Evaluating the impact of the US-China trade war on euro area economies: a tale of Global Value Chains

Ilaria Fusacchia

Roma Tre University and Rossi-Doria Centre for Economic and Social Research

ilaria.fusacchia@uniroma3.it

Abstract

The US-Sino trade war will have significant repercussions on the global trade system. This study assesses the implications of the subsequent rounds of tariff hikes implemented by the US and Chinese governments on global value chains, with a focus on the major European Union economies. The evaluation is based on a computable general equilibrium model which incorporates a decomposition of trade in a value-added basis and allows to identify how changes in the conditions under which US-China trade is conducted affect the value contributed by different countries and to what extent. I find that US integration within GVCs contracts whereas China increases its participation mainly as a seller to global networks. The EU countries strengthen their linkages with the US and EU regional integration increases as a consequence of the tariff war between the US and China.

Keywords**:** Trade war; Global Value Chains; Trade in Value Added; Computable General Equilibrium model; Trade policy

JEL classification**:** F14, F17

1 Introduction

The Trump administration's offensive unilateralism enacted last year has brought protectionism back onto the global agenda and old-fashioned protectionist instruments, i.e., tariffs, back to the attention of trade analysts. Starting in spring 2018, the US implemented several waves of sanctions in the form of tariff increases mostly targeting China. To date, the US tariff has increased on about 11,000 products imported from China, amounting to approximately $250 billion. For its part, Beijing's retaliation has increased tariffs on about 2,000 US goods, amounting to approximately $110 billion. More than half of the bilateral trade between the two economies has been hit. Whether it is "the biggest trade war in economic history so far" as declared by the China's Ministry of Commerce or not, it is clear that the increase in trade barriers between key players in the global trade system has repercussions that go well beyond their national borders. The world economy is likely to be impacted.

Since global production is increasingly organized within Global Value Chains (GVCs) and trade in intermediates is a dominant feature of global trade shaping countries' backward and forward linkages within global production networks, the question of who bears the burden of the trade tariff and who gains from it is less straightforward than it would be in a Ricardian world in which countries only trade final goods produced domestically. Since the income generation role of exports strictly depends on international exchanges of intermediates and services which are required to produce final goods, increased tariffs on imports can negatively affect domestic producers' competitiveness in international markets since they reduce access to the most efficient inputs (Cattaneo et al., 2013; Taglioni and Winkler, 2014), also impacting domestic firms exporting intermediate inputs processed abroad and then imported back. Moreover, tariffs faced in the destination market have ripple effects on the production activities that are linked to the GVCs, spanned across different countries (Balié et al., 2017; Antimiani et al., 2018a). Given the size of the US and Chinese economies, it is likely that trade measures negatively impacting those countries will significantly affect suppliers of intermediate goods and services wherever they are located.

This study deals with the complexity of global trade relations and assesses the implications of the subsequent rounds of tariff hikes implemented by the US and China's governments on global trade linkages, with a focus on the major European Union (EU) economies, namely Italy, France and Germany. The evaluation is based on Computable General Equilibrium (CGE) modelling. Since the aim is to estimate the impacts of the changes in trade policy on GVC-related trade, the key aspect of the approach used in this analysis is that the global CGE model incorporates a decomposition of trade in Value Added (VA) metrics. This allows us to capture indirect effects due to GVCs by identifying which countries create the value that is embodied in US-China trade flows as traditionally measured, and hence to identify how changes in the conditions under which such trade is conducted will affect the value contributed of different countries and to what extent.

Trump's 'America First' mantra has fuelled several research projects aimed at providing counterfactual evaluations of the potential impacts of trade war triggered by the current US trade policy. Earlier studies focus on the optimal US bilateral tariffs imposed on the main target partners and the partners' optimal responses[1] (Balistreri and Hillberry, 2017; Bouët and Laborde, 2017; Aizenberg et al., 2018) and find relatively modest optimal US tariff rates vis-à-vis China. The optimal tariffs could be lower once supply chains linkages are taken into account. Blanchard et al. (2016) demonstrate that when foreign content in domestic goods is high, some of the benefits of protection are passed back up the supply chain to foreign suppliers, thus lowering optimal tariffs. Caliendo and Parro (2015) show that the optimal tariff may in fact be negative once production linkages and intermediate goods are taken into account.

As US tariffs went into effect, empirical studies have mostly focused on the quantification of the effects of the implemented tariff increases and further announced tariff changes (for example, Balistreri et al., 2018; Fajgelbaum et al., 2019; Guo et al., 2018; Li et al., 2018; Charbonneau and Landry, 2018; Bollen and Rojas-Romagosa, 2018). Three main arguments of convergence among these analyses can be found. First, there is an agreement on the fact that current trade is costly for the countries imposing import protection, as well as for the world as a whole; the welfare cost for the global economy is higher when scale economies and variety effects are considered (Balistreri et al., 2018). Second, the tariff hikes produce a reallocation among sectors, but sectoral gains are small, to the detriment of other sectors, and mostly offset by retaliation. Finally, since bilateral trade is strongly reduced, there may be economic benefits for other regions through trade diversion. These studies mostly have a domestic focus, that is, they mainly look at the consequences for the US and China. Bolt et al. (2019), on the other hand, focus on the effects of the bilateral trade war on a third country. They find benefits for the EU which gets access to cheaper imports from China since they are diverted from the US and gains improved competitiveness in the US in response to tariffs imposed on Chinese products. Third country effects are also central to this paper, but the way of looking at trade is different. My main contribution is to evaluate "GVC-related effects", that is, the variation in the output which is required to produced traded goods wherever the production of each ring within the chain takes place, in addition to standard trade diversion effects (that is, countries that are not directly affected by the increased tariffs may intensify trade with the belligerent countries).

The bulk of the empirical literature which aims to quantify the impacts of Trump's trade policy relies on a general equilibrium framework. Although they are based on different model specifications[2], all the models that have been used (e.g., GTAP-class CGE models, or the so-called New Quantitative Trade models)

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[1] The literature on optimal trade policy dates back to the seminal contribution by Johnson (1953), who first conceptualized the beggar-thy-neighbour motive behind increases in tariffs and showed that in a trade war a country can gain by imposing an optimal tariff even when others retaliate. The case in which all trading partners lose from a trade war has been considered more probable in the literature (for example, Ossa 2014, Kutlina-Dimitrova and Lakatos, 2017), and even under the "Johnson case", world welfare is decreased (Bouët and Laborde, 2017).

[2] See Balistreri et al. (2018) for a structural sensitivity analysis which considers three alternative microeconomic foundations of international trade: Armington, Krugman, and Bilateral representative firms.

feature domestic and imported intermediate inputs in the production functions. However, the implications of the back-and-forth of intermediate goods across borders are barely addressed. Charbonneau and Landry (2018) use the Caliendo and Parro (2015) model and explicitly incorporate trade in intermediate goods with the aim of capturing global value chains and understanding the impact of tariff changes on key systemic sectors of the economy. Using intermediate trade as a rough proxy for GVCs, they find that the US-China trade tensions ripple through the global economy, especially among Canadian, Mexican and other Asian economies that either are part of the global supply chain affected by the tariffs or offer close substitutes to Chinese and US exports. However, their analysis is based on standard (that is, gross) trade data and national input-output tables and does not consider the value-added content of trade. Similarly, UNCTAD (2019) assesses the effects of the US and retaliatory tariffs on the reallocation of assembly processes away from the US and China as well as the effects on direct suppliers to those assembly lines. The report finds that both the North American and East Asian value chains will be negatively affected by the US and retaliatory tariffs, whereas other countries, in particular the EU, will attract some trade related to value chains. Even in this case, since the estimations are based on gross trade data, the analysis only considers the impacts on direct suppliers, that is, on the demand for foreign inputs, but does not reallocate the value added along the global chains.

The main contribution of the analysis presented here is that the impacts of the US-Sino tariff war are assessed by disentangling the value added embedded in gross flows, which allows the effects on the domestic value-added content of exports to be followed across borders, and through the backward and forward trade linkages. In other words, a trade in VA perspective is assumed. The approach used in this study is linked to the literature aimed at decomposing gross trade flows[3]. This line of research, which started with the pioneering work of Hummels et al. (2001) who provided the first indicator of vertically integrated trade, mostly referrs to the contribution made by Koopman et al. (2014) who provide a unified framework for the decomposition of total gross exports into three main components: the domestic value added, foreign value added, and 'reflected' value added., i.e. the domestic content in intermediate exports that finally returns home. Each of these components can be further split by taking into account the intermediate or final use of the exported goods. Furthermore, they quantify double counted items from standard trade statistics. This framework has been extended by Wang et al. (2013) and Borin and Mancini (2017) to provide a breakdown of bilateral exports at the sector level.

[3] Others macro-approaches include the decomposition of final goods as in Johnson and Noguera (2012) who measure inter-country production sharing as the ratio of value added to gross exports (VAX), where value-added exports are defined as the value added produced in one country, but absorbed in final demand by another. A complementary perspective in decomposing final goods looks at the production side and consists of allocating the value added generated in the production of final goods back to the countries in which that income is generated. This "GVC Income" approach traces the value added by all labour and capital that is directly and indirectly needed for the production of final manufacturing goods (Timmer et al., 2013; Timmer et al., 2014; Los et al., 2016).

