects that are tackled in this work.

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INTRODUCTION

Over the last decades, production processes and supply chains have become increasingly interlinked across countries and continents. The drivers explaining the continuous integration of Global Value Chains (GVCs) include, among others, cost reduction, greater market openness (lower tariff and non-tariff barriers), changes in the political environment, as well as multiple technological innovations. GVCs enable firms to improve their market position through delocalisation strategies, generate benefits from a more efficient production process (including, in some cases, lower prices for final consumers), and help firms reduce risks.

China's importance in the global economy has increased dramatically in recent decades and has been a crucial driver of trade integration in Asia. In the latest Regional Economic Outlook for Asia and the Pacific, the IMF assesses the potential effects of a downside scenario from 'de-risking' between China and the Organisation for Economic Co-operation and Development (OECD) economies. The de-risking strategies by China and the United States and other OECD countries that aim to reshore production domestically or friend-shore away from one another can result in a significant drag on growth around the world even assuming no new trade restrictions with third countries—especially in Asia.

The EU economy is both a major importer and exporter on the international stage. Ensuring an open and fair trading system is of key importance for the prosperity and future growth of the EU industry and to the benefit of European consumers and citizens. Despite severe disruptions in production, transport and people's mobility, most value and supply chains have shown remarkable resilience. Still, the crisis has also highlighted that while the EU gains resilience from open and integrated world markets in global value chains, disruptions in these global value chains can affect specific essential products and inputs that are particularly critical for society and the EU economy.

One of the key lessons of the crisis is that there is a need to get a better grip and understanding of where Europe's current and possible future strategic

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dependencies lie. External dependencies concern the EU's reliance on external partners (third countries or firms). This is the case, for example, concerning political tensions and geo-political uncertainty, which can be important risks for the EU at an international level. There are different types of shocks that play a role when assessing the impact of dependencies. Such shocks can be supply-related (e.g. a given supplier within a value chain no longer producing or delivering certain goods and services, or in reduced quantities; or the country where the supplier is based imposing certain export restrictions) as well as demand-related (e.g. a sudden important drop in the EU or global demand for goods and services, or a sudden global rise in market demand for certain goods or services) and they can have multiple origins (man-made, natural, etc.).

According to Vicard and Wibaux (2023), the number of dependent products has shown no clear pattern since the mid-1990s in terms of the sectoral composition. On the other hand, the map of the EU dependencies, based on the top country of origin for each dependent product, shows a clear shift in the origin toward China. Considering the top 10% most concentrated products in world exports, China appears in the first five exporters for 249 of them in 1996 but 527 in 2019. This calls into question the potential for supplier diversification. Such patterns suggest that it is not the underlying structure of dependencies that has changed but the perceived risks associated with them because of the concentration of imports of dependent products from a source country, China, that is now considered less aligned geopolitically to the EU, and/or increasing risks of supply-chain disruption due to pandemics or natural disasters.

The EU is worried China is increasing its industrial capacity, particularly in renewable energy products, at a time when China's domestic demand is weak and other trading partners, such as the US, are limiting access to their markets. This leaves Europe as an important target for an overflow of China's exports. Valdis Dombrovskis, the EU trade commissioner, told the Financial Times that Chinese overcapacity was "a cause for concern", and European business claims that the EU trade deficit is at least partially explained by China's state subsidies and barriers to foreign companies.

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We investigate in this deliverable how tensions between highly interdependent economies will impact trade, income and GVCs.

In this deliverable, we analyze the role of these input linkages in determining how demand for value-added responds to changes in international relative prices. The fact that decoupling takes place in a world economy characterized by GVCs has major implications since by linking domestic and foreign production processes, global supply chains alter how shocks are transmitted across borders.

Conventional frameworks treat exports as composed entirely of domestic value-added, while imports are entirely foreign value added. As a result, they focus on demand-side channels (e.g., expenditure switching) via which trade transmits shocks across countries. The growing importance of global supply chains poses a challenge to these frameworks since they also link countries together on the supply side. Global supply chains break the one-to-one correspondence between demand for gross exports and demand for domestic value added. This means that gross expenditure switching away from exported goods translates less than one-for-one into demand for domestic value added. Moreover, part of the cost from decreased exports is passed back through the production chain to countries that supply inputs. When those inputs come from third countries, gross bilateral trade may be a poor guide to bilateral spillovers.

We rely on a set-up featuring General Equilibrium, GVC module and, importantly, differentiating demand for goods according to their use for final or intermediate consumption. The decoupling has indeed a direct impact on the targeted products, but GVCs, along with General Equilibrium effects, trigger additional consequences worth investigating. This allows tracing the impact of decoupling along the value chains on prices, value-added and factor income. In particular, we can assess to what extent the EU's exports are affected due to reduced competitiveness led by vertical linkages along the value chains. the EU's exports will likely suffer a loss of competitiveness in all markets as production costs increase in industries using Chinese imported goods as inputs. By the same token, restricting Chinese exports to the EU market that contain previously exported EU

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intermediate inputs also hurts the EU value added. These are the effects that will be tackled in this deliverable.

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OBJECTIVES

The main objective of this deliverable is to conduct a trade policy experiment motivated by the EU-China trade relationship as mentioned above and use this experiment to test the GVC module created under task T4.5. The purpose of creating this GVC module is to enable a flexible switch between the MAGNET-GVC version and the standard MAGNET version. With a switchable module, modellers can attach this module to other GTAP-based CGE models (e.g., MAGNET) and use this module to gain insights into the results at the MRIO level (e.g. value-added movements across borders) and compare these results with those derived from the standard version. The module code and the associated documentation for this module have been made available on a wiki page[1]. For this policy experiment, we attach this module to the standard MAGNET model and switch on this module to conduct the GVC analysis.

To conduct this test properly, we need to run this policy experiment in two different model versions - the standard MAGNET model version and the GVC version of the MAGNET model. In doing so, we will be able to check, for example, whether the same policy change produces similar results in the two different model versions or to what extent the results in the two model versions differ. The results to be compared and reported include not only regular indicators like domestic value-added by sector and employment but also the GVC-related trade protection indices and other welfare indicators. This comparison analysis will allow us to better capture and understand the differentiated impacts of shocks inside and outside the GVC sectors across different production locations.

The policy experiment we conduct reflects a hypothetical decoupling between the EU and China, with policy changes implemented from the EU perspective. To capture a possible policy change in the EU in response to the increasing concern of the EU's businesses and industries over the mounting inflow of China's exports, we expect the policy measure to be

[1] The wiki page is available at: https://github.com/BATModules/BATModules/wiki/GVC-Module-%E2%80%90-Global-value-chains

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implemented in such a way that would make China's exports in the EU market more difficult and/or more costly. To simplify this experiment, we do not consider potential retaliatory measures implemented by China, which will naturally complicate the situation and the analysis. Furthermore, while the mounting trade between the EU and China over the recent decades has been reflected in a wide range of products, we do not consider that all of these traded products will cause large repercussions in the EU's market if a decoupling policy is in place. In light of this, we focus on the sectors where China's export accounts for a relatively large share of the EU's import. This would better reflect usual policy practices in the real world, where trade measures typically target certain products or services.

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METHODS

Our quantitative analysis is based on MAGNET, a multisector, multiregion, recursively dynamic computable general equilibrium (CGE) model of the world economy (Woltjer and Kuiper, 2012). As with other CGE models, MAGNET explicitly represents the economic linkages across the sectors of each model region, which is particularly important when analysing policy effects in sectors that are vertically linked with each other, such as trade flows in value added. MAGNET is built upon the GTAP (Global Trade Analysis Project) database and has the standard GTAP model (Hertel, 1997) at its core, and extends the GTAP model by adding a number of policy-relevant modules. Due to its policy relevance, MAGNET has been widely used for policy analysis (for example, Nowicki et al., 2009, Woltjer, 2011, Doelman et al., 2019, Kuiper and Cui, 2021, Latka et al., 2021) and used by many international organizations including the FAO, OECD (2019), the JRC (2018), IFAD (IFAD, 2021), and others.

For this modelling exercise, we employ the latest version of MAGNET which has been upgraded to be compatible with GTAP model version 7 and its database version 10.1 with 2014 as the base year. In light of policy relevance, we prepare a model aggregation which contains 51 commodities/sectors and 16 world regions. The 51 commodities/sectors corresponding to the standard GTAP commodities/sectors are aggregated from the 115 standard MAGNET commodities. The only exception is the services sector which represents an aggregated services sector containing all the standard GTAP services sectors. We make this simplied commodity aggregation since the trade policy shocks in our experiment are only applied to goods rather than to services. The list of these aggregated commodities is presented in Table 1.

In terms of regional aggregation, we take into account the EU's possible reshoring options in response to changes in trade policy, meaning that those countries having substantial amount of trade with the EU or China needs to be particularly investigated into. This motivates us to make the major trading partners of the EU and China as separate model regions. Eventually, we come up with 16 model regions in order to effectively

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capture potential reshoring options and trade diversion effects, as shown in Table 2.

