Dollar invoicing, exchange rates and international trade

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Abstract

This paper studies the role of exchange rates and dollar invoicing in driving the dynamics of international trade flows. It uses a granular decomposition of trade flows at the bilateral level to highlight a bifurcation, whereby in response to a rise in US interest rates, final goods trade between non-US countries, as well as trade that is more regionally oriented, declines by more than does trade that is global value chain-oriented. These results highlight an important role played by global value chains in mitigating the negative impact of external shocks.

Keywords: dollar invoicing, international trade, global value chains, monetary policy.

JEL classification: E2, E5, E6.

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1. Introduction

The relationship between exchange rates and international trade is one of the most intensively researched areas in economics. Going back at least to the work of Friedman (1953), Fleming (1962), and Mundell (1963), the mainstream view of exchange rate depreciations being expansionary is built on a set of frameworks in which exports are priced in the currency of the exporter. This has been labelled the producer currency pricing (PCP) paradigm. Under this setting, an exchange rate depreciation in the exporting country makes its exports more competitive in the global market, and its imports less competitive in the domestic market. Both these effects contribute to a rise in the trade balance. Subsequent studies challenged the PCP premise and considered alternate frameworks in which exports are invoiced in the currency of the importer. This gave rise to the literature on local currency pricing (LCP) or pricing to market (PCM).[3]

Recent empirical literature on export invoicing has shown that none of these pricing paradigms is an accurate description of reality (see McKinnon and Schnabl (2004); Cook and Devereux (2006); Goldberg and Tille (2006); Gopinath (2016); Boz at al (2017)). Instead, an overwhelming majority of exports around the world are priced in a handful of key "global currencies", with the US dollar being the most prominent among them. Goldberg and Tille (2008) document this outsized role of the US dollar by showing that the share of exports and imports invoiced in US dollars is consistently and substantially higher than the corresponding share of trade with the United States for most countries around the world.

Casas et al (2016) study the implications of this dollar pricing paradigm for the relationship between exchange rates and international trade flows. They show how the standard Mundell-Fleming prediction of a depreciation leading to a rise in exports becomes weaker, and most of the adjustment in the trade balance comes from the import side. They also highlight that a uniform rise in the value of the dollar can lead to a fall in global trade (including bilateral trade between non-US countries), as exports which are priced in dollars become more expensive globally.

Building on this literature, this paper contributes to the study of the implications of dollar pricing on the dynamics of international trade. Specifically, it makes two contributions. First, it takes a general equilibrium perspective on the impact of exchange rate changes brought about by interest rate shocks on the relationship between exchange rates and international trade. This addresses an important limitation in the existing literature, which typically models the exchange rate as determined outside the system and subject to random shocks. Second, recognising the increasing complexity of international trade networks and the rising importance of global value chains, the paper focuses on uncovering the differences in the impact of shocks on different types of international trade flow depending on the degree of participation in global (and regional) value chains, and the number of border crossings involved.

The main result emerging from the analysis is that, in response to an exchange rate depreciation brought about by a rise in global (US) interest rates, final goods trade between two non-US countries, as well as trade flows that are more regionally oriented, declines more than do trade flows that are global value chain-oriented and supply final demand outside the region. The reason for this difference comes from

[3] See for instance Betts and Devereux (1996).

the fact that an appreciation of the global currency gives a competitive price advantage to the imports into the global economy, which mitigates the overall decline in demand for traded goods brought about by the rise of the dollar. For example, consider a world comprising on two regional economies and a large "global" economy in which all internationally traded goods are priced in dollars. When global interest rates rise and the dollar appreciates, exports of both regional economies become more expensive (irrespective of destination) and lose competitiveness vis-à-vis domestically produced goods. This can be understood as a "price effect" which affects the demand for all traded goods. In addition, there is also a "demand effect". Since the global economy experiences a real appreciation in response to the shock, its demand for imports increases. To the extent that these imports are produced via global value chains that involve intermediate goods trade between the regional economies, the share of this global value chain-oriented trade between the regional economies rises. To summarise, while the negative price effect works for all trade flows, the positive demand effect works only for global value chain trade.

The remainder of this paper is structured as follows. Section 2 discusses a schematic representation of a framework to guide the interpretation of implications of changes in exchange rates on international trade flows in the presence of global value chains. Section 3 discusses the main empirical analysis in the paper. Section 4 concludes with a summary of the main message in the paper.