Antimiani et al. (2018b) follow this strand of the literature and integrate the VA decomposition of gross bilateral trade into a CGE model. They provide the VA module for the Global Trade Analysis Project (GTAP) model which is used in this study. The incorporation of trade in VA decomposition in a CGE context allows us to consider all the implications that the tariff war may have on the complex set of general equilibrium interdependencies between countries (and sectors) reflecting a combination of preferences, technology, endowments, and policy (Walmsley et al., 2014), that shape the GVCs. The GTAP-VA model has two important features. First, it implements a novel decomposition of bilateral gross trade balances that accounts for the differences between gross and VA concepts. Accordingly, I am able to identify the trade flow in which value added is actually recorded for the first time in international trade statistics. Second, it provides a distinction between VA that is due to demand of the direct trading partner and VA that is due to demand in third countries. In the case of a bilateral tariff war, as bilateral trade between the two belligerent economies becomes more costly, it is likely that more value would be exported multilaterally, that is, through other countries in the global trade system whose trade costs have not been changed.

This analysis finds restructuring effects on regional and global value chains due to the increased costs of trading between the US and China. First, I find a contraction in the backward integration into GVCs of both the US and China: the increased import tariffs raise the cost of importing intermediate inputs which pushes belligerent countries to rely more on domestic providers, thus lowering the import content of their exports. An opposite trend is found for the EU countries under examination which increase the degree of backward linkages. Second, the disruption of trade between the US and China impacts their demand for foreign inputs, affecting suppliers of intermediates. Germany and, to a lesser extent, Italy strengthen their linkages as providers of intermediates with the US while contracting linkages with China. France is the less affected country. Third, more Chinese VA is exported multilaterally to the US, that is, through other countries' exports. EU countries, and Italy in particular, are important platforms in this kind of trade. Finally, EU regional integration increases as a consequence of the tariff war, mainly due to the strengthening of relationships with the US market.

The remainder of this paper is structured as follows. Section 2 introduces the methodology and describes the data. Section 3 provides a characterization of bilateral trade and GVC-related trade between the US and China, and between them and the three major European economies. Section 4 describes the tariff profiles and the trade war scenario. Section 5 presents and discusses the findings. Finally, Section 6 concludes.

2 Methodology and data

The methodology adopted to conduct the quantitative evaluation of the impacts of the US-Sino trade war is based on a counterfactual approach using the GTAP model, a perfectly competitive comparative static computable general equilibrium model. It is built on general equilibrium theory and designed to assess the inter-regional, economy-wide incidence of economic policies (Hertel and Tsigas, 1997). The main advantages of the CGE approach are its solid micro-theoretical underpinning and its economy-wide scope, as well as its complete and consistent coverage of all bilateral trade flows.

The model underlying our analysis has a symmetric structure; consequently, the treatment of production and utility functions is homogeneous across regions and products. This implies that the only differences in regional behavior in the model are those arising from differences in the relative importance of economic flows and differences in the model parameters related to consumer demand mostly drawn from the literature (Hertel, 2013). The model assumes the presence of a representative regional household that receives the factor rewards and allocates regional income (through a Cobb-Douglas utility function) between private consumption, government consumption and saving to maximize its utility. The utility function is nested, with a first aggregation made over distinct goods or sectors and in the latter, a choice is made between domestic or imported quantities. As for the production side, separable, constant returns-to-scale technologies are assumed. A common approach in CGE literature is to model the production side through a sequence of nested Constant Elasticity of Substitution (CES) functions that aims to re-produce the substitution possibilities across the full set of inputs. The firms' conditional demand for components of value added depends on the relative prices of factors of production whereas composite value added and intermediates are used in fixed proportions (fixed coefficient function of the Leontief type). In the intermediate input side, imported intermediates are assumed to be separable from domestically produced intermediate inputs. The import demand is modelled following the Armington aggregation structure, with an exogenously differentiation scheme given by the geographical origin of homogeneous products. That is, under Armington trade, the output of each sector is assumed to be a region-specific variety. Consumer and intermediate goods are a CES composite of domestic and trade partner varieties. This specification explains the cross-hauling of similar products and makes it possible to track bilateral trade flows. Transaction costs are also accounted for in the model since transport services are explicitly considered among the activities in the economy.

For this application I adopt the extension made by Antimiani et al. (2018b), the GTAP-VA module for the GTAP model that introduces GVCs analysis into a CGE, and enable to carry out a post-simulation decomposition/analysis of the sources of value added. This framework allows to assess the effect of the policy change on the global structure of GVCs, thus taking into account the interdependence between sectors, allowing relative prices to adjust and factors to be reallocated across sectors as well as admitting substitution effects in production and consumption both within and across countries (Walmsley et al., 2014;

Ferrarini and Hummels, 2014). In the GTAP-VA the gross trade flows are decomposed to reallocate the value added generated in the production of goods back to the countries in which that income is generated. The 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 main indicators related to the value added in an exported good or service which are used in this analysis are the following:

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.

ii) Multilateral domestic value added (DVAM)

This is defined as the domestic value added contained in intermediate goods and services that is exported to a partner country which then re-exports it to the final market, embodied in other goods or services. DVAM, also referred to as "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 DVAM indicators are adjusted for double-counting, meaning that the domestic value added embodied in an export that has previously crossed the international border, and hence has already been counted as domestic value added, is netted out.[4]

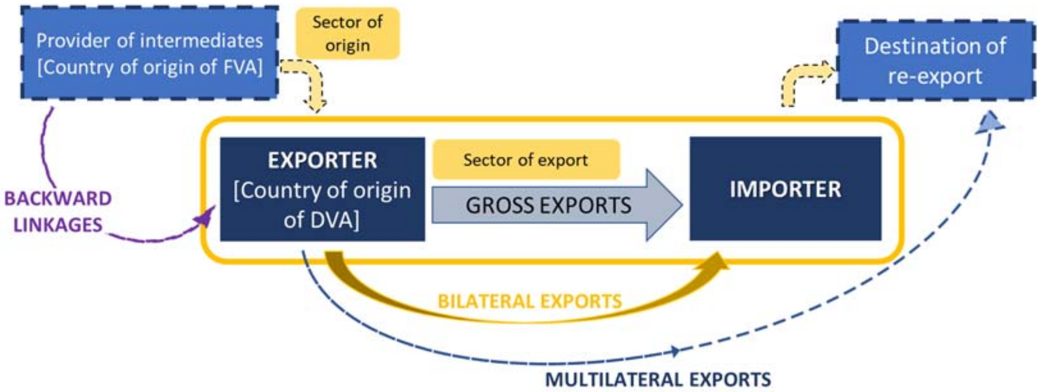
iii) Foreign value added (FVA)

This is the value of imported intermediate inputs embodied in a country's exports, and represents the import content of exports. It is sometimes referred to as the backward linkages in global production networks because it reflects linkages back up the value chain towards its origin. Within FVA, a portion can refer to trade that is exported back to the country of origin of the value added (circular trade).

Figure 1 gives a graphical representation of standard gross trade and GVC-related linkages. Standard, or Ricardian, trade involves an exporter and an importer, and assumes that the entire production process occurs in the exporting country which ships the final good to the importing country which finally consumes it. The exchange within the yellow rectangle exhausts standard trade. Instead, GVC-related trade is related to goods and services crossing more than one border, thus involving at least two production stages located in different countries before the final product reaches the destination market (Borin and Mancini, 2017). Thus, it implies a third country (country of origin of the FVA), providing intermediate inputs to the exporter and backwardly linked to the international value chains. Moreover, the importer may not consume the imported good or service but perform a further processing phase before re-exporting it to the destination country.

[4] The treatment of the double counting adopted in this study is based on the source method introduced by Nagengast and Stehrer (2014), implemented by Borin and Mancini (2017), and refined by Antimiani et al. (2018b), who introduce double counting related to the multilateral exports to a trade partner.

Figure 1. Gross and GVC-related trade



Measuring these linkages requires a huge amount of data, gathering national accounts and bilateral trade data on goods and services into a consistent statistical framework, tracing transactions in final and intermediate goods both within and between countries, and finally allowing (indirectly) trade to be measured on a value-added basis. The current standard for GVC analysis relies on an Inter-Country Input Output (ICIO) table which harmonizes national input-output tables for multiple regions and links trade flows directly from producers in each region to importing firms and consumers in all other regions. Various research initiatives have undertaken the development of different versions of an ICIO table. Among the most well-known are the World Input Output Database (WIOD), Trade in Value Added (TiVA) as well as the Global Trade Analysis Project (GTAP) Data Base.

In this study, data are drawn from the (pre-released) version 10 of the GTAP Data Base, a baseline of consistent data on consumption, production, and trade updated to 2014 (Aguiar et al., 2016). The GTAP Data Base is a fully documented global database that provides comprehensive and balanced data on production, bilateral trade, transport, and trade policies, covering 121 countries (representing 98% of world GDP and 92% of world population) and 20 aggregate regions for all 57 GTAP commodities for 2014. It has been extensively used to perform economic analysis of TVA, mainly due to its consistency, full global coverage, and the large country and sectoral details it provides (Aguiar et al., 2016). The advantage of using the GTAP Data Base for GVC analysis is that it reconciles data from different sources and puts them into one consistent database with a broad sectoral and regional coverage. However, the database itself does not account for how imported intermediate products are used. Within the GTAP framework, imports of intermediates from all countries are aggregated at the product level at the border into a composite imported good. This composite good is then allocated across sectors and uses based on relative demands and shares. In this way, we cannot trace exports of intermediates from one country into the production processes of another, and following on from that, into their contributions to the other countries' exports. That is to say, we cannot directly identify the industry-to-industry trade required for the construction of ICIO data, harmonizing input-output tables for multiple regions and linking trade flows directly from producers in each region to importing firms and consumers in all other regions, which is required to implement the above GVC indicators.