Table 1: Aggregated commodities/sectors in the model

	Code	Commodity Description		Code	Commodity Description
1	pdr	Paddy rice	27	tex	Textiles
2	wht	Wheat	28	wap	Wearing apparel
3	gro	Cereal grains nec	29	lea	Leather products
4	v_f	Vegetables, fruit, nuts	30	lum	Wood products
5	osd	Oil seeds	31	ppp	Paper products, publishing
6	c_b	Sugar cane, sugar beet	32	p_c	Petroleum, coal products
7	pfb	Plant-based fibers	33	chm	Chemical products
8	ocr	Crops nec	34	bph	Basic pharmaceutical products
9	ctl	Bovine cattle, sheep and goats	35	rpp	Rubber and plastic products
10	oap	Animal products nec	36	nmm	Mineral products nec
11	rmk	Raw milk	37	i_s	Ferrous metals
12	wol	Wool, silk-worm cocoons	38	nfm	Metals nec
13	frs	Forestry	39	fmp	Metal products
14	fsh	Fishing	40	ele	Computer, electronic and optic
15	coa	Coal	41	eeq	Electrical equipment
16	oil	Oil	42	ome	Machinery and equipment nec
17	gas	Gas	43	mvh	Motor vehicles and parts
18	oxt	Minerals nec	44	otn	Transport equipment nec
19	cmt	Bovine meat products	45	omf	Manufactures nec
20	omt	Meat products nec	46	ely	Electricity
21	vol	Vegetable oils and fats	47	gdt	Gas manufacture, distribution
22	mil	Dairy products	48	otp	Transport nec
23	pcr	Processed rice	49	wtp	Water transport
24	sgr	Sugar	50	atp	Air transport
25	ofd	Food products nec	51	svcs	Services
26	b_t	Beverages and tobacco products			

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Table 2: Aggregated regions in the model

	Code	Region Description		Code	Region Description
1	EU	EU 27	9	MENA	Middle East & North Africa
2	REU	Rest of Europe	10	SAF	South Africa
3	FSU	Former Soviet Union	11	SSA	Rest of Sub Saharan Africa
4	CHN	China	12	USA	United States
5	JAP	Japan	13	NAM	Rest of North America
6	EAS	Rest of East Asia	14	BRA	Brazil
7	IND	India	15	LAM	Rest of Latin America
8	RAS	Rest of Asia	16	OCE	Oceania

The policy experiment we implement in the MAGNET model reflects a reduced demand of the EU for China's agri-food and manufacturing exports. Specifically, the experiment targets the EU's products with an above-average import share from China. In other words, we are targetting major imports of the EU from China that take a reasonably large share in the EU's total import of that particular product and thus may have a significant influence on the EU's domestic economy if a new trade measure is applied. The targeted commodities with their respective import share from China are presented in Figure 1, which shows that out of the 51 aggregated commodities, the EU's import from China in 17 of them exceeds the (weighted) average share of 14%, ranging from just about the average share of 14% for ferrous metals to the highest import share of 50% for leather products.

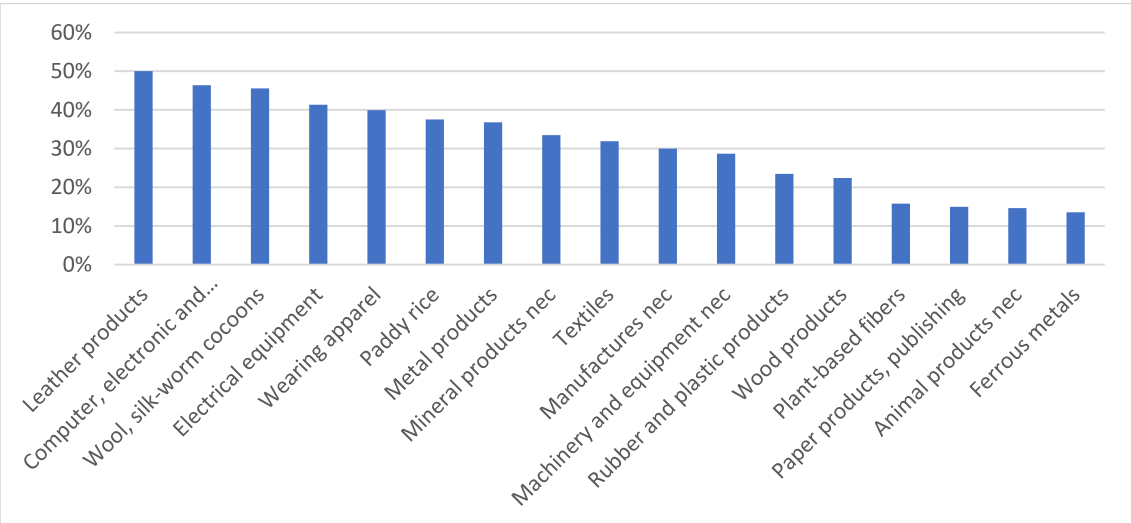

Figure 1 targeted commodities with an above-average import share from China

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In our policy experiment, we are aiming to halve the EU's import share from China in these targeted commodities, following a hypothetical trade measure imposed by the EU. That is, if a commodity's initial import share from China is at the average level (14%), the expected import share from China for that product will be reduced to 7% after the policy simulation is completed. Likewise, the leather products with the initial 50% maximum import share from China will have its import share reduced to 25%. The same reduction rule applies to all the other targeted commodities.

We implement the reduction in import share from China through non-tariff measures (NTMs) rather than tariff escalation. The consideration is that NTMs can potentially capture a wide range of policy instruments such as quota, labelling, technical standards, preference shift, etc., rather than focus on a single trade measure such as tariff. This choice reflects the uncertainty we now face around what instruments the EU may choose to implement its reshoring policy. In MAGNET, the same as in GTAP, a change in non-tariff trade costs is captured by the policy variable, ams, which is defined as an iceberg trade cost distinguishable by commodity, exporting region and importing region. In the GVC version of the model, this variable is also distinguishable by activity, which helps gain insights into the MRIO level of the simulation results.

To make the two model versions comparable, the experiment to reduce the EU's import from China must be undertaken at the bilateral trade level rather than at the agent-specific MRIO bilateral trade level. This is because in the standard MAGNET/GTAP model, there are no direct input-output relationships between two traded sectors located in two different model regions while these direct input-output relationships capturing the MRIO level trade flows are reflected in the GVC version of the model. That is, the MRIO level trade flows have one more dimension than the GTAP level trade flows. This makes it impossible to implement a comparable trade measure at the MRIO level and this measure has to be implemented at the GTAP level. In doing so, the GTAP level trade cost captured by the policy variable, ams, acts as an aggregation of MRIO level trade costs summed over all sectors importing the same commodity. In this experiment, the ams

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variable is endogenously determined such that the import share from China for the targeted commodities is halved. Due to the difference in trade structure between the two model versions, the resulting change in this policy variable in response to the same trade shock might be different in the two model versions. This thus allows us to assess the implied trade costs in the two different model versions and compare other model results as well.

In the GVC version of the MAGNET model the GTAP-VA module is attached where the gross trade flows are decomposed to reallocate the value added generated in the production of goods and services back to the countries in which that income is generated. This framework allows us to assess the effect of the policy change on the global structure of global value chains, by comparing the baseline values and the updated values derived from the simulated shock.

Value added is defined as the difference between the value of output and the total value of purchased intermediate inputs, and includes compensation for labour and capital and taxes. The analysis in this deliverable uses the following indicators related to the value added embedded in a traded good or service:

i) Bilateral domestic value added (DVA)

This corresponds to the value originated in all sectors of the exporting country which is embedded in a domestic sector's exports. The DVA in exports gives a measure of the real contribution a given export makes to an economy's income. Within the DVA, two components can be further distinguished: a) the value originating in the domestic exporting sector (direct); and b) the value that originated in a domestic sector providing intermediate inputs to other domestic exporting sectors (indirect).

ii) Multilateral domestic value added

This is defined as the domestic value added contained in intermediate goods and services that is exported to a partner country which then re-

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exports it to the final market, now embodied in other goods or services. Multilateral DVA, also referred to as a “triangular” production chain (Johnson and Noguera, 2012), provides a measure of the forward linkages a country has in selling in international VCs.

Both the DVA and the multilateral DVA indicators are adjusted for double-counting, meaning that the domestic value added embodied in an export that has previously crossed a region’s international border, and hence has already been counted as domestic value added, is netted out.

iii) Foreign value added (FVA)

This is the value of imported intermediate inputs embodied in a country’s exports. It is sometimes referred to as backward linkages in global production networks because it reflects linkages up the value chain towards its origin. The FVA includes the country of origin value-added that is re-imported (circular trade).

With these value added indicators, we can decompose the overall trade value related to the EU and China into different value added components. This would help us gain insights into how the imposed trade measure may affect the import and export of the EU as some of these insights may not be revealed with conventional indicators.