2. Model environment

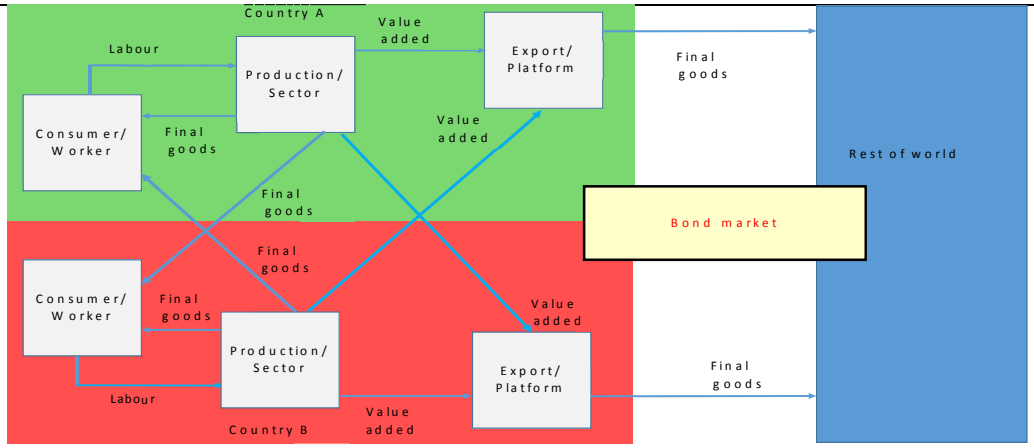
Consider a three-country world consisting of two identical regional economies (labelled A and B) and a rest-of-the-world region (Figure 1).[4] Each regional economy consists of a representative consumer/worker, a production sector, and an export platform. The consumer provides labour to the production sector, which uses it to produce output. This output can be consumed by consumers in the home country, or be exported and consumed by consumers in the regional economy as final goods, or be sold to an export platform within the economy, or be exported to an export platform in the other regional economy. The export platforms in the two regional economies in turn combine intermediate inputs from both regional economies and produce output that is exported to the global economy.

The key assumptions, which are also the key frictions in the model, are with regard to the currency of invoicing of different goods. All goods that do not cross international borders are priced in the local currency, whereas all goods that are sold across an international border are priced in the global currency. For example, goods sold by the production sector in country A to the export platform in country A are priced in the domestic currency of country A, whereas goods sold by the production sector in country B to the export platform in country A, as well as the final goods sold by the regional economies to the global economy are priced in the global currency. Prices are assumed to be sticky in the currency of invoicing, and therefore adjust only slowly in response to shocks. The two regional economies are assumed to be completely symmetrical, including their monetary policy responses, so that the exchange rate between the two regional economies is always fixed, and this combined currency is referred to as the regional currency.

[4] See Cook and Patel (2017) for a detailed mathematical description of the framework.