There are different methods in which supplementary information is used to distinguish between countries of origin on an industry-use basis. The approach used in this study, as well as in others using the GTAP Data Base (for example, Daudin et al., 2011; Johnson and Noguera, 2012; Lejour et al., 2014; Greenville et al., 2017), applies proportionality assumption to allocate the imports of products from any given country between final demand and intermediates, and then within intermediates, between the intermediate usage by individual production commodities.[5]

The multi-region general equilibrium is calibrated to GTAP10 Data Base. The simulation is performed on a geographic and sectoral disaggregation that includes 23 regions and 43 sectors. For expositional purposes, results are shown for 13 aggregated sectors (see Table 1).

[5] To illustrate this, we know from direct data collection what proportion of the value of cars is accounted for by steel. We have to assume that this is the same for cars produced for the domestic and all export markets. We also know how much of a country's steel comes from each country (including that country) and we have to assume that each use of steel is spread over sources in exactly those same proportions. Since these assumptions are bound to be violated in detail, the results they support will be approximations, but equally, because they are based on real aggregates, they are not likely to be grossly misleading.

Table 1. Sectoral aggregation of the GTAP Data Base

GTAP sector code	Sectoral aggregation (simulation)	Sectoral aggregation (post-simulation)
pdr	Paddy rice	Agriculture
wht	Wheat	
gro	Cereal grains nec	
v_f	Vegetables, fruit, nuts	
osd	Oil seeds	
c_b	Sugar cane, sugar beet	
pfb	Plant-based fibers	
ocr	Crops nec	
ctl	Cattle, sheep, goats, horses	
oap	Animal products nec	
rmk	Raw milk	
wol	Wool, silk-worm cocoons	
frs	Forestry	
fsh	Fishing	
coa, oil, gas, omn	Extraction	Extraction
cmt	Meat: cattle,sheep,goats,horse	Food
omt	Meat products nec	
vol	Vegetable oils and fats	
mil	Dairy products	
pcr	Processed rice	
sgr	Sugar	
ofd	Food products nec	
b_t	Beverages and tobacco products	
tex	Textiles	Textiles
wap	Wearing apparel	
lea	Leather products	
lum	Wood products	Wood and Paper prodcuts
ppp	Paper products, publishing	
p_c	Petroleum, coal products	Petroleum and coal products
crp	Chemical,rubber,plastic prods	Chemicals
nmm	Mineral products nec	Minerals and metals
i_s	Ferrous metals	
nfm	Metals nec	
fmp	Metal products	
mvh	Motor vehicles and parts	Motor vehicles
otn	Transport equipment nec	
ele	Electronic equipment	Electronics
ome	Machinery and equipment nec	Machinery and equipment nec
omf	Manufactures nec	Manufactures nec
ely, gdt,wtr	Utilities	Services
otp,wtp,atp	Transport	
cns, trd,cmn,ofi,isr,obs	Construction, communication, business services	
ros,osg,dwe	Other services	

3 US and Chinese patterns of trade

In this section, I provide a characterization of bilateral trade and GVC-related trade between the US and China, and between them and the three major European economies, namely, Italy, France and Germany.

3.1 US and China bilateral trade

Table 2 displays US exports to and imports from China, both in gross and VA metrics.

Table 2. US and China bilateral trade (billions of US dollars)

	US exports to China	*US imports from China*	*Trade balance*
Gross trade	171.1	495.4	-324.3
VA trade	141.8	393.8	-252.0

Source: Author's calculation based on the GTAP Data Base (2014 baseline).

We can observe that the $324.3 billion US trade deficit with China (the value of exports less the value of imports) is scaled down by more than 20 percent (about $72 billion) in terms of DVA embedded in trade flows, that is, once the remuneration of domestic factors of production for the two trading partners is considered. This reflects the higher DVA content of US exports (accounting for 82.9 percent of gross exports) compared to that of China in exporting to the US market (accounting for 79.5 percent of gross exports).

Considering the structure of bilateral exports (Table 3), we see that almost half of Chinese exports to the US are represented by motor vehicles (49.9 percent), a sector which is more intensive of foreign inputs and where only 73.6 percent represents Chinese domestic value added. Although this is the most important sector also in US exports to China (accounting for 21.6 percent of exports), the US shows a more diversified export structure. Beside motor vehicles, four main macro-sectors, that is, agriculture, machinery, chemicals and services (together accounting for almost 50 percent of those exports), show a higher DVA share (ranging from 91.4 percent in agriculture to 81.9 percent in chemicals).

Table 3. Composition of US-China bilateral trade, by sector.

	US exports to China		***China exports to the US***	
	*DVA share**	*Sector share***	*DVA share**	*Sector share***
Aggregate	82.9	100.0	79.5	100.0
Sector:				
Agriculture	91.4	13.4	94.5	0.3
Food	88.1	4.5	88.2	1.3
Extraction	94.7	1.4	89.3	0.1
Textiles	83.5	1.1	87.1	15.2
Wood and Paper product	90.7	3.7	84.7	1.9
Petroleum and coal products	45.4	1.3	46.5	0.2
Chemicals	81.9	11.3	81.2	6.6
Minerals and metals	80.4	6.8	82.3	6.1
Motor vehicles	73.1	21.6	73.6	49.9
Electronics	75.2	8.8	77.2	2.1
Machinery and equipment nec	89.1	11.9	82.3	0.8
Manufactures nec	84.0	2.9	87.7	8.1
Services	91.3	11.3	88.3	7.4

* DVA share on gross exports.

** Sector weight on total bilateral exports.

Source: Author's calculation based on the GTAP Data Base (2014 baseline).

Table 4 displays European countries' trade with the US and China, and the DVA content of each flow.

Table 4. US and China trade with selected EU countries (billions of US dollars)

	US		**China**	
	Gross exports	Gross imports	Gross exports	Gross imports
Italy	24.7	48.5	40.7	20.3
DVA share	*(83.8)*	*(71.0)*	*(81.4)*	*(70.2)*
France	61.9	53.5	45.0	33.0
DVA share	*(78.0)*	*(67.3)*	*(80.5)*	*(67.2)*
Germany	87.4	142.7	100.1	121.4
DVA share	*(83.9)*	*(66.6)*	*(80.3)*	*(63.8)*

Source: Author's calculation based on the GTAP Data Base (2014 baseline).

The analysed EU economies are far more dependent on foreign inputs produced in other countries than both the American and Chinese economies. In terms of cross-country variability, we observe that Italy shows the highest value-added content, which accounts for slightly more than 70 percent of its exports to the two countries. Germany, on the contrary, has the lowest DVA share in its gross exports (66.6 percent to the US and 63.8 percent to China), showing a higher level of integration in international VCs. This reflects the fact that Germany is a final hub within the so-called "Factory Europe", that is, it delivers a relevant share of, for example, "made in Italy" and "made in France" products, especially towards more distant markets such as China (see also Borin and Mancini, 2017).

Both US and China exports to EU countries embed a relatively high share of DVA. About 78 percent of US gross exports to France represents US VA; the share is about 84 percent in its exports to both Italy and Germany. The figure for China is fairly similar, suggesting that the country is no longer a final assembler of parts and components coming from abroad, but has significantly increased its specialization in high value-added phases of production (see, for example, Lall and Albaladejo, 2004; Giovannetti et al., 2018). Interestingly, China's 21.3 billion trade deficit with Germany becomes an around 3 billion trade surplus in a VA metric. This data reflects the opposite trends of the two countries in the last decade: while Germany (as other EU economies) has seen a gradual fall in the DVA content of its exports since 2005 (notwithstanding a decline in the years close to the crisis), the DVA content in Chinese exports has consistently increased (up to 10 percent more if compared with 2005 data; see also TiVA, 2018).[6]

3.2 US and China GVC-related trade

As already stressed, the difference between gross and VA statistics tells us to what extent the exporting country relies on foreign intermediates. Table 5 shows the geographical origin of the FVA embedded in US (a) and China (b) bilateral and total exports.

Table 5. Origin of FVA in US and China exports, region share on total FVA component.

a) US exports

		Importer	
		China	World
Provider	China	15.4	13.1
	Rest of Asia	18.9	17.9
	Rest of America	26.8	28.3
	Europe	23.3	20.7
	Rest of the World	15.6	19.8
	Total	100.0	100.0

b) China's exports

		Importer	
		US	World
Provider	US	9.5	9.2
	Rest of Asia	40.0	37.6
	Rest of America	7.4	7.8
	Europe	21.1	21.0
	Rest of the World	22.1	24.4
	Total	100.0	100.0

[6] Available at: https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2018_C2.

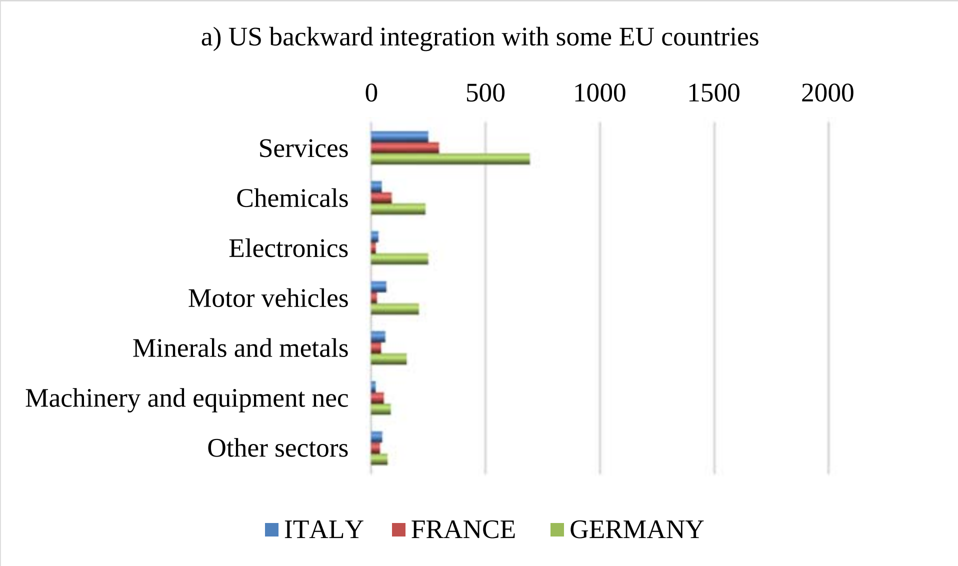
Source: Author's calculation based on the GTAP Data Base (2014 baseline).