Applying these value added indicators to the model's base data, we can get a better understanding of the composition of the EU's imports from China. Figure 2 reports China-originated value added embedded in the EU's import for each of these targeted commodities. The Chinese VA can reach the European market both bilaterally (through direct exports) and multilaterally (through other countries' exports). Although most of the Chinese value added is traded bilaterally, a consistent part of the exported VA in some sectors with a high level of GVC integration, like Computer, electronic and optic (8.2 billion US$), passes through other regions before reaching the EU. Essentially, this value added figure shows not only the importance of each traded commodity in the EU’s import from China and the likely impact on

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the trade flows, but also how China's domestic economy may be hurt due to the presence of its domestic VA in these exports into the EU market.

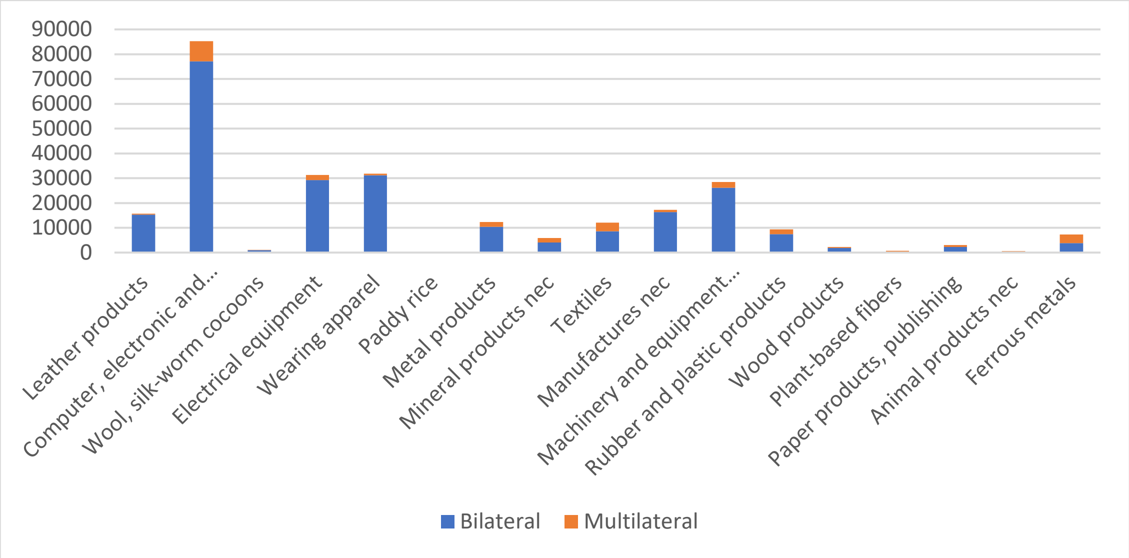

Figure 2 EU's import of Chinese VA (million US$)

The value added decomposition also reveals that the EU's imports from China contains not only China-originated VA but also its own VA, that is, the EU-originated VA but re-imported from China. Import in some of the targeted commodities, such as Computer, electronic and optic and Electrical equipment, embed a non-negligible value originated within the EU (3.8 billion and 1.1 billion US$, respectively). The EU's VA ranking in the figure indicates how the EU's domestic sectors are likely affected due to the presence of its domestic VA in these imports.

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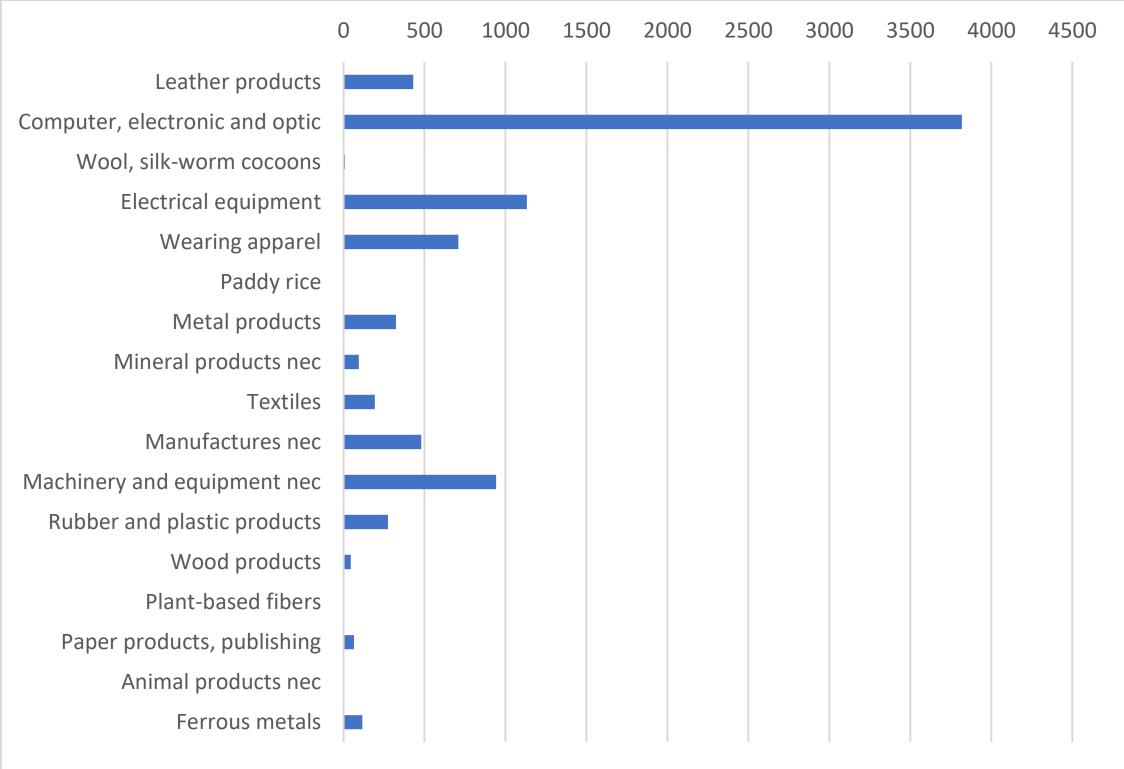

Figure 3 EU's VA re-imported from China (million US$)

Another GVC perspective is to look at the value added composition in the EU's export. When the import shock strikes, it will affect not only directly the EU's import from China, but also indirectly the EU's export to all the regions. This VA compositon thus can tell us how the EU's export will be affected following an import shock, and importantly, to what extend a shift in the EU's export is caused by the input-output induced supply chain effect rather than by a trade-off with domestic supply. In Figure 4 we represent the main EU exporting sectors and decompose their gross exports to identify the extent to which the EU's exports depend on imported inputs of goods and services. This dependency is sizeable — about 21.5% in total, of which 12% originates in China. The relevance of China as a provider is particularly high for some sectors such as Computer, electronic and optic and Wearing apparel in which China's VA represents 8.3% and 6.3% of the gross exports, respectively. A higher dependency ratio implies that the EU's export in these sectors more likely suffers from the supply chain effect if the import of intermediate inputs is disrupted.

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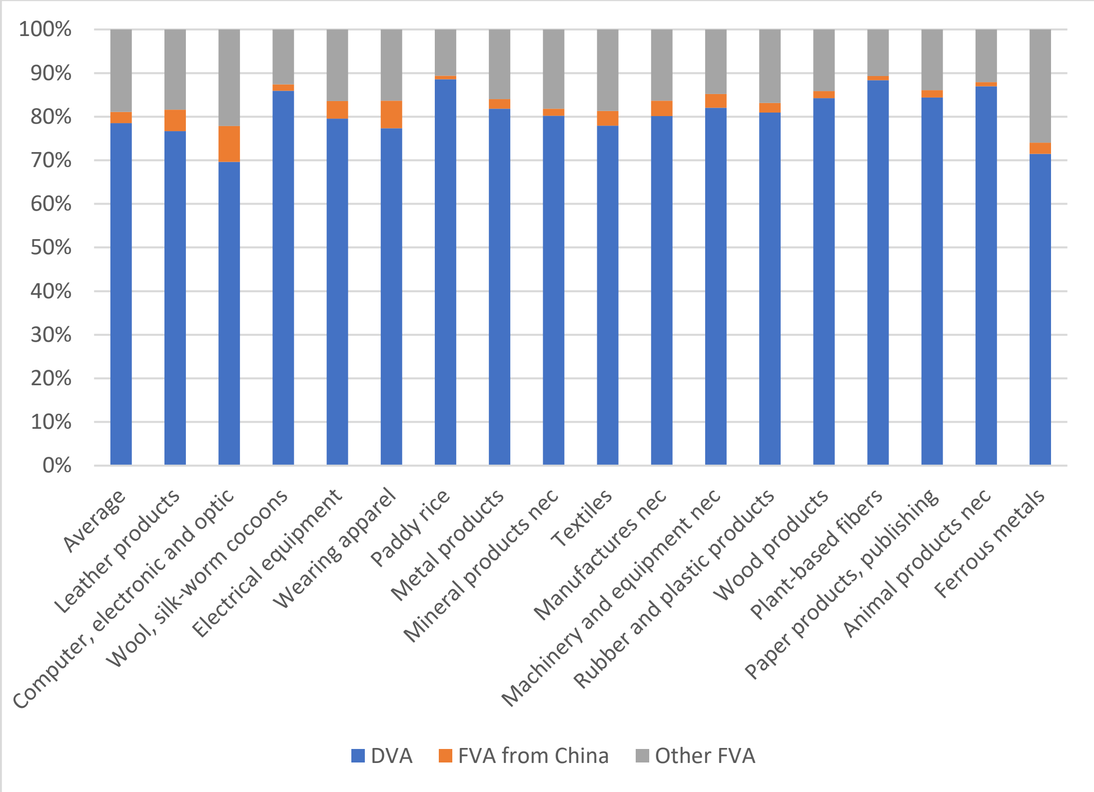