Model setup

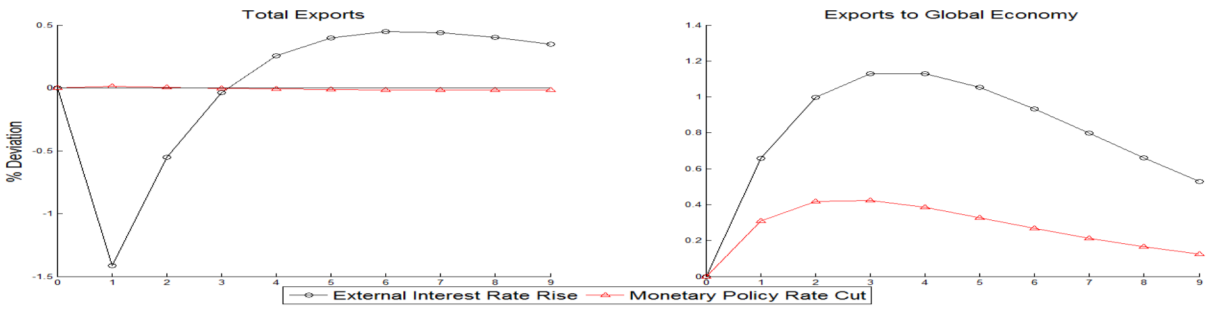
Figure 1



Under this setting, an interest rate rise in the global economy causes an appreciation of the global currency vis-à-vis the regional currency. Since all exports, irrespective of their country of origin and destination, are priced in the global currency, they become relatively more expensive than domestically produced goods for the two regional economies. Demand therefore shifts away from exports and towards domestic production in both country A and country B. The key insight of the framework is that this fall in demand for exports is not uniform across different types of export. In particular, final goods exports between the regional economies decline by more than intermediate goods exports that are subsequently used by the export platforms to produce exports for the global economy. This is due to the fact that an appreciation of the global currency leads to a rise in demand for exports from the regional economy that are produced by the export platforms, through the standard competitiveness channels. The net result is that final goods trade, and regional trade which is eventually confined to the region (such as back-and-forth trade between the two regional economies) falls in a much sharper way than final goods trade (Figure 2).

Response of exports to an interest rate shock

Figure 2



Note: The figures denote impulse responses to domestic and foreign interest rate shocks based on the benchmark framework and calibration in Cook and Patel (2017).

The opposite is true in the case of a monetary policy rate cut undertaken by the two regional economies. In this case, since the monetary expansion has a positive impact on demand for final consumption in the two regional economies, final goods

exports fall by less than regional intermediate goods exports that are eventually destined for the global economy.

3. Empirics

The preceding discussion highlights how interest rate shocks can have a markedly different impact on different forms of international trade. This section aims to analyse these implications by using data on bilateral trade flows and other macroeconomic variables in a sample of 40 major economies.

Stylised economic frameworks like the one in Figure 1 have a precise definition of intermediate and final goods trade flows. For example, as far as the regional economies are concerned, in the framework in Figure 1 there are only two kinds of trade flow, each with a clearly defined path towards the final destination. Final goods exports originate in one regional economy and are exported and consumed in the other. Intermediate goods exports originate in one regional economy, are exported to export platforms in the other regional economy, and are subsequently exported to the global economy.

International trade is much more complicated in the real world, and defining different categories, let alone measuring them precisely in the data has for the most part proved to be a forbiddingly challenging task. For example, unlike in the framework in Figure 1, not all intermediate exports are subsequently exported to other countries. In fact, as shown below, the largest part of intermediate exports is used to produce final goods that are consumed by the direct importer. In addition, some are also shipped back to the original exporting country, either in the form of final goods or intermediate goods. Standard sources on international trade data, which at best offer a two-way decomposition of international trade flows (intermediate vs final goods), are therefore not rich enough to capture these complexities, as they only track exports up to one border crossing, and do not track the subsequent journey and final destination of the exports.

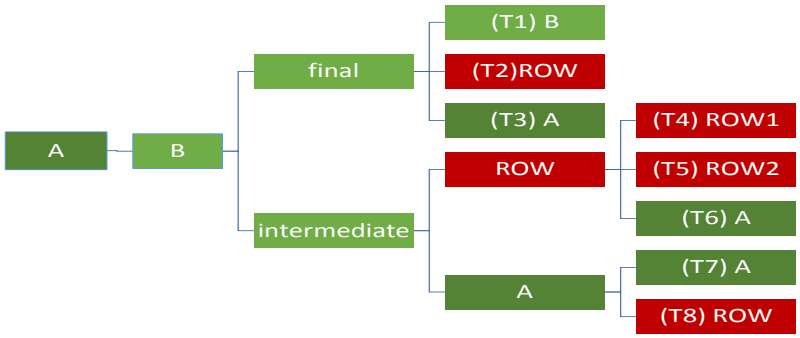
To address these challenges, we rely on recent advances in export accounting frameworks that allow for a more granular decomposition of intermediate goods trade flows. For this purpose, we use the eight-term decomposition in Wang et al (2013). Figure 3 illustrates the main idea behind the decomposition. Let A and B be the two regional economies and let "ROW" denote the rest of the world (akin to the global economy in Figure 1). The figure starts on the left with an initial shipment of intermediate exports from A to B. Standard data sources typically stop here. Once these exports reach B, they can be used either to produce intermediate goods or to produce final goods. Focusing on the latter category first, these final goods can be shipped to the rest of the world (as in the framework in Figure 1; T2), or they can be consumed in B itself (T1), or they can be shipped back to A (T3).