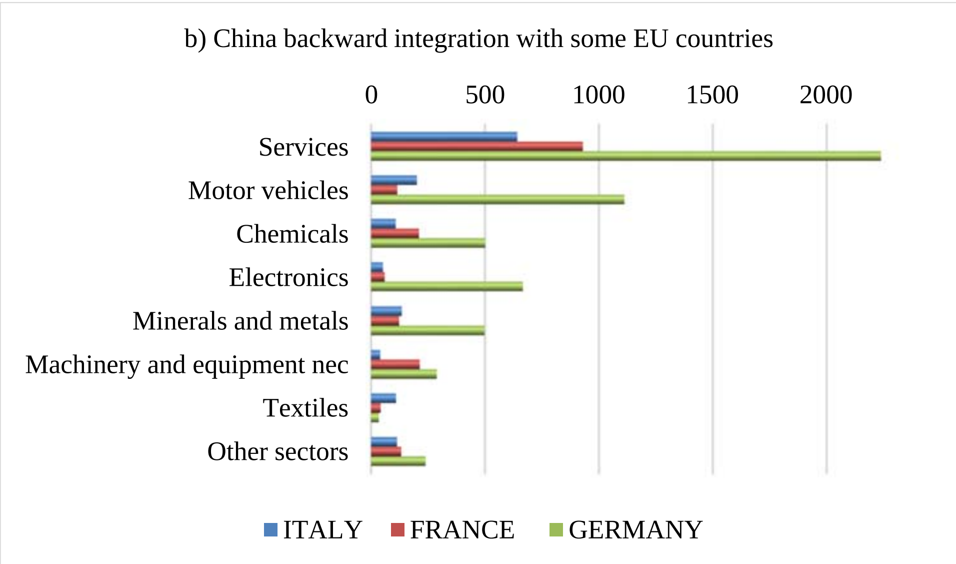
The 'circular trade' (i.e., intermediate inputs provided by the importer to the exporter) shows a significant share in US exports: 15.4 percent of the foreign content in US exports to China comes from China itself. US regional providers are more relevant in the production of exports to countries other than China. Conversely, Asian as well as European intermediates are more important for US exports to China than they are in US exports to the World. The differences in regional sourcing of intermediates depend on the sectoral composition of US exports and are mostly explained by one sector, motor vehicles. Indeed, China represents the most important market for this sector, absorbing 16 percent of total US exports in motor vehicles (ahead of Mexico and Canada, each of which accounts for about 10 percent). As already observed, motor vehicles production highly relies on foreign inputs (see Table 3), and absorbs more than one third of the total FVA embedded in US exports to China. Asian and European providers are particularly important for US motor vehicles producers, together accounting for about 40 percent of the total foreign inputs used by motor vehicles.

The pattern of China's sourcing of intermediate inputs shows strong regional integration. Asia provides 40 percent of foreign inputs used by Chinese firms to produce goods finally exported to the US. Their importance is slightly reduced in exporting to markets other than the US (37.6 percent). US providers to China account for less than 10 percent of total FVA and the inputs originated in Europe account for around 20 percent.

The global input-output framework underlying this study allows us to explicitly consider the linkages between different sectors within the global trade system. I use this information in order to provide a picture of the US and China sectoral GVC-linkages with the three analysed EU economies. In Figure 2, the value of EU intermediate inputs provided to the US (a) and Chinese (b) production of exports is shown at the sector level. Sectors are ordered according to their importance in terms of overall value.

Figure 2. US and China backward linkages with Italy, France and Germany, by sector (millions of US dollars)





Source: Author's calculation based on the GTAP Data Base (2014 baseline).

We can observe that the EU countries here considered are more backwardly linked to China than to US in all sectors. There is a great variation in the degree of backward linkages among the three EU countries: Germany is the major provider of inputs to both the US and China, whereas Italy is less integrated with both countries overall.

Both the US and China mainly use EU services in order to produce their exports. They represent around half of the total value of EU inputs provided to the two countries. Other relevant EU sectors are chemicals, electronics, motor vehicles, minerals and metals and machinery equipment. Chinese firms also demand textiles, mainly from Italy.

It is worth noticing that even if the EU sectors involved in this kind of trade with the two countries are very similar (the only exception being textiles), the type of linkages are different between the US and China.

When considering which sector in the exporting country (i.e., US or China) demands European inputs, we observe that in the case of US firms, they mostly demand intra-sector inputs, that is inputs from the same sector in EU countries. This is the case of chemicals, electronics and motor vehicles. As for China, we observe less intra-sector trade. For example, Chinese motor vehicles is the sector that mostly absorbs inputs from EU electronics and chemicals. Table 6 shows details on inter-sectoral exchanges.

Table 6. Backward linkages with some EU countries in US and China's exports, by providing and exporting sector (millions of US dollars)

a) US exports

		US sector							
		Services	Chemicals	Electronics	Motor vehicles	Minerals and metals	Machinery and equipment	Other sectors	Total
EU sector	Services	79	139	198	429	74	104	218	1,241
	Chemicals	11	120	31	75	14	25	99	375
	Electronics	8	7	179	56	3	30	20	303
	Motor vehicles	6	4	4	268	1	9	10	302
	Minerals and metals	3	13	29	109	36	32	40	262
	Machinery and equipment	6	10	20	64	12	26	24	162
	Other sectors	1	20	13	38	4	10	74	160
	Total	114	313	474	1,039	144	236	485	2,805

b) China's exports

		China's sector								
		Services	Motor vehicles	Chemicals	Electronics	Minerals and metals	Machinery and equip.	Textiles	Other sectors	Total
EU sector	Services	162	2,442	198	172	156	29	388	264	3,811
	Motor vehicles	28	1,325	11	4	10	2	21	27	1,428
	Chemicals	29	409	123	23	36	7	117	75	819
	Electronics	30	424	15	219	17	13	29	31	778
	Minerals and metals	27	548	25	24	42	5	39	46	756
	Machinery and equipment	19	403	17	20	20	6	27	30	542
	Textiles	0	47	3	0	0	0	117	19	186
	Other sectors	12	257	24	13	14	1	52	112	485
	Total	307	5,855	416	475	295	63	790	604	8,805

Source: Author's calculation based on the GTAP Data Base (2014 baseline).

We then consider the forward connections, or multilateral trade, linking the US and China, that is, we look at all the value added that originated in the US and ends up in China embedded in other countries' exports to China and vice versa, from China to the US, through all the other countries.

Table 7 shows how US goods and services reach China (first column) and how Chinese products reach the US (second column), distinguishing 4 main regional aggregates as platforms, i.e., as regions re-exporting the value added from one country to the other.

Table 7. US and China multilateral trade by platform (region share on total DVAM)

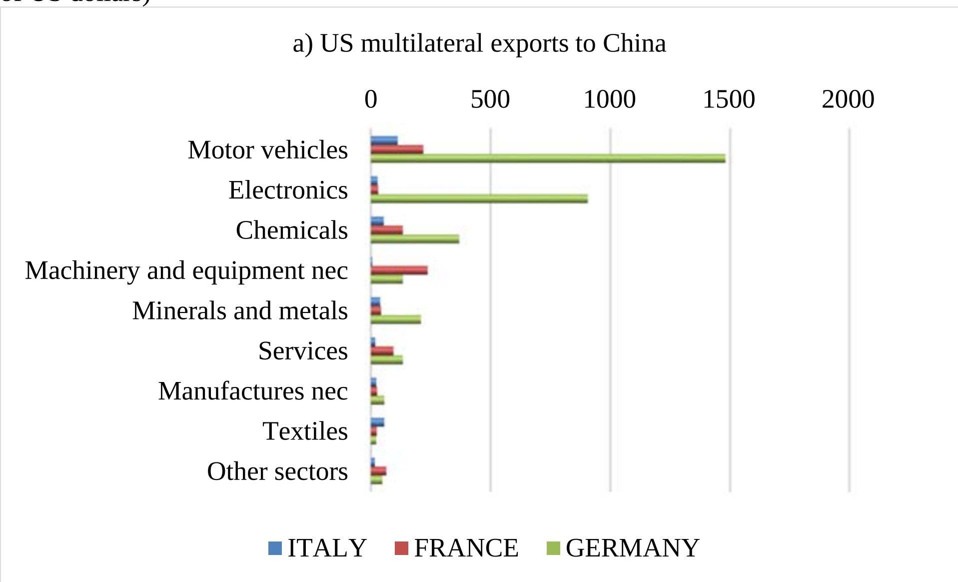
		US multilateral exports to China	China multilateral exports to the US
Platform	Rest of Asia	55.2	44.7
	Rest of America	13.5	30.8
	Europe	23.9	19.1
	Rest of the World	7.4	5.4
	Total	100.0	100.0

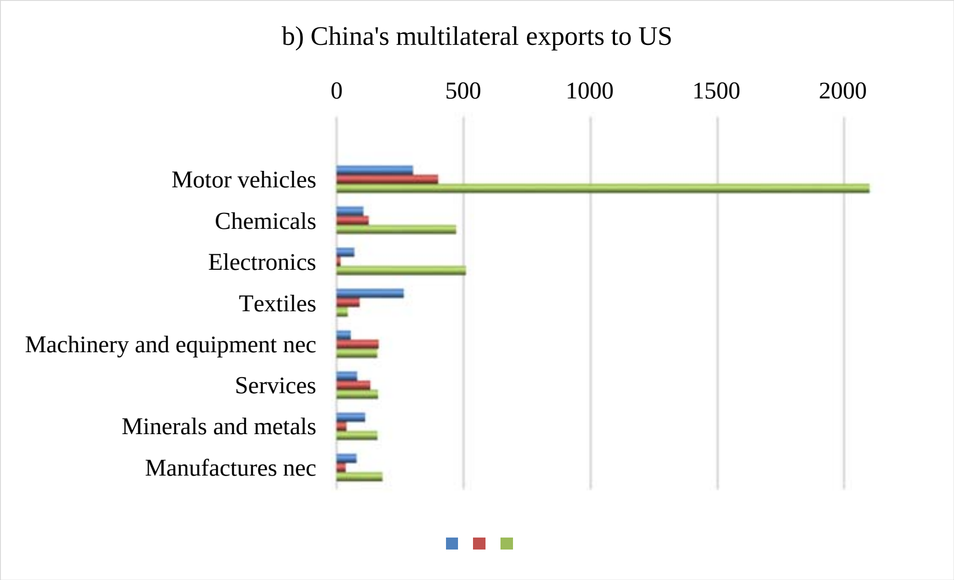
Source: Author's calculation based on the GTAP Data Base (2014 baseline).