Figure 4 VA composition of EU's exports (% of gross exports)

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RESULTS AND DISCUSSION

In this section, we present the simulation results coming out of our policy experiments. We divide the results into two subsections. In the first subsection, the results are based on conventional indicators which are available in both model versions we experiment with. Thus, the results shown in this subsection are compared between the two different model versions. In the second subsection, we present the results which are only available in the GVC version of the model to showcase the strengths of the GVC module in providing insights into the MRIO level findings.

1) Conventional results available in both model versions

Using the postsim results for the coefficient capturing bilateral trade flows for imports, VMSB, we can compute the EU's end import shares from China for those targeted commodities and compare them with the start import shares (presim values) in the base data. As shown in Figure 5, these shares are halved to 50% of their respective presimulation values, indicating that these shocks are implemented as expected.

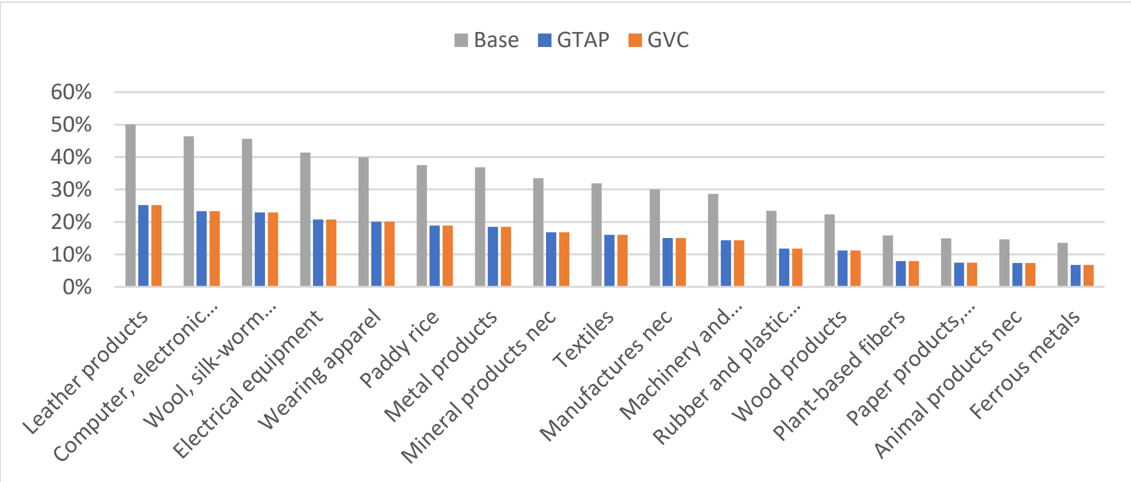

Figure 5 EU's start and end import shares from China for targeted commodities

As mentioned earlier, the policy instrument we use to achieve the 50% reduction in the EU's import shares from China is via a productivity variable to capture an iceberg trade cost. The required trade cost change to achieve

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their respective end shares for the targeted commodities are reported in Figure 6, which shows the required increases in trade cost in both model versions. Most commodities are expected to have a trade cost increase between 10% and 20%, with a weighted average of 14%. The only exception is Animal Products nec., which requires a higher trade cost increase of nearly 40%. This is likely due to relatively low Armington elasticities being applied to this commodity group - an elasticity of 1.3 between domestic and imported and 2.6 between import source regions, compared to the elasticities of 3-5 between domestic and imported and 6-10 between import source regions for the other targeted commodities. These relatively low Armington elasticities cause more difficulties in the EU's production and trade system when adjusting to meet the overall demand for this targeted commodity group.

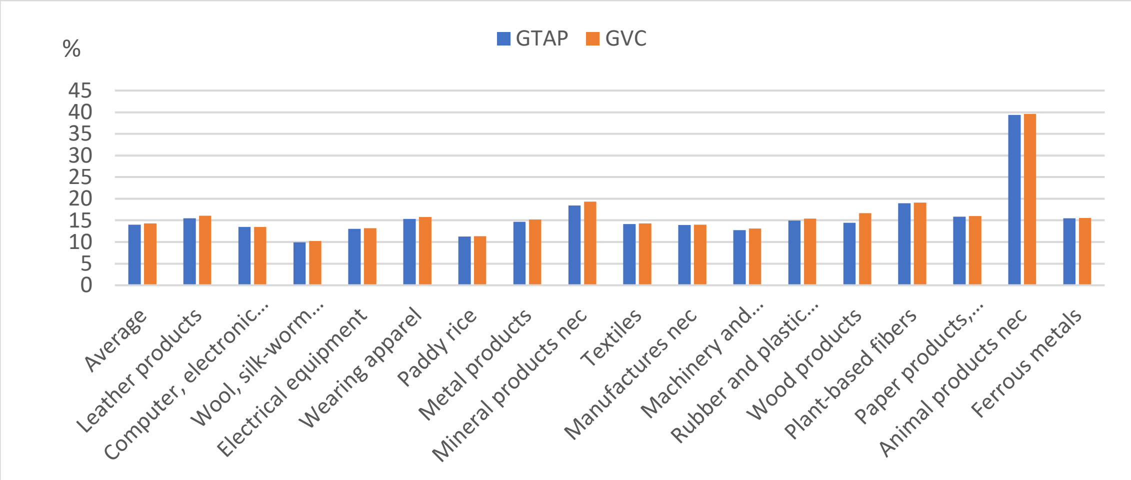

Figure 6 Increase in the EU-China trade cost to achieve targeted shares

The reduction in the EU's import from China will direct the import of targeted commodities to the rest of the world, causing the EU's import from the rest of the world to increase by approximately 21% on average for the targeted commodities and this increase is again very close between the two model versions. The distribution of this increased import across targeted commodities is largely consistent with the EU's reliance on China's supply of these commodities, as reflected in Figure 7 that is, a highly reliant commodity will be subjected to a larger reduction in import and thus needs to be offset more from the rest of the world. For the consistency of counting

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international trade flows, we exclude the changes in intra-EU trade from the trade responses shown here.

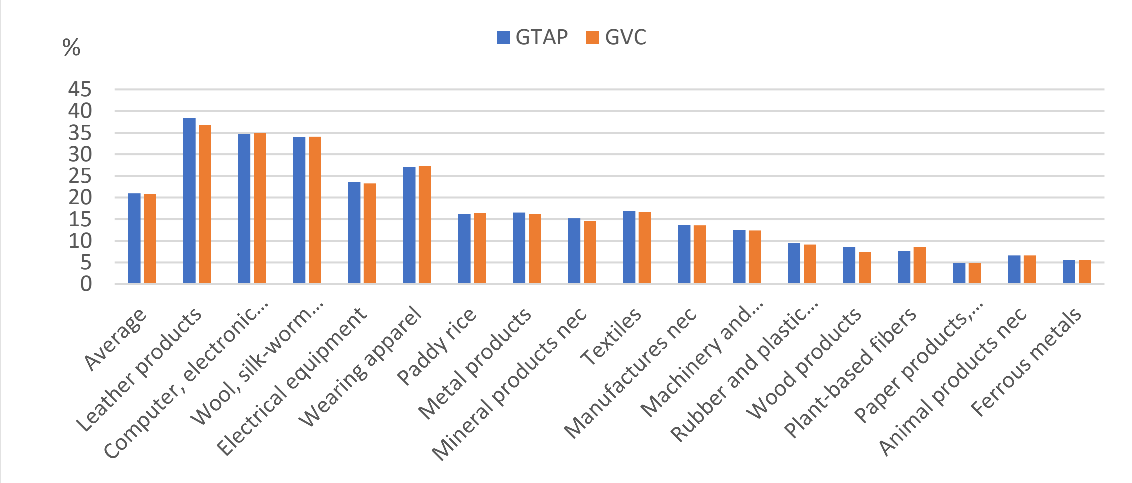

Figure 7 Response in EU's import from the rest of the world (excl. China & EU)

The changes in imports of the EU from the rest of the world for the targeted commodities are distributed unevenly across regions, as shown in Figure 8, which also shows that this regional landscape is very similar between the two model versions. For an overall reduction of 175 billion US dollars (2014 constant price) worth of imports from China, both model versions show that the EU's import in these targeted commodities will be offset mostly by other Asian countries that are geographically adjacent and also have close trade ties with China. A large part of the import will also be offset by the Rest of Europe, which includes countries adjacent to the EU and by the United States. Albeit with all the import offsets from the rest of the world, the EU's overall import in these targeted commodities still declines significantly, left with about a 53 billion dollar import gap globally.