Likewise, the remainder of the diagram shows how the share of intermediate exports from A to B that is used to further produce intermediate exports can be traced based on the subsequent journey of these exports until they are consumed as final goods. While the framework in Figure 1 is parsimonious in comparison and does not cover all the possibilities offered by this eight-term decomposition, it nevertheless offers insights on the direction of effects of the different mechanisms that are at play. Specifically, the response of trade flows to an interest rate rise can be expected to vary depending on whether they are eventually consumed as final goods in the region constituted by A and B (identified by the green boxes in Figure 3), or consumed in

the global economy (corresponding to the red boxes in Figure 3). In response to an exchange rate depreciation of A and B brought about by an external (global economy) interest rate increase, the share of the former should fall and the share of the latter should rise (while the converse would be true in the case of an exchange rate depreciation brought about by a domestic interest rate cut in A and B).

Schematic representation of intermediate export decomposition and evolution of shares of different components in intermediate exports

Figure 3



Year	1995	2008	2009	2011
T1	69.37518	62.7517	63.79737	62.46203
T2	11.08952	12.78733	12.96956	12.90795
T3	0.05006	0.07703	0.07293	0.07328
T4	14.53779	17.17629	16.62317	17.8149
T5	2.73803	4.63388	4.05513	4.26818
T6	0.02254	0.05058	0.04182	0.04457
T7	0.08847	0.1294	0.11174	0.11649
T8	0.01824	0.03878	0.03155	0.03247

Source: Wang et al (2013).

Data and specification

We use dynamic panel regressions to study the impact of changes in US interest rates on bilateral trade between non-US countries. While the framework has implications for both domestic and external interest rate shocks, we focus on the latter as they are easy to uncover in the data, given the endogeneity concerns associated with identifying domestic monetary shocks. The empirical model is specified as follows:

$$Y_t^{i,j}(s) = \alpha^{i,j}(s) + \eta Y_{t-1}^{i,j}(s) + \beta i_{us,t} + \delta X_t + \epsilon_t^{i,j}(s)$$

The dependent variable is a measure linked to bilateral exports from sector s in country i to country j in year t. X includes a number of control variables such as contemporaneous and lagged values of changes in the bilateral exchange rate between the importer and the exporter, change in real GDP and inflation of the importer and exporter, change in total imports by the importer, and change in total imports and exports by the importing country to the US (to control for global demand effects), contemporaneous and lagged values of US GDP growth and inflation, as well as the change in unit labour cost in the exporting country. A quadratic time trend is also included in the regressions. Dynamic responses of the dependent variable at

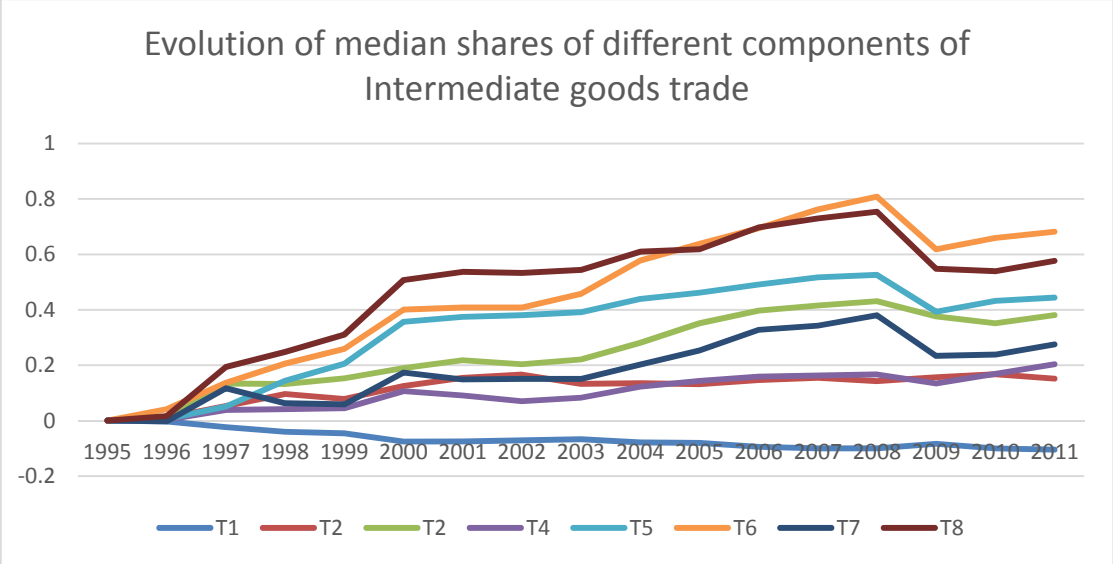
different horizons are computed using the local projection method in Jordà (2005). Acknowledging the issues that arise from estimating dynamic panel models with a lagged dependent variable, we use the difference GMM estimator proposed in Arellano and Bond (1991).