Asia is the main platform for both countries, i.e., the US (China) ships inputs to Asian countries which are then embedded in goods exported from Asia to China (US). This region re-exports to China more than half of all US value added finally reaching the Chinese market. It is also an important bridge for Chinese VA to the US. The Rest of America is more important for Chinese multilateral exports (30.8 percent) than for US ones (13.5 percent). About one quarter of US multilateral exports to China passes through Europe (23.9 percent). The region has a lower weight in forwardly linking China to the US (19.1 percent).

Finally, we look at the Italian, French and German sectors involved in multilateral trade between US and China (Figure 3).

Figure 3. Importance of some EU countries' sectors in multilateral trade between US and China (millions of US dollars)





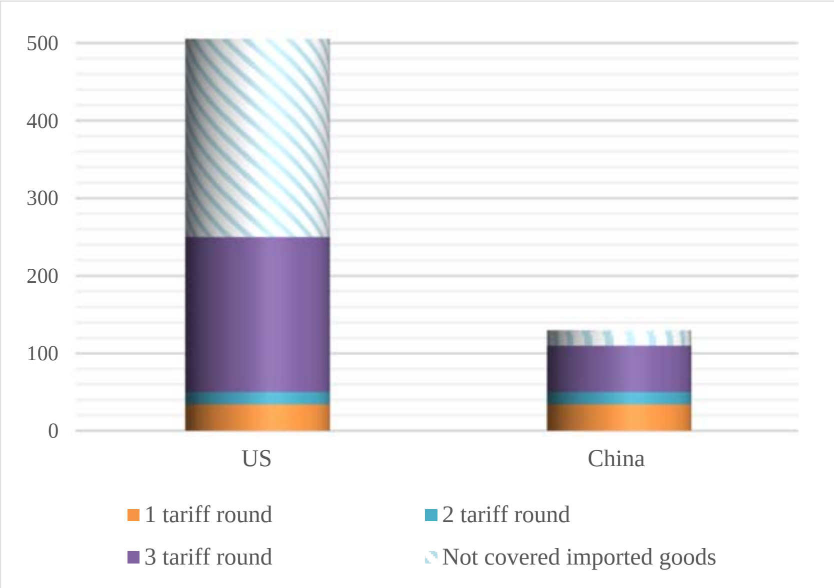
Source: Author’s calculation based on the GTAP Data Base (2014 baseline).

Even if in relative terms, the EU platform is more relevant for the US than for China and, in terms of re-exported value, the selected EU countries are more involved in Chinese forward linkages with the US than vice versa. This is explained by the higher value of Chinese multilateral exports to the US (almost to $73 billion, against the overall 46 billion multilaterally exported by the US to China). As for sectors, motor vehicles, electronics and chemicals are the main sectors embedding US (Chinese) VA in EU countries’ re-exports to China (US).

4 Scenario design

This study simulates the trade war between the US and China that has arisen from sanctions implemented by the US government and the tit-for-tat strategy adopted by Beijing. Specifically, I consider the different rounds of reciprocal increase in tariffs as of March 2019. The total US tariffs on goods applied exclusively to China amount to approximately $250 billion, and the total Chinese tariffs applied exclusively to US amount to $110 billion. The relatively lower amount of trade affected by Chinese duties reflects its large bilateral trade surplus with the United States. Overall, more than half of their bilateral trade is hit by the tariff war (Figure 4).

Figure 4. The three rounds of bilateral tariffs: total value of imports affected (US$ billion)



Source: USTR trade data for 2017.

The first step in the trade dispute dates back to March 2018 when the Trump administration imposed a 25 percent additional tariffs on all steel imports and a 10 percent tariff on all aluminum imports. These measures, undertaken under Section 232 national security justifications[7], were introduced not only vis-à-vis China (for $2.8 billion of imports), but also the majority of third countries. China answered by imposing tariffs of between 15 and 25 percent on 128 US products (including fruit, wine, steel, pork meat, and aluminium), which together totalled $2.4 billion of imports. Chinese retaliation was proportional to the suffered loss.

A few months later, unilateral duties applied specifically against China began. In July, the first round of US tariffs entered into force, imposing additional 25 percent duties on 818 tariff lines valued at $34 billion

[7] The Section 232 of the Trade Expansion Act of 1962 authorizes the President to impose import restrictions to protect US national security. Tariffs (or other means) can be imposed to adjust the imports from other countries if it deems that the quantity or circumstances surrounding those imports threatens national security.

imports of Chinese products. This has been the first stage of the two-stage plan announced by the US Trade Representative (USTR) to impose 25% ad valorem tariffs on $50 billion worth of Chinese imports (an annual trade value considered commensurate with the harm caused to the US economy by China's unfair policies), as the results of the investigation undertaken under Section 301[8] into the government of China's acts, policies, and practices related to technology transfer, intellectual property, and innovation. The second round of tariffs went into effect on August 23, covering 279 tariff lines with a value of $16 billion of imports from China. The measures covered a broad range of products including minerals, chemicals, metals, machinery and motor vehicles.

In parallel to US tariffs, China implemented comparable countermeasures on US products. Beijing took retaliatory measures by imposing a 25 percent tariff on 545 tariff lines of goods originating from the US (worth $34 billion), including agricultural products and motor vehicles. The second of China's lists concerned 333 products from the US (worth $16 billion), including agricultural and food products, minerals and electronics.

Chinese responses caused the modification of the prior USTR's action in the investigation by imposing additional 10 percent duties on products from China classified under 5,745 tariff subheadings with an approximate trade value of $200 billion[9]. Again, China raised tariffs (by 5% and 10%) on $60 billion worth of imports from the United States.

The procedure to simulate the implemented tariff hikes between the US and China starts from governmental lists with a Harmonized System (HS) 8-digit tariff code.[10] The HS 8-digit codes have been attributed to the corresponding HS 6-digit codes in order to calculate the trade-weighted average applied tariffs to be converted to a GTAP sector code, using the correspondence table from the World Bank-World Integrated Trade Solution (WITS).

The outcome of this procedure is reported in Figures 5 and 6 where the baseline tariff levels and the percentage variation in US and Chinese bilateral tariffs, respectively, due to the trade war, are shown. US tariff hikes hit mainly manufacturing products, machinery and equipment, motor vehicles and other transports, chemicals and electronics. These products represent the principal US imports from China (see Table 3). Beijing's retaliations heavily increased duties on agricultural and food products (for which China represents the second largest export market), notably vegetable and fruit, meat, oil seeds and beverage products. Extractive, machinery and equipment, chemicals and motor vehicles were also hit by China's measures.