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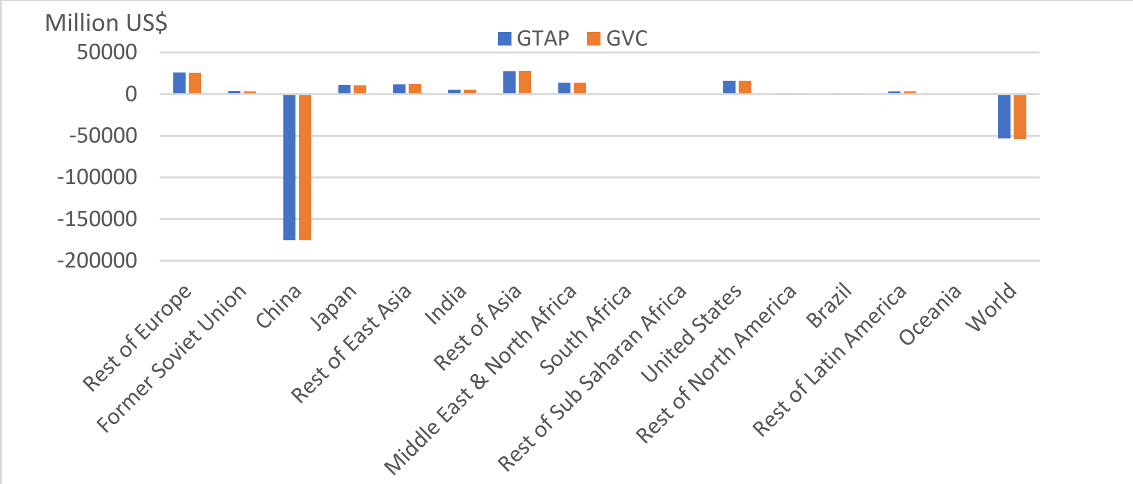

Figure 8 Response in EU's total import in targeted commodities

This import gap needs to be offset to some extent by an expansion in the EU's domestic production. Both model versions project that the EU's domestic production for these targeted commodities will increase by slightly over 1% on average (Figure 9). The GVC version projects a larger increase in leather products and wool but smaller increases in the other products. Notably, the production response in individual commodities does not necessarily reflect the EU's import reliance on China. This is because a commodity's production is bound by a production system that for different commodities may have different technological, biophysical, or other constraints. Paddy rice, for example, is not expected to respond sharply even if with a large import decline since this is not a major product in the EU in light of the specifically required growing conditions for paddy price. As a result, its demand gap in the EU will be offset mostly by the increased import from the rest of the world and, to some extent, substituted by the increased demand for other commodities.

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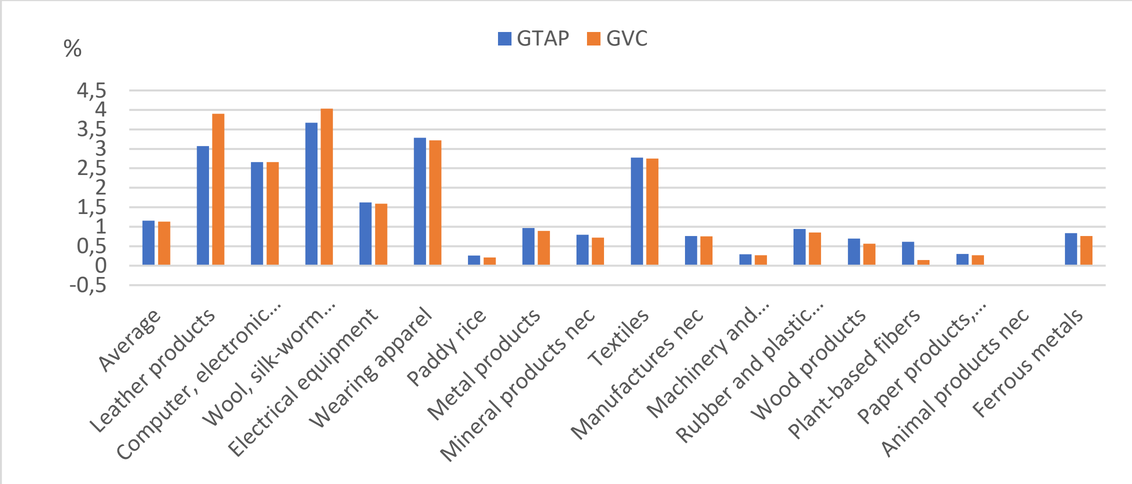

Figure 9 Response in EU's domestic production in targeted commodities

Following the halved import from China, the EU's exports in the targeted commodities need to decline, together with increased domestic production, to compensate for the overall reduced domestic supply. This implies that the EU's export reponse in these targeted commodities is mainly driven by import rather than by production. As shown in Figure 10, the two model versions project a similar decline in the EU's export of these targeted commodites with an average decline of 3%. The magnitude of the declines across targeted commodities is largely consistent with the EU's import reliance from China for these commodities, with the more reliant commodities overall declining more than the less reliant commodities. A small difference between the two model versions lies in the projection for paddy rice as the standard model projects a small positive growth in the EU's export in this commodity.

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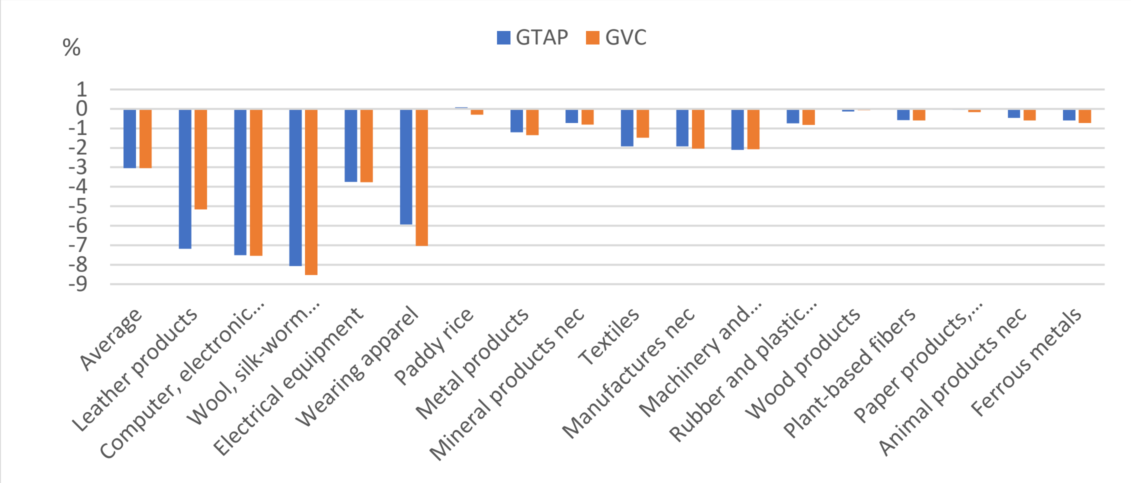

Figure 10 Response in EU's export in targeted commodities

With import reshoring, export shrinking, and production expanding in these targeted commodities, non-targeted commodities also respond to this trade shock although in a somewhat different way. Figure 11 shows that the import decline in the targeted commodities also causes an overall import decline in the non-targeted commodity groups, leading to a total import decline of nearly 2% if all commodities are counted. This overall decline is also reflected in all major commodity groups divided into agri-food, manufacture and services. To a great extent, this common declining trend across commodity groups suggests that traded products and services are mostly complements in nature, so the declining import in those targeted commodities cannot just be substituted away with an import increase in the other commodities. This is consistent with the typical view held in the growing body of GVC-related trade literature that international trade is increasingly dominated by intra-industry trade in intermediate goods. This view will also be confirmed by our value added results shown later.

In terms of the EU's domestic production, however, the response in the non-targeted commodities is quite different from the targeted commodities. Figure 11 shows that the production responses in the two different commodity groups move in the opposite way, reflective of the rivalry in the EU's domestic resource use as resources are moved away from the other sectors to boost the production of those targeted commodities. Manufacturing sectors as a whole in the EU experience an increase in

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production, reflecting that the EU's imports from China are mostly manufactures, while this increase is at the cost of an output decline in agri-food and services. Overall, the EU's domestic production barely changes if all the commodity groups are taken into account, an expected general equilibrium result following such a single trade shock.