Across different specifications, we consider as the dependent variable different measures of bilateral trade between two (non-US) countries. In addition to gross final goods and intermediate goods exports, we also consider the dynamics of different subcomponents of intermediate goods exports in Wang et al (2013) that are summarised in Figure 3. The main data source for bilateral exports is the World Input-Output Database (WIOD). It contains bilateral trade data at the sector level for 35 sectors in 40 countries at annual frequency. The sample runs from 1995 to 2011.[5] The full list of countries and sectors is available in the appendix. The remaining data (including GDP and other macro variables) for the analysis are taken from the IMF's International Financial Statistics.

The bottom panel in Figure 4 shows the median shares of each of the eight components of intermediate goods exports across all the sectors and countries in the sample. As evident from the numbers, the largest share corresponds to intermediate inputs that are subsequently used by the direct importer to produce final goods for domestic consumption (T1). This highlights the drawback of simply using a two-term decomposition (final vs intermediate goods), as unlike in any model of global value chains, the largest part of intermediate goods in the data are actually absorbed domestically and are not re-exported. From the perspective of international shock transmission, this part is more akin to final goods trade rather than intermediate. That said, as shown in Figure 4, the share of T1 has declined, and the share of all other components that involve deeper involvement in global value chains has risen markedly between 1995 and 2011.

Response of exports to an interest rate shock

Figure 4



Notes: Percentage changes in shares of different components of intermediate exports (as a share of total intermediate exports). All shares are normalised to zero in 1995. Absolute values for benchmark years are displayed in Figure 3.

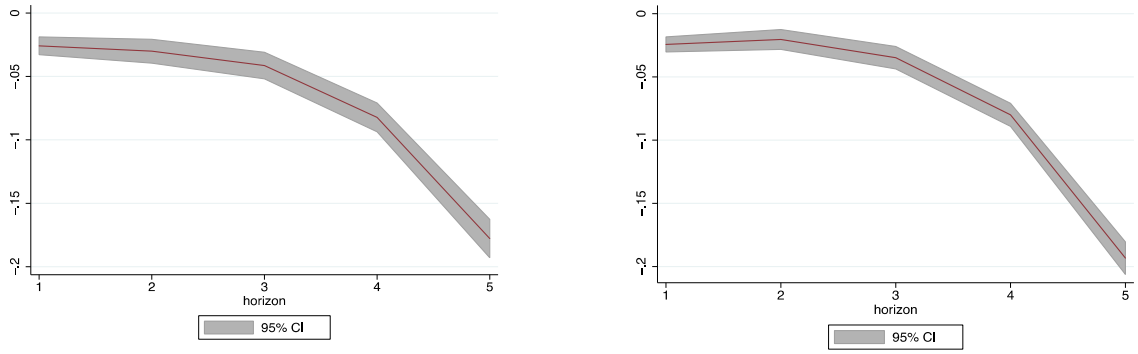
[5] See Dietzenbacher et al (2013) for a detailed description of the World Input-Output Database including information on data sources and methods used in the computations.

Results and discussion

Figure 5 shows the response of bilateral final goods and intermediate exports to a 1 percentage point rise in US interest rates. As expected, both these trade flows decline. However, there is no discernible difference between the two responses as predicted by the model. This is not surprising, since as shown in Table 1, the majority of intermediate exports are directly absorbed as final goods in the importing country. They are therefore analogous to final exports rather than the supply chain-oriented intermediate exports that we wish to study.