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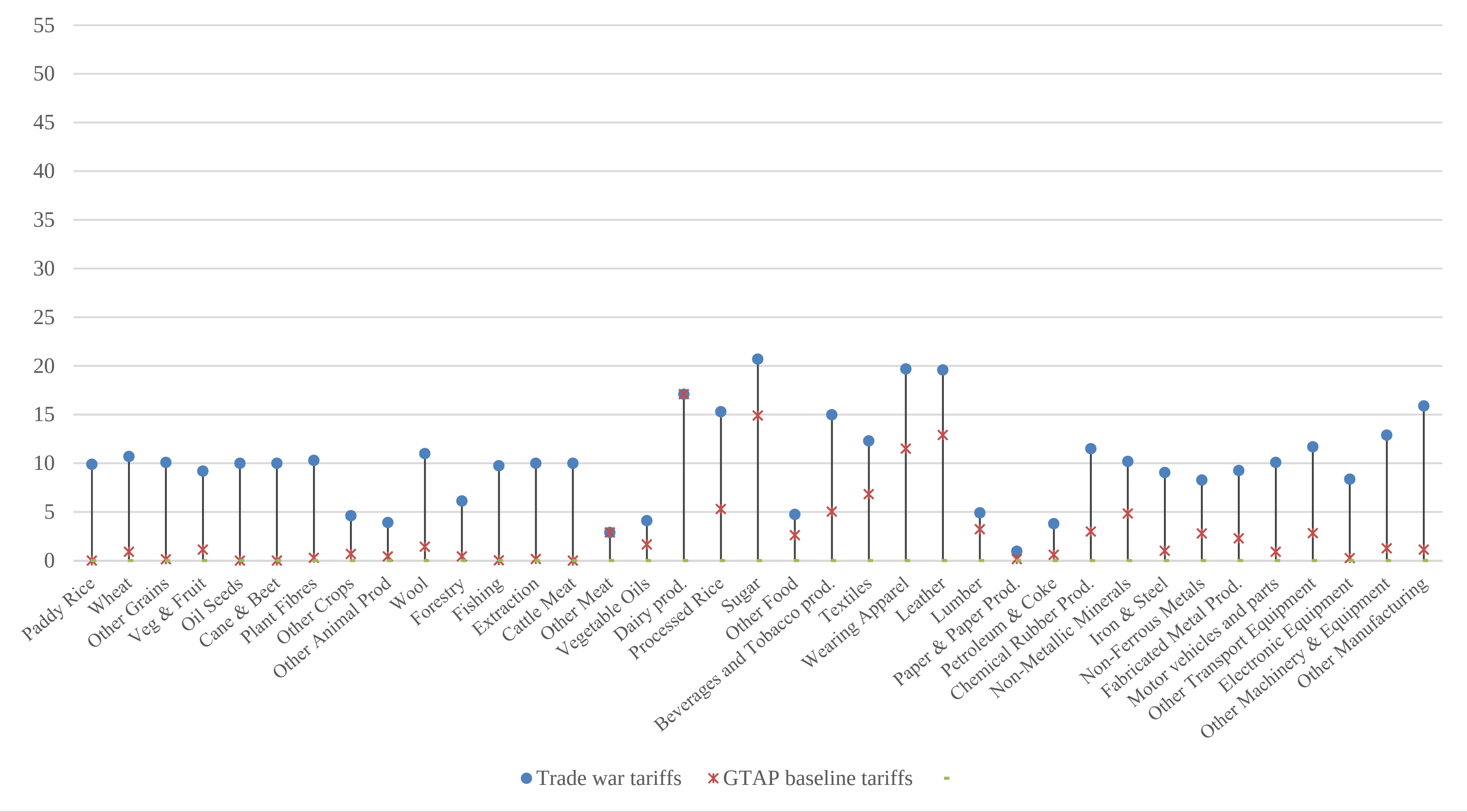
[8] Section 301 of the Trade Act of 1974 a key enforcement tool for addressing a wide variety of unfair acts, policies, and practices of US trading partners.

[9] The rate of the additional duty was scheduled to increase to 25 percent ad valorem on March 2, 2019, but the increase is currently delayed.

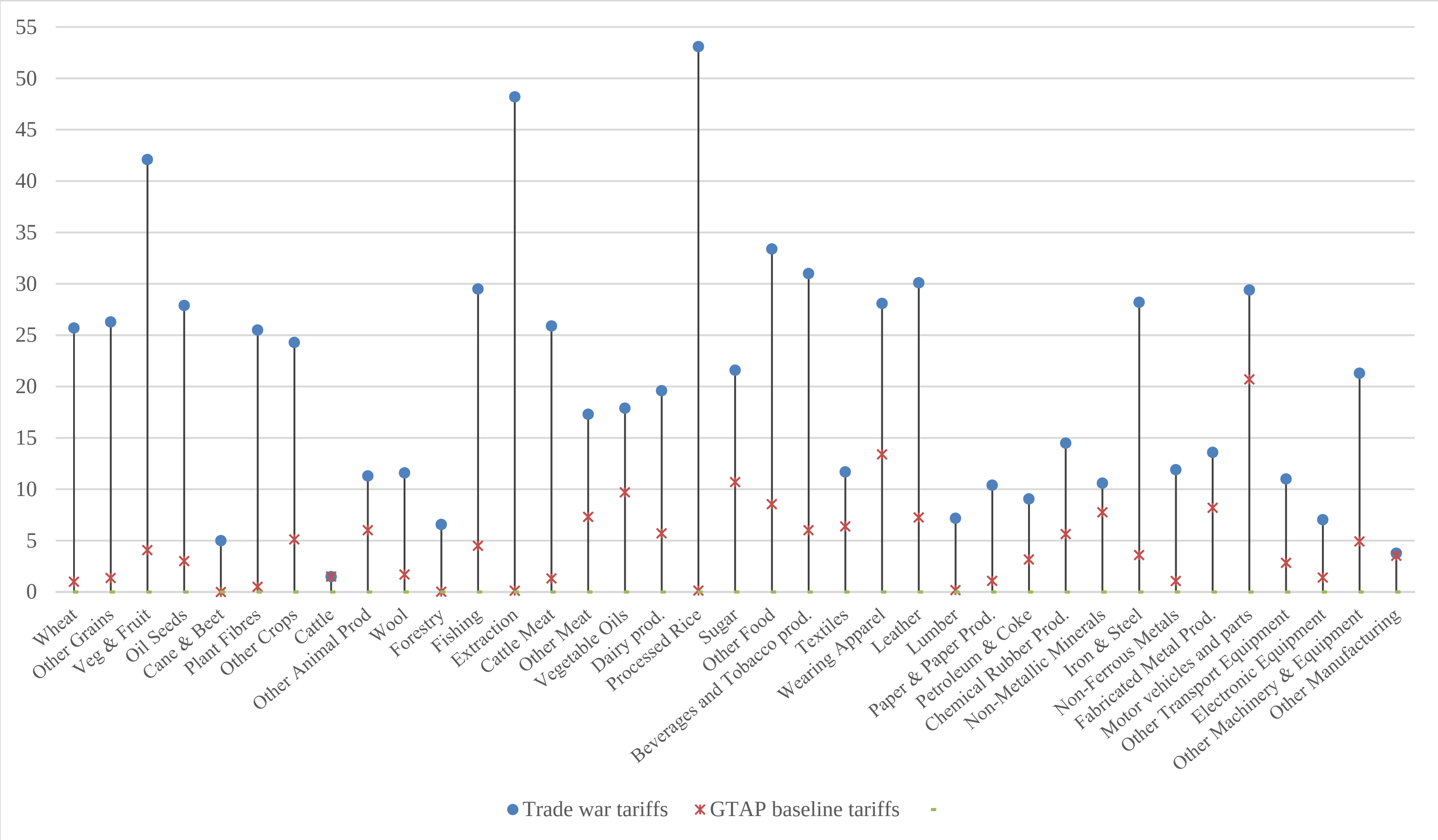
[10] US tariff lists have been downloaded from the USTR whereas the English version of Chinese lists has been obtained from the Peterson Institute for International Economics website.

Figure 5. Comparison between baseline and simulated tariffs for China



Source: Author's calculation based on WITS.

Figure 6. Comparison between baseline and simulated tariffs for US



Source: Author's calculation based on WITS.

5 Results

This section discusses the results of the simulated trade war between the US and China. The assessment is focused on trade patterns and is performed considering both gross values and value-added trade flows. This allows us to evaluate the effects on countries' GDP due to the variation in trade and to capture the impacts on the forward and backward linkages of all the players in world trade. The focus is on the three major European Union countries.

5.1 US and China bilateral trade

First of all, the implications of the tariff war for the US trade balance, the main preoccupation of the Trump administration, are considered. Table 8 presents the effects on the overall US account balance[11] and the bilateral balance with China.

Table 8. US-China trade war scenario: US trade (percentage change[12])

	US exports		US imports		US trade balance	
Partner	China	World	China	World	China	World
Gross trade	-39.2	-2.2	-28.6	-2.7	23.1	3.8
VA trade	-38.9	-1.9	-28.1	-3.5	22.0	8.4

Source: Author's simulation using the GTAP-VA model.

The strong contraction in bilateral trade between the US and China due to the increase in tariffs reduces the US deficit with China by 23.1 percent ($74,909 million). Overall, the US trade deficit is reduced by 3.8 percentage points (corresponding to $30,298 million).

The impact on US trade balance is less pronounced in terms of value added (relatively to gross values) with China (22 percent), while the opposite is true with respect to overall VA trade for which amelioration corresponds to 8.4 percent. This is explained by two factors. First, US overall imports (which rely more on foreign intermediates) contract relatively more than exports (which are more intensive of domestic value added), whereas US imports from China decrease relatively less than US exports to China. Second, the increased import tariffs raise the cost of importing intermediate inputs which pushes belligerent countries to rely more on domestic providers. Consequently, the domestic value-added content of traded goods tends to decrease less then gross values (and foreign value added), thus contracting their integration into GVCs. Conversely, third countries facing unchanged tariff profiles will find more convenient to source intermediate inputs from abroad (since they are less expensive due to the increased availability in supply)

[11] In the GTAP model, the balance of trade is determined by the relationship of regional investment (based on equating expected rates of return) and savings (driven by net national income). The standard closure, which is the one adopted here, allows flexibility of the current account.

[12] The trade balance can be either positive or negative, consequently, the sign of the percentage changes depends on whether the original position is in surplus or deficit. To facilitate the interpretation, in Table 7, absolute values are considered, meaning that the percentage change is positive if the existing deficit has become smaller.

which explains why the domestic value added embedded in their exports to the US diminishes relatively more than their gross exports.

The effects of the US-Sino tariff war on third countries' trade are then assessed. Table 9 records the impact on bilateral trade of three major European economies with the US and China.