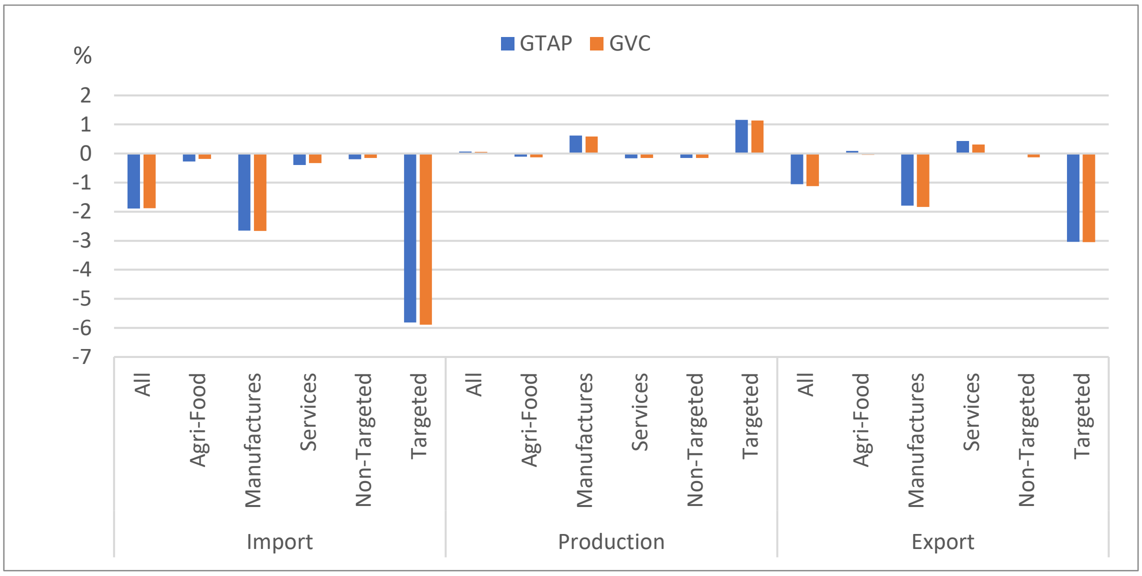

Figure 11 Response in EU's import, export and production in key commodity groups

The export response in the EU is yet another different situation compared with the import and production responses. Non-targeted commodities experience a small decline in exports, similar to the import response in these commodities. However, the responses across different industrial groups are quite different. Manufactures experience an export decline as their import counterparts do, but export in non-manufactures, especially export in services, is expected to experience a moderate increase. This is likely due to the substitution effect induced by the import shock as commodities, especially the non-targeted commodities, previously demanded more services but now demand less due to a contraction in producing these commodities, and this leads to redundant services demand being diverted towards export.

the EU's domestic value-added components largely follow the response in the EU's domestic production. Figure 12 shows that the two main value-added components, labour and capital, will be reallocated from non-

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targeted commodities to targeted commodities and from non-manufactures to manufactures, consistent with the output response shown in Figure 11. Since this is a comparative static analysis and no shocks to employment or capital supply are imposed, the overall value-added components at the EU level are held constant, meaning that the value-added response across different commodity groups simply reflects a resource reallocation across sectors following the trade shock.

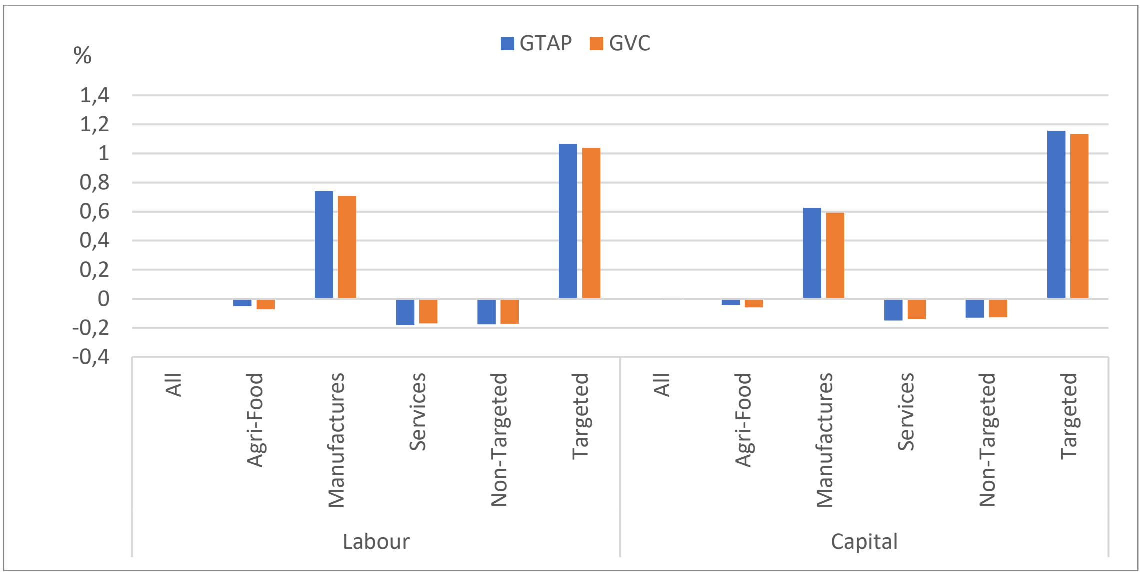

Figure 12 Reallocation of EU's domestic value-added components

Following the reduction of the EU's import from China, both economies are expected to suffer an overall contraction, reflected by a similarly negative GDP growth projected in both model versions, as shown in Figure 13. The rest of the world, on the other hand, may benefit from this trade shock as the EU's import demand in the targeted commodities will be directed towards these regions. Overall, the world GDP on average still suffers a loss as inefficiency arises in resource allocation when the production structure and trade flows reshuffle in each world region. Between the two directly affected economies, the EU appears to suffer a greater loss in GDP than China does, due likely to the fact that, for the targeted commodities, the EU's import share from China (36.5%) is greater than China's export share to the EU (15.8%), and the EU's import ratio (import over domestic production, 6.7%) is greated than China's export ratio (export over

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domestic production, 3.2%). Relatively, this makes it harder for the EU to absorb this trade shock in the domestic market and via import reshoring.

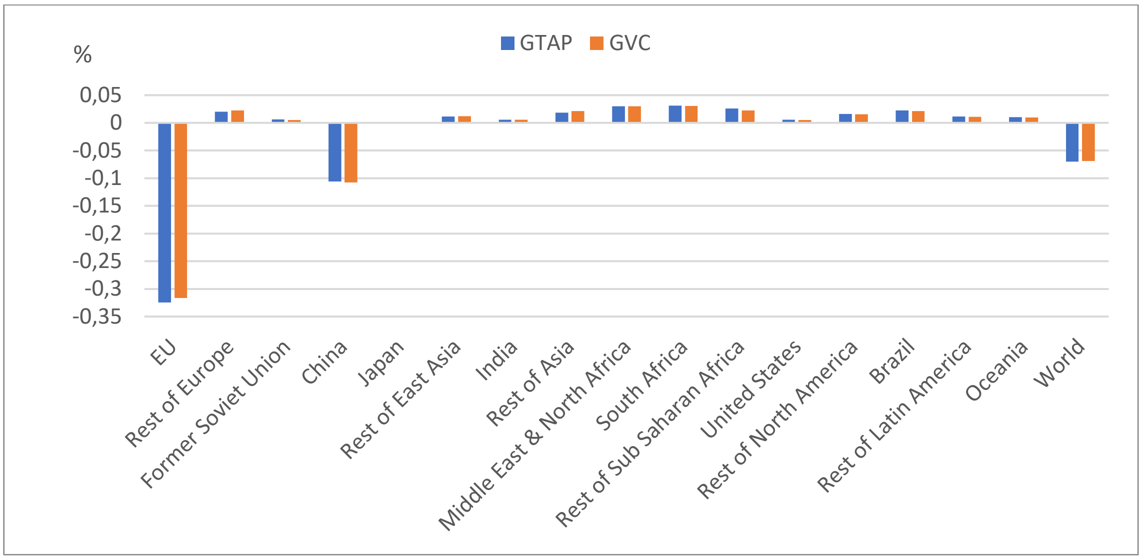

Figure 13 change in GDP in world regions

While the regions in the rest of the world (excluding the EU and China) share similar responses in GDP, their production responses in the targeted commodities differ. Figure 14 shows that the total production of the targeted commodities increase in regions including Rest of Europe, Former Soviet Union, India, Rest of Asia, and Middle East and North Africa, but decline in the other regions. This difference across regions reflects their respective trade relationships with the EU and China, and in particular, which one of the two economies dominates in the total trade with these regions. When China's production in the targeted commodities contracts following the trade shock, China's demand from the rest of the world contracts as well but its export to the rest of the world rises. This will have a negative effect on the domestic production of the affected commodities in these regions, with regions having closer trade ties with China being affected more negatively. On the other hand, the EU's import reshoring also attracts a production expansion in these regions, offsetting to a certain extent the negative effect induced by China's contraction. This creates a substitution effect as the rest of the world now can export more to the EU in replace of China's previous exporting role. Thus, whether the overall production in the targeted commodities rises or declines in these regions

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depends on the dominance of the trade ties with the two regions. If a region has a closer trade tie with China than with the EU for the targeted commodities, this region tends to get a contraction in the overall production in these commodities. If a region has a closer trade tie with the EU than with China in the targeted commodities, the production in these commodities is expected to rise.