Response of exports to US interest rate rise — Figure 5

Final goods exports (real) | Intermediate goods exports (real)



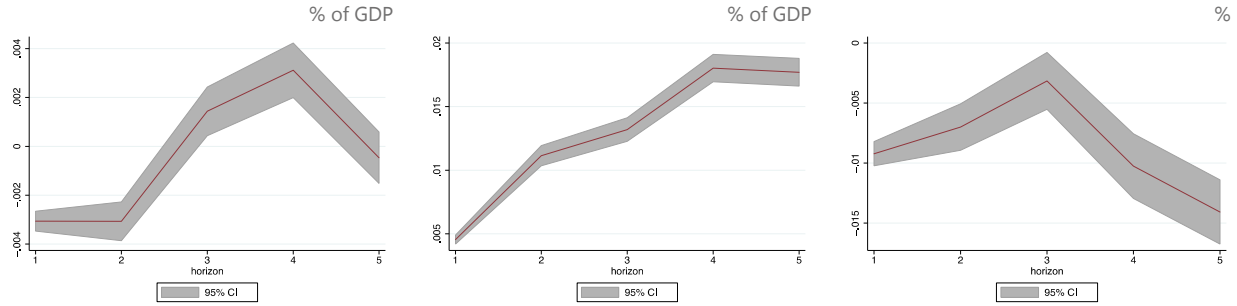
Notes: Percentage deviations from steady state. The figures display dynamic impulse responses computed using local projection methods.

Source: Authors' calculations.

To address this concern and further investigate the response of different categories of trade flows, we now consider the response of the shares of different components of bilateral intermediate goods exports in Figure 3.

Response of intermediate exports used by direct importer to produce final goods — Figure 6

Consumed domestically (ie by the direct importer) | Exported to third countries | Exported back to the source country



Notes: Percentage deviations from steady state. The figures display dynamic impulse responses computed using local projection methods.

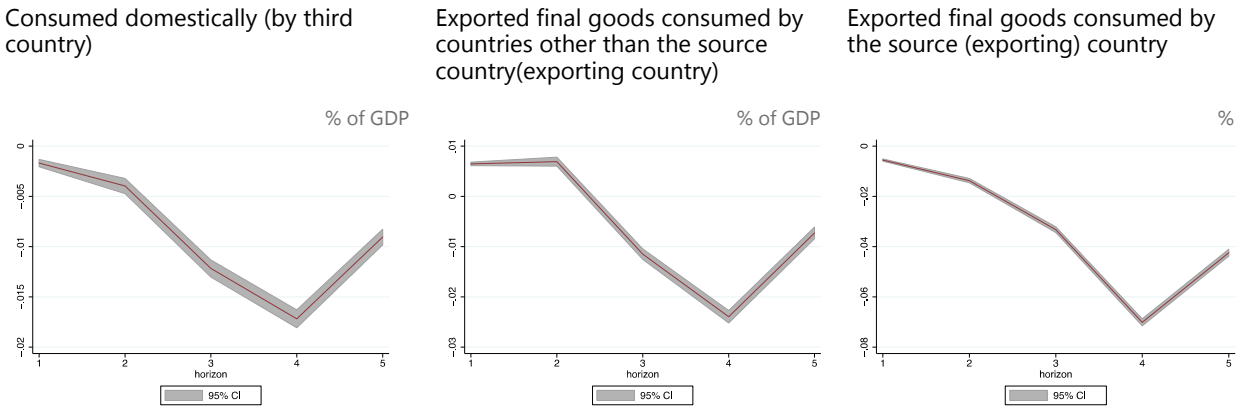
Source: Authors' calculations.

Figure 6 shows the response of the shares of the components that are used by the direct importer to produce final goods (these correspond to T1–T3 in Figure 3).

Within this category, the share that is consumed domestically declines (although it begins to rise starting in three years), as does the share that is exported back to the source country. On the other hand, the share that is exported to the global economy rises. All these responses are consistent with the predictions of the framework in Figure 1.

Response of intermediate exports first used by direct importer to produce intermediate goods exports, then used by third countries to produce final goods

Figure 7



Notes: Percentage deviations from steady state. The figures display dynamic impulse responses computed using local projection methods.

Source: Authors' calculations.