Table 9. US-China trade war scenario: US and China bilateral export-import (percentage change)
a) US trade

	US exports			**US imports**		
Partner	Italy	France	Germany	Italy	France	Germany
Gross trade	1.8	1.9	2.0	6.0	2.8	4.9
VA trade	2.2	2.4	2.4	5.9	2.2	4.2

b) China's trade

	China exports			**China imports**		
Partner	Italy	France	Germany	Italy	France	Germany
Gross trade	5.8	6.0	5.7	-1.0	3.4	0.1
VA trade	6.2	6.5	6.2	-1.0	3.5	0.1

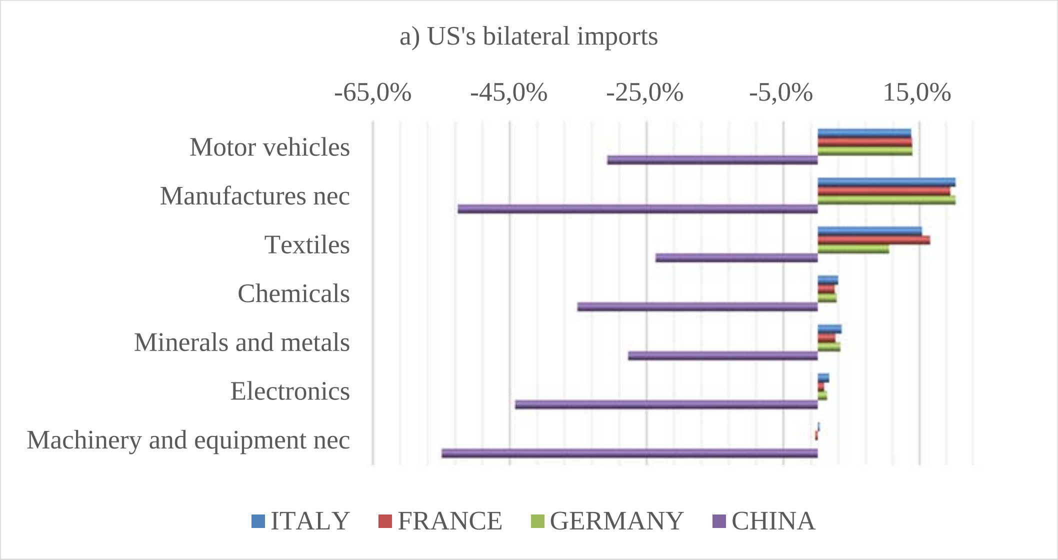
Source: Author's simulation using the GTAP-VA model.

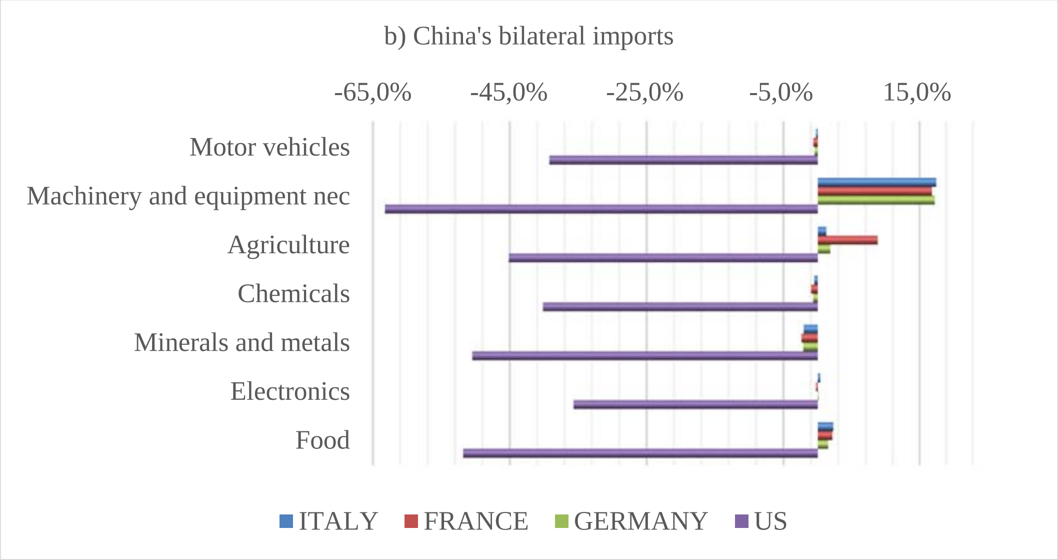
As bilateral trade between US and China declines, we observe a replacement by trade from and directed towards European countries. Under our scenario, trade between US and the three European countries under examination intensifies. US exports to Italy, France and Germany grow by around 2 percent, and the exported US DVA increases relatively more than its gross exports. As already discussed, this is explained by the fact that the increased costs in buying inputs from abroad (namely, from China) make US firms rely more on domestic providers, thus increasing the DVA content of US exports. Conversely, EU countries increase their reliance on foreign inputs to produce exports, which is reflected in the fact that US imports from European countries increase more in gross than in VA terms. While this pattern is similar for the selected EU countries, the impact on their exports to the US is heterogeneous. Both Italy and Germany seem to take advantage of the US-China trade war, being able to substitute for Chinese products in the US. This result is consistent with studies that find a high similarity between China and EU structures of exports, especially to developed countries (see, for example, Wang and Liu, 2015). Italy gains more than other EU countries in the US market (+6 percent) due to its export composition seemingly benefitting from the competitive effect between Chinese and Italian exports, both concentrated on low tech, traditional products (Giovannetti et al., 2018). For example, the competitiveness of Italian textiles in the US - a sector which represents 12 percent of Italian exports to the US and faces high protection in that market - increases as a consequence of the increased costs of Chinese textiles caused by the tariff hikes.

China ameliorates its trade balance with all the three EU countries. It redirects its exports to European markets, where it exports around 6 percent more. Similarly to what has been observed for the US, as China's backward integration decreases, the DVA content of Chinese exports increases more than gross exports. Among the EU countries, France only increases its exports to China (by more than 3 percent), whereas neither Italy nor Germany replace US products in China. The explanation lies in the fact that the only sector in which the EU is able to replace US exports in China is machinery and equipment, which are strongly affected by the analysed increase in tariffs. This is the most important sector in French exports, accounting for more than 30 percent of its exports to China, whereas it represents barely 5 percent for Germany and only 2 percent for Italy.

The impacts on sectors are shown in Figure 7 where we look at the effects on US (a) and China (b)'s gross imports at the sector level.

Figure 7. US-China trade war scenario: US and China bilateral import, by sector and exporter (percentage change)





Source: Author's simulation using the GTAP-VA model.

In the US market, Chinese exports mostly contract in motor vehicles (-$76 billion), manufactures (-$21 billion) and textiles (-$18 billion) which represent the sectors where tariffs increase the most (refer to Figure 5). The EU countries succeed in substituting for Chinese products, gaining market shares in the US in all three sectors.

China imports from the US $14 billion less motor vehicles, $13 billion less machinery and equipment, and $10 billion less in agriculture. As already noticed, the ability of EU countries to substitute for US products in China is very much lower and mostly limited to one sector, machinery.

5.2 US and China GVC-related trade

The disruption of trade between the US and China impacts their demand for foreign inputs, affecting suppliers of intermediates wherever they are located. Moreover, as bilateral trade between the two economies becomes costlier, it is likely that more value will be exported multilaterally, that is, through other countries in the global trade system whose trade costs have not been changed. This is the object of this section which assesses the impact of the US-China trade war on their backward and forward linkages, focusing on the three selected EU countries.

When comparing the changes in gross and VA trade (Table 8 and 9), a more than proportional contraction of the US and China's demand for foreign inputs has been observed. Table 10 looks deeper at the decrease in the backward integration into GVCs of both the US and China and highlights the strong and negative impact in terms of bilateral demand of intermediate products.

Table 10. US-China trade war scenario: FVA content of exports from the US (a) and China (b) (percentage change)

a) US exports

		Importer	
		China	World
Provider	China	-53.1	-24.3
	World	-40.4	-3.7

b) China's exports

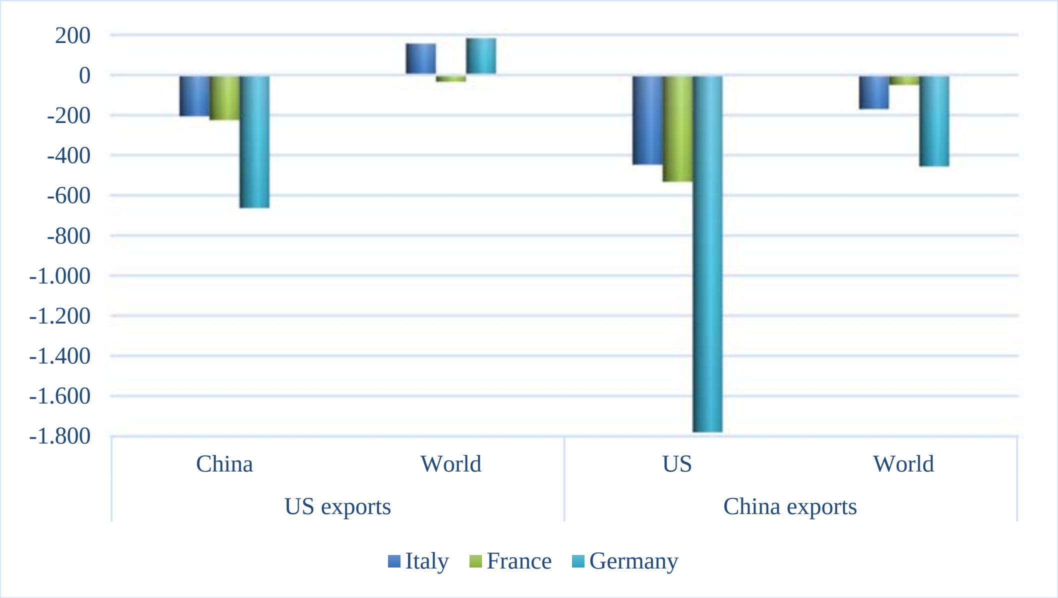
		Importer	
		US	World
Provider	US	-48.6	-29.4
	World	-31.0	-4.1

Source: Author's simulation using the GTAP-VA model.