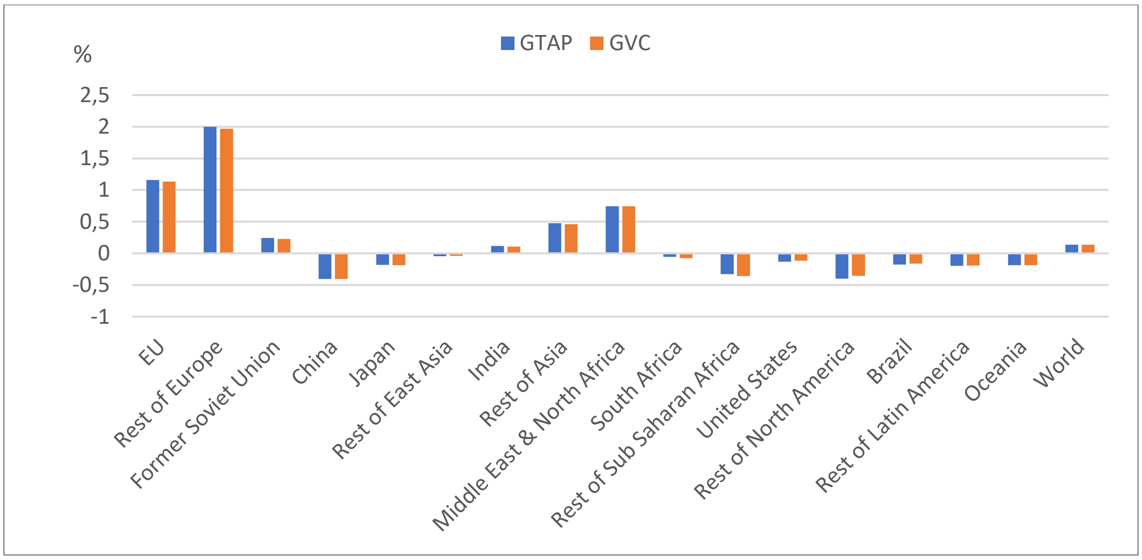

Figure 14 Change in total production in targeted commodities

Figure 14 also shows that while the regions differ in their respective production responses, the world on average still registers an expansion in the production of these targeted commodies. This indicates a resource reallocation towards the negatively affected commodities as well as a rise in overall inefficiency as more of these commodities need to be produced domestically, a finding similar to Attinasi et al. (2023).

2) Value added results only available in the GVC model version

These results are the change in value added compared with the VA composition data reported in the Methods section. Figure 15 presents the changes in the EU's import of Chinese value-added by sector. Notwithstanding a small increase in the multilateral channel, the share of Chinese VA exported in the EU decreases in most of the targeted sectors. These declines reflect a direct income loss borne by China and this loss will

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be counted towards the calculation of China's GDP. The declines are straightforward to understand as the EU's import declines will naturally cause the Chinese VA embedded in the EU's import to decline accordingly. With all the import shares from China down by 50% in these sectors, some sectors experience a larger decline in dollar values (e.g. Computer, electronic, and optic) than other sectors, reflective of the relative importance of these sectors in the EU's import.

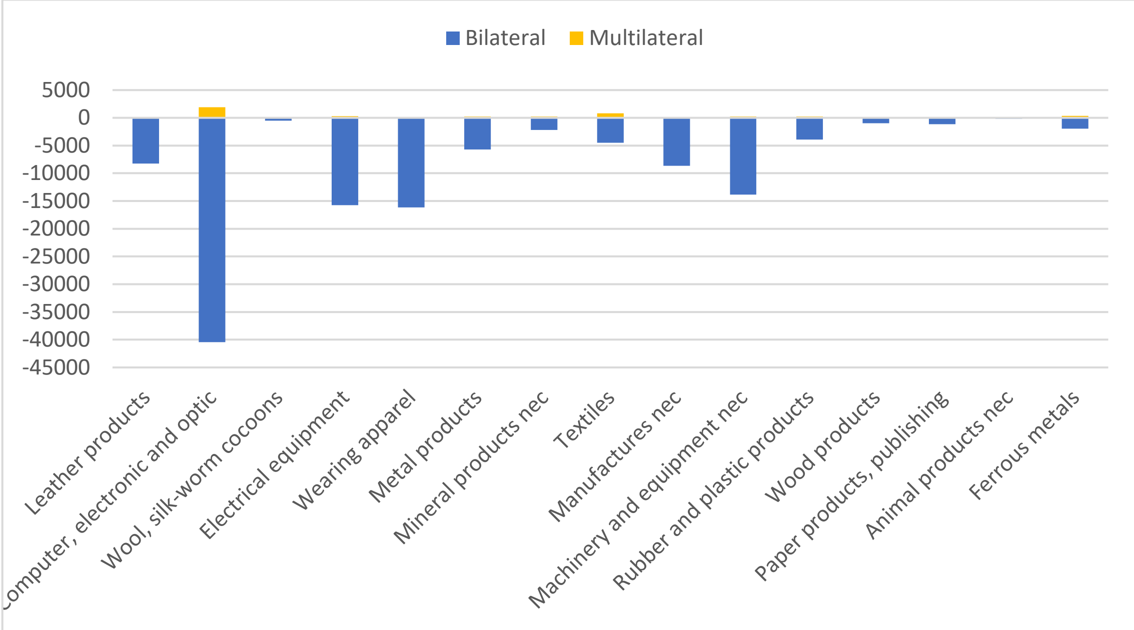

Figure 15 Change in EU's import of Chinese value-added (million US$)

Figure 16 presents the changes in the EU'S VA re-imported from China. As expected, the contraction in the EU's import from China brings a reduction in the EU'S VA reflected through China. This is a direct income loss borne by the EU which highlights the cost of the 'beggar thyself' implications of the decoupling scenario. While these losses do not appear to be very large compared with the losses in Chinese VA, as shown in Figure 15, these losses may have large repercussions in the EU's domestic economy as resources used to contribute to these VAs have to be reallocated elsewhere. Consequently, inefficiencies may rise following these reallocations.

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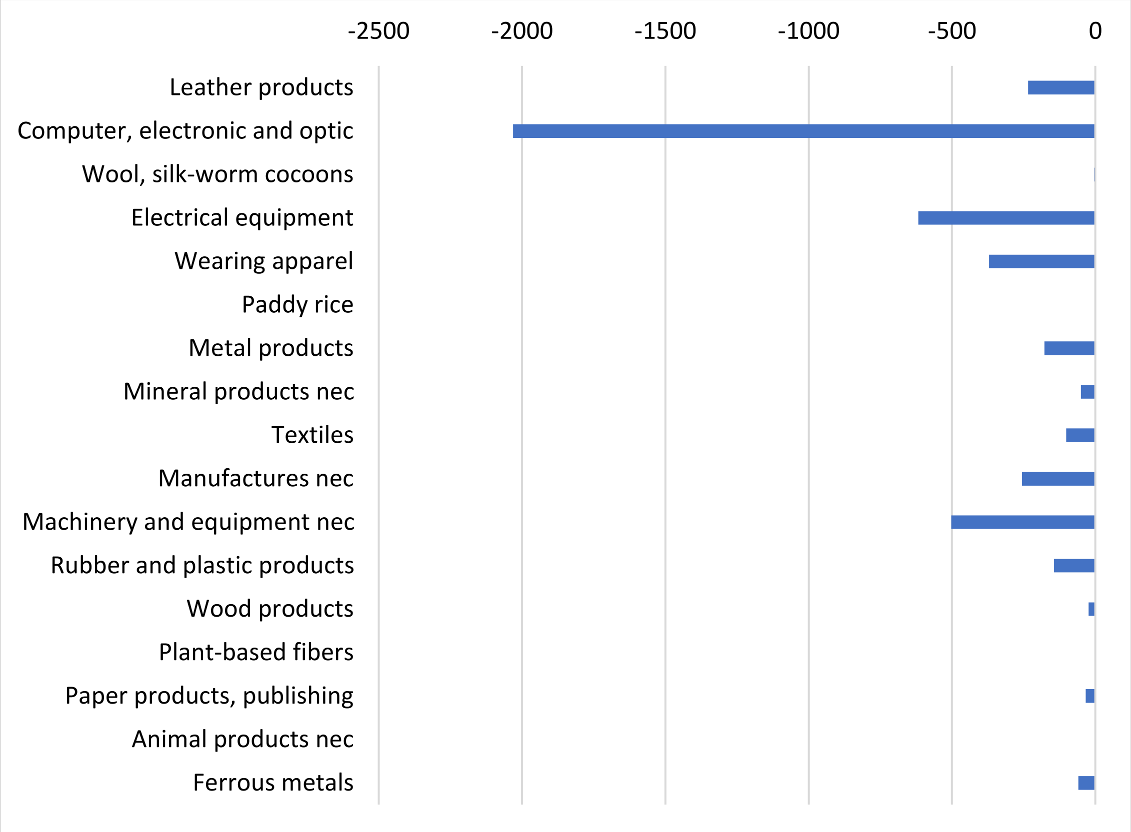