Next, we examine the response of the share of bilateral intermediate exports that are used by the direct importer to further produce intermediate goods that are exported to third countries, and are used by third countries to produce final goods (these components correspond to T4–T6 in Figure 3). Within this category, the share that is exported back to the original exporting country is found to decline persistently, as predicted by the model (Figure 7). The share that is consumed domestically by the third country also declines. Although the model does not have a direct counterpart to this component, it is likely to imply the opposite pattern in this case.

Lastly, we examine the response of the components with an even deeper global value chain structure involving back-and-forth trade (Figure 8). These include bilateral intermediate goods exports that are used by the direct importer to further produce intermediate exports that are shipped back to the source country. Within this category, the component that is consumed as final goods in the original exporting (source) country declines persistently, as would be expected based on the model. On the other hand, the response of the component that is subsequently exported to the global economy is more ambiguous. In this context, it is perhaps pertinent to note that, as the number of border crossings increases, the exchange rate effect tends to dominate the final demand effect. This may explain why the response of this component is more muted when compared with the ones above that involve fewer border crossings, especially within the region comprised by the original exporter and the original importer.

To summarise, the dynamics of regional trade uncovered here are broadly consistent with the main prediction from the framework in Figure 1. In particular, in response to an exchange rate depreciation brought about by a US interest rate rise, final goods, as well as the components of trade that are more regionally oriented,

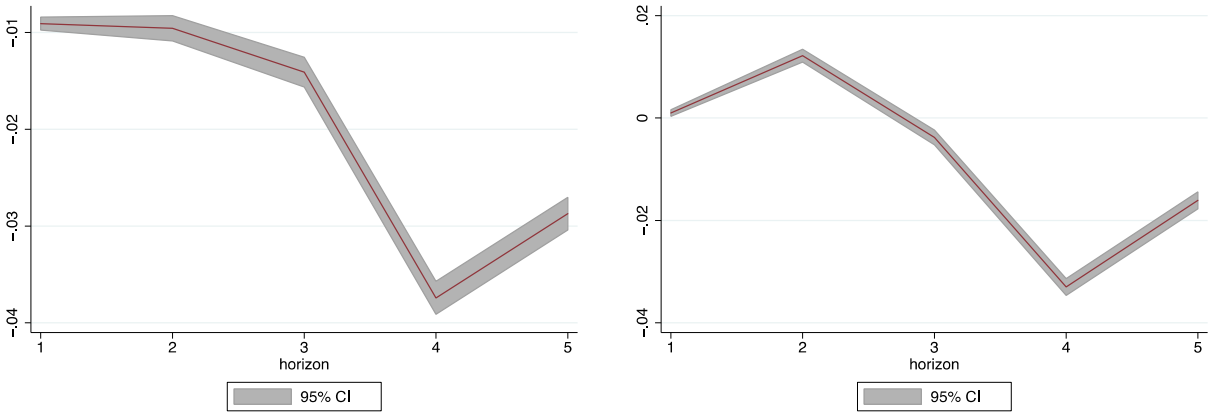
decline by more than do the components that end up being consumed as final goods in the global economy.

Response of intermediate exports first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods

Figure 8

Domestic final goods consumed by the source (exporting) country

Exported final goods consumed by other countries



Notes: Percentage deviations from steady state. The figures display dynamic impulse responses computed using local projection methods.

Source: Authors' calculations.

4. Conclusion

Recent literature on export invoicing has shown overwhelming evidence for the prominence of a handful of key global currencies (in particular the US dollar) and their outsized role in trade invoicing. In particular, these studies have documented that a majority of the share of bilateral trade flows are invoiced in the US dollar, even when the United States is not one of the trading partners.

As shown by Casas et al (2016), this phenomenon of dollar invoicing has challenged the implications of the "producer currency pricing" and "pricing to market" paradigms for understanding the impact of changes in the exchange rate on trade flows. This paper builds on this literature along two dimensions. First, it takes a general equilibrium perspective to understand the role played by exchange rate movements in transmitting the impact of interest rate shocks on macroeconomics variables including international trade flows in a world in which all exports are invoiced in the global currency. Second, it analyses the impact of exchange rate changes brought about by interest rate shocks on different types of international trade flow ranging from simple final goods trade to more complicated global value chain-oriented trade flows that repeatedly cross international borders.