Both the US and China contract their demand for foreign inputs in producing exports, respectively by 3.7 percent and 4.1 percent, as a consequence of both the reduction in exports and the increased reliance on domestic inputs. As expected, the biggest cuts are found for circular trade, that is intermediate inputs provided to the exporting countries by the importer, suffering higher tariffs at both borders at each crossing. Chinese inputs used in the US production of exports to the Chinese market are more than halved (-53.1 percent) and US intermediates used by producers in China to export to the US go down by 48.6 percent. As for exports to all markets, both the US and China consistently reduce their demand for bilateral intermediate inputs (-24.3 percent and 29.4 percent, respectively).

The contraction of trade between the US and China also has an impact on EU providers of intermediate inputs to the two economies. This effect is considered in Figure 8 where the impact on intermediate inputs produced in EU countries and demanded by the US and China for their bilateral and total exports is shown.

Figure 8. US-China trade war scenario: demand of intermediates from Italy, France and Germany in US and China bilateral and total exports (millions of US dollars)



Source: Author's simulation using the GTAP-VA model.

We can observe that both the US and China would decrease their demand for intermediates that originated in EU countries in their bilateral trade as a consequence of the drop in flows. The contraction is particularly significant for the demand from China, since it is the country that experiments the biggest cut (in absolute terms) in its exports to the US and also experiences a more than proportional reduction in FVA content. German providers, who have an initial higher rate of integration, are the most impacted by the reduction in Chinese demand for intermediates.

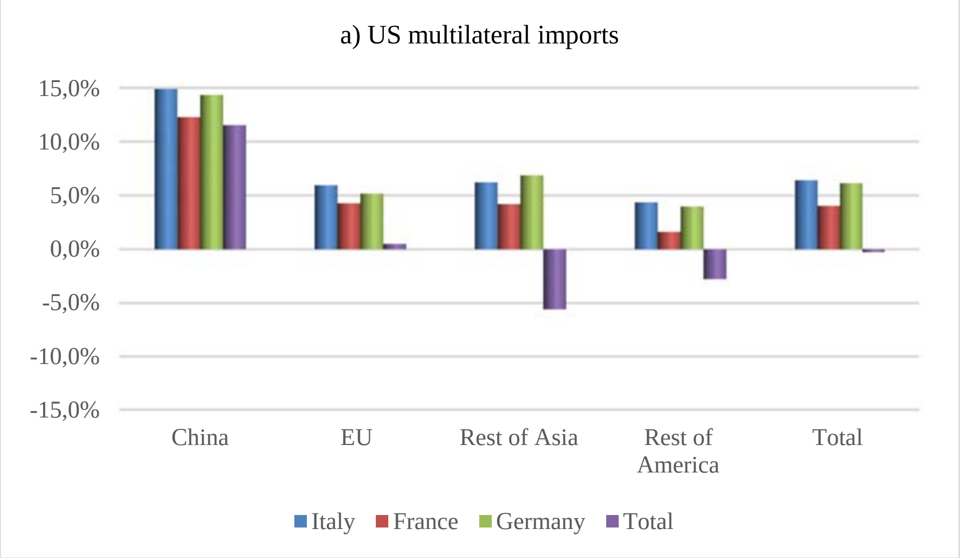
Although US total exports decrease (see Table 8), US demand for inputs from Italy and Germany slightly increases overall, suggesting growing integration with the two EU countries.

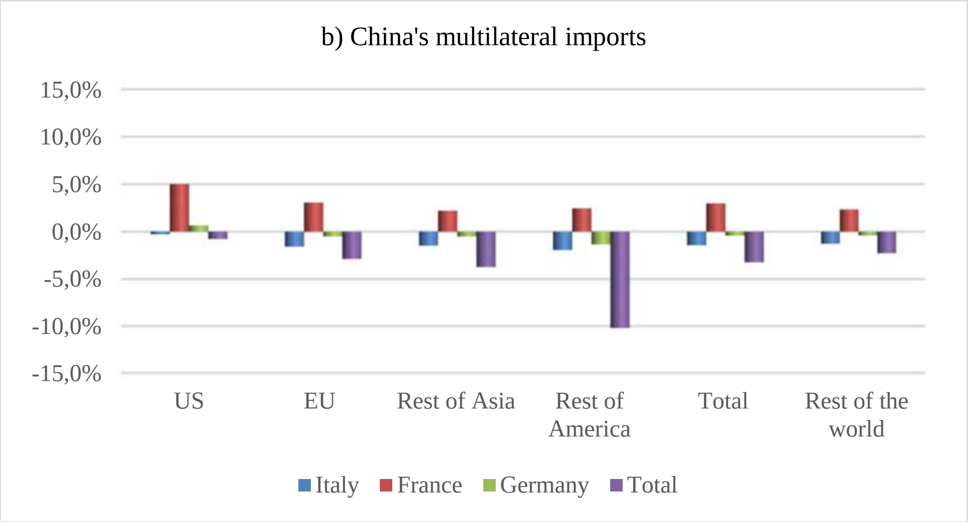
In terms of sectors, the huge contraction in US-China bilateral trade of motor vehicles drives a sharp reduction in the demand for EU services, motor vehicles and chemicals (refer to Figure 2 and Table 6).

Finally, I present the changes in the structure of multilateral imports to the US and China (i.e., those reaching the final destination through other countries' re-exports), in order to assess how tariff hikes between the two economies impact the creation of value added in different regional locations linked indirectly to consumption in the US and Chinese markets. I also explore if and how the role of EU countries in this kind of trade is impacted.

Figure 9 shows percentage changes in the US (a) (and China (b)) multilateral imports of VA originated in China (US) and in different regional aggregates (reported in the x-axis). For each of the two countries, total multilateral imports and re-exports from the EU platforms (namely, from Italy, France and Germany) are considered.

Figure 9. Multilateral imports, by EU platform and regional provider (percentage change)





Source: Author's simulation using the GTAP-VA model.

An analysis of US multilateral trade shows that the US-China trade war would leave the total VA pushed by the demand in the US market unchanged. However, it would affect the geography of the exchanges. Specifically, we can observe that Italy, France and Germany increase all their role as platforms re-exporting other countries' VA to the US. This reflects both the increase in their exports to the US (which pulls their demand for intermediates from abroad) and the more than proportional growth of the FVA content in EU countries' exports relatively to gross flows (refer to Table 9a).

Interestingly, US multilateral imports of Chinese VA increase (+11.5%). This result suggests that simply relying on trade statistics in gross terms entails an overestimation of China's losses due to the trade war with the US, because a) part of the decline in gross exports is explained by the drop in foreign VA (refer to Table 8), and b) US demand still pushes Chinese production albeit through an indirect channel, that is, more Chinese VA reaches the US market by crossing other countries' borders. Given the increased importance of the EU countries as platforms exporting Chinese VA to the US, this result can also suggest that EU countries substitute for the US in performing the last stage of processing intermediates from China to satisfy US consumption demand.

Another figure that emerges is that EU regional integration would increase due to the strengthening of relationships with the US market. This can be seen from the increase in the EU VA re-exported by the three selected EU economies to the US. Italy, France and Germany are also more relevant in vehiculating VA from the rest of Asian and American regions to the US, even though the VA from those two regions multilaterally linked to the consumption in the US seems to be negatively affected overall by the US-China trade war (-5.6% and -2.8%, respectively).

As for China, its multilateral imports fall overall. The decrease is more pronounced for the VA that originated in the rest of America. The explanation is that for that region, the US is an important platform suffering the increased costs in exporting to China due to the higher tariff barriers. Conversely to what has been found for the US, the Chinese absorption of US VA is reduced overall.
Among the analysed EU countries, only France experiences an improvement in its role as a platform to China, in line with the already discussed intensification of their trade relationships.

6 Concluding remarks

In this paper, I have analysed the impacts of the 2018 US-Sino trade war on global trade networks. Using value-added metrics in a computable general equilibrium framework, I have evaluated the "GVC-related effects" of the implemented rounds of tariff hikes on the belligerent countries and on the euro area. I have found that the disruption of trade between the US and China affects countries' participation in global production networks and acts as a restructuring force for regional and global value chains. The extent to which increased bilateral tariffs impact countries' GVC integration depends on the kind of linkages they have. Since the increased import tariffs raise the cost of importing intermediate inputs, both the US and China are pushed to rely more on domestic providers and to substitute for imports from other providers. This effect is particularly strong for the US because China is the main provider of foreign intermediate inputs for US firms. Consequently, US integration in GVCs contracts. As for China, the reduction in backward participation is more than compensated for an increase in forward integration with its most important end market, i.e., the US. In this vein, initiatives such as the "One Belt One Road" can be seen as an attempt to diversify supply and end markets thus reducing Chinese dependence on the US market. European countries are important players in GVC-related trade with the US and China. I have demonstrated that the increased linkages of the euro area with the US strengthen European regional integration, while the opposite holds for GVC-related trade with China, the only exception being France.

I conclude with a few reflections on future work in this area. First, I have developed the analysis based on an Armington structure for imports, thus ignoring scale economies and variety effects. In future work, I plan to extend the analysis to different trade assumptions (e.g., Krugman and Melitz). Second, I have applied a proportionality assumption that has allowed me to recover data on industry-to-industry trade. The UN Broad Economic Categories (BEC)-influenced sourcing shares for intermediate and final demand are a more refined categorization method that could improve the estimations. Finally, in this paper I have considered only tariffs and used weighted average schemes for the aggregation. Since trade protection concerns different policy instruments applied over thousands of commodities, a more refined method of aggregation could improve the measurement of trade policy. For example, trade restrictiveness indexes based on a value-added basis could give a synthetic and theoretically sound measurement of the overall protectionist stance on the different segments of the GVCs. This is an area which could be worth further exploring.

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