Figure 16 Change in EU's VA re-imported from China (million US$)

Figure 17 shows the changes in the EU's export by sector, highlighting the diffent value-added components. Apparently, the EU's competitiveness on the world market is hurt by the higher cost of Chinese inputs. For most sectors (e.g., Computer, electronic and optic, Machinery and equipment nec and Electrical equipment), FVA decreases relatively more than the DVA, if their respective shares reflected in the base data, as shown in Figure 4, is taken into account. The relatively large decline in FVA is due to a strong contraction in intermediates imported from China poorly compensated by other providers, suggesting less backward integration of the EU. This figure essentially decomposes the results reported in Figure 10 and confirms that the overall export decline in the EU's targeted sectors is more than proportionally driven by the input-output induced supply chain effect, which dwarfs the regular domestic trade-off effect - an effect capturing the declined export used to meet domestic demand which is reflected through the falling DVA.

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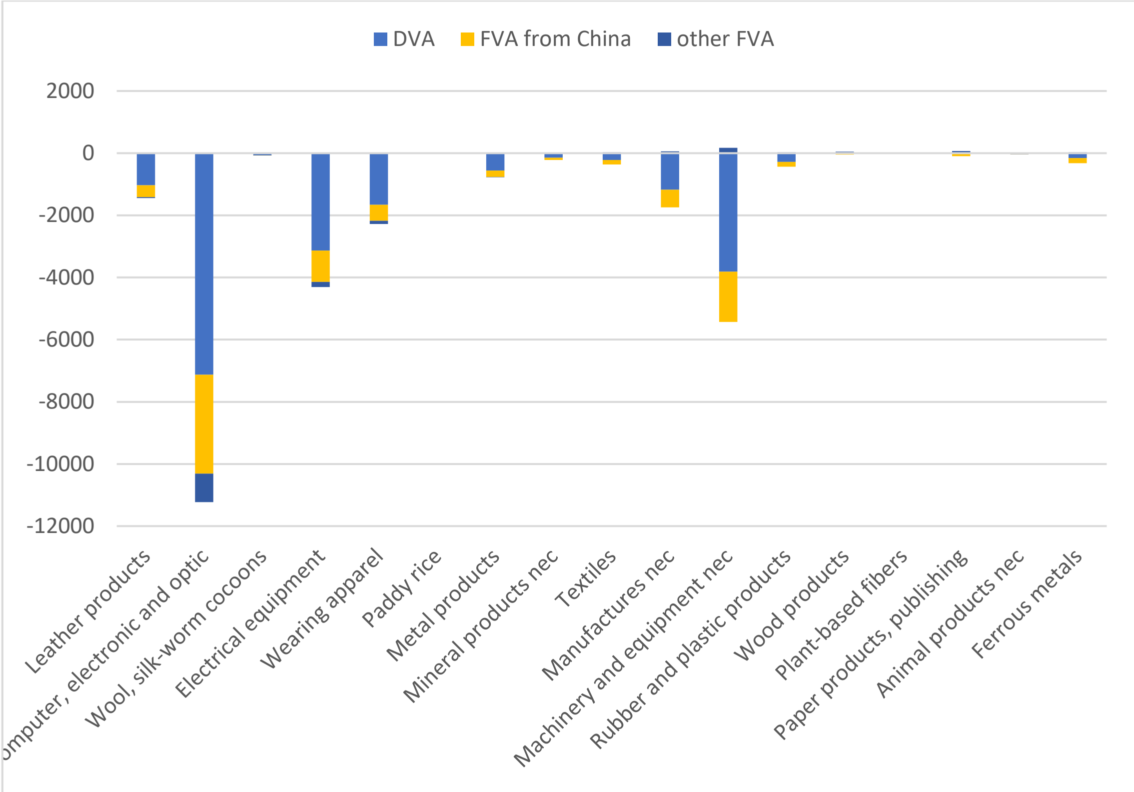

Figure 17. Change in EU's export, gross and value added (million US$)

Table 3 looks at how the impacts on gross export are allocated across the sources of VA. We first report the decline in each sector's gross export (Column [1]). As expected, the targeted sectors register a reduction. The change in DVA shows a similar pattern (Column [2]), but the reduction is smaller by proportion than the one registered by the FVA which implies a more intensive use of domestic inputs following the import shock.

It is important to emphasize that the DVA originated in each sector can be exported either by the sector itself (Column [3]) or by the other sectors in the region (Column [4]). Accordingly, the difference between Columns [3] and [2] is the value of intermediates purchased by the exporting sector from the other sectors in the region. For instance, out of the 7,129 million US$ export decline registered by the Computer, electronic and optic sector, only 3,711 million US$ accrue to the sector itself. The difference represents the loss suffered by the rest of the economy. On the other hand, the export reduction in this sector is partially compensated by the increased use of this

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commodity group as input for the export of other products (411 million US$). Such an indirect impact can be so large to even change the sign of the overall impact as it happens in the case of Services where the lost VA income from the rest of the economy (6209 million US$) outweigh the VA gains from abroad (1795 million US$)

Table 3 Change in EU's export, gross and value added (million US$)

	Gross export	DVA by exporting sector	DVA by origin sector	
			DVA direct	DVA indirect
	[1]	[2]	[3]	[4]
Leather products	-1449	-1031	-547	16
Computer, electronic and optic	-11225	-7129	-3711	411
Wool, silk-worm cocoons	-75	-64	-34	12
Electrical equipment	-4313	-3138	-1677	105
Wearing apparel	-2276	-1658	-792	49
Paddy rice	0	0	0	1
Metal products	-767	-556	-342	-445
Mineral products nec	-214	-149	-85	-38
Textiles	-338	-219	-123	-101
Manufactures nec	-1678	-1176	-631	-13
Machinery and equipment nec	-5258	-3811	-2248	-14
Rubber and plastic products	-402	-276	-189	-228
Wood products	5	19	-3	-50
Plant-based fibers	-3	-2	0	0.5
Paper products, publishing	-36	5	-28	-127
Animal products nec	-26	-22	-12	0
Ferrous metals	-297	-153	-78	-200

Source: The MAGNET model simulation results.

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CONCLUSION

With the two counterfactual experiments based respectively on the standard MAGNET model and the GVC version of MAGNET, both model versions provide similar findings as expected. Following a 50% reduction in the EU's import share from China for the targeted commodities, the EU's domestic production and import from the rest of the world will increase while the export will decline to meet domestic demand for these affected commodities. the EU's import, export and production in the non-targeted commodities also decline due partly to a supply chain effect reflected as input-output linkages, partly to a resource reallocation to boost the domestic supply of the targeted commodities.

Both model versions project that the EU may experience a slightly larger decline in GDP than China does, due mainly to the fact that the targeted commodities account for relatively a larger share in the EU's imports than in China's exports and these commodities have a higher ratio over domestic production in the EU than in China. This makes it relatively harder for the EU to absorb the import shock domestically and via reshoring. Interestingly, total sectoral output in most regions and total GHG emissions in all the regions move in an opposite way with GDP. This implies that regional GDP changes in this experiment are not driven by usual economic activities, but rather a terms of trade effect that triggers, among other things, a revaluation of domestic value-added inputs and the resulting shifts in tax revenue as all of these contribute to regional GDP. GHG emissions, however, still move largely in line with the total sectoral output in most regions, consistent with our production-based emissions accounting, with a couple of exceptions indicative of sectoral restructuring leading to a change in emissions intensity in the region.

Global supply chains reshuffle in response to this trade shock, with similar projections in both model versions. While benefiting from China's export expansion and the EU's import expansion of the targeted commodities, regions differ in their respective production reponse as this depends on their trade ties with the EU and China. Regions with a closer trade tie with China in the targeted commodities are expected to experience a decline in

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the overall production of the these commodities, consistent with the decline in China, while regions with a closer trade tie with the EU in these commodities tend to have an increase in the production, similar to the expansion in the EU.

Our GVC analysis based on the value added indicators largely confirms the observations based on the model's regular indicators. When the EU's import from China falls following the imposed trade shock in the targeted sectors, the value added components associated with these trade flows decline accordingly, including both the value added originated from China and the EU's domestic value added re-imported from China. The EU's overall export in the targeted commodities also declines in response to the import shock. The value added decomposition suggests that this export decline is more than proportionally driven by the input-output induced supply chain effect - less imported input causes less exported output, and this effect dwarfs the regular domestic trade-off effect - export declines to meet domestic demand.

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