The main result that emerges from the analysis is that, in response to an external interest rate rise, final goods trade and trade that is more regionally oriented fall by more than trade that is global value chain-oriented and supplies final goods to the global economy. The reason for this is that an interest rate rise in the global economy and the associated appreciation of the dollar has two opposing effects on the volume

of international trade flows. On the one hand, since all exports are priced in dollars, for non-US countries imports become more expensive compared with domestic goods, leading to a decline in demand for imports. On the other hand, an appreciation of the dollar translates into a rise in the demand for imports in the United States due to standard expenditure switching effects.

Given the limitations of standard trade data, which do not provide a detailed characterisation of trade flows beyond the first border crossing, we use the granular decomposition of international trade flows at the bilateral level using the framework proposed in Wang et al (2013).The key contribution in the paper is to show how the interaction of these two effects in the data implies that final goods trade and trade that is regionally oriented decline more in response to a US interest rate rise than does trade that is more global value chain-oriented and provides final goods to consumers in the global economy.

These results illustrate an important channel though which global value chains play a role in mitigating the negative impact of shocks on small open economies. While many recent studies have emphasised the benefits of global value chains for economic development and productivity that are of a structural nature,[6] this paper highlights a complementary cyclical benefit which further reinforces the case for active policy engagement in promoting global value chain integration.

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[6] See for instance Del Prete et al (2017) and World Bank (2017).

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Appendix

List of countries: Australia (non-EU), Austria, Belgium, Brazil (non-EU), Bulgaria, Canada (non-EU), China (non-EU), Chinese Taipei (non-EU), Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India (non-EU), Indonesia (non-EU), Ireland, Italy, Japan (non-EU), Korea (non-EU), Lithuania, Luxembourg, Latvia, Mexico (non-EU), Malta, Netherlands, Poland, Portugal, Romania, Russia (non-EU), Slovak Republic, Slovenia, Spain, Sweden, Turkey (non-EU), United Kingdom, United States (non-EU).

List of sectors in the World Input-Output Database

Table A1

WIOD sector	Sector description	NACE code	(Primary, secondary and tertiary)
c01	AGRICULTURE, HUNTING, FORESTRY AND FISHING	AtB	Primary
c02	MINING AND QUARRYING	C	Primary
c03	FOOD , BEVERAGES AND TOBACCO	15t16	Primary
c04	Textiles and textile	17t18	Secondary
c05	Leather, leather and footwear	19	Secondary
c06	WOOD AND OF WOOD AND CORK	20	Secondary
c07	PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22	Secondary
c08	Coke, refined petroleum and nuclear fuel	23	Secondary
c09	Chemicals and chemical	24	Secondary
c10	Rubber and plastics	25	Secondary
c11	OTHER NON-METALLIC MINERAL	26	Secondary
c12	BASIC METALS AND FABRICATED METAL	27t28	Secondary
c13	MACHINERY, NEC	29	Secondary
c14	ELECTRICAL AND OPTICAL EQUIPMENT	30t33	Secondary
c15	TRANSPORT EQUIPMENT	34t35	Secondary
c16	MANUFACTURING NEC; RECYCLING	36t37	Secondary
c17	ELECTRICITY, GAS AND WATER SUPPLY	E	Secondary
c18	CONSTRUCTION	F	Secondary
c19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50	Tertiary
c20	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51	Tertiary
c21	Retail trade, except of motor vehicles and motorcycles; repair of household goods	52	Tertiary
c22	HOTELS AND RESTAURANTS	H	Tertiary
c23	Other Inland transport	60	Tertiary
c24	Other Water transport	61	Tertiary
c25	Other Air transport	62	Tertiary
c26	Other Supporting and auxiliary transport activities; activities of travel agencies	63	Tertiary
c27	POST AND TELECOMMUNICATIONS	64	Tertiary
c28	FINANCIAL INTERMEDIATION	J	Tertiary
c29	Real estate activities	70	Tertiary

c30	Renting of m&eq and other business activities	71t74	Tertiary
c31	PUBLIC ADMIN AND DEFENSE; COMPULSORY SOCIAL SECURITY	L	Tertiary
c32	EDUCATION	M	Tertiary
c33	HEALTH AND SOCIAL WORK	N	Tertiary
c34	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O	Tertiary
c35	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	P	Tertiary