Research Article

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Dominant Currency and Value-Added Exports

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Abstract

This study investigates the real effects of exchange rate changes on exports with three key features; pricing in a dominant currency like the US dollar, imported intermediary use in production, and exports dependent on major demanded countries. We test the longitudinal effects of exchange rates using a data set of both gross and value-added bilateral exports. The key finding distinguishes the positive panel effect of US dollar depreciation due to the dollar liquidity effect from the negative panel effects of other currencies depreciations due to the intermediary import effect. The two detailed results stand out mostly due to the impacts of intermediate goods imports. First, the panel effect of currency depreciation on value-added exports is smaller than gross exports. Second, the panel effect of depreciation on intermediary goods exports is bigger than final goods exports. Also, the panel effects of income and exports-FDI feedback are significant, enriching for the relationship between trade flows and foreign investment.

Keywords: *Dominant Currency, Exchange Rate, Intermediate Goods, Panel Effect, Value Added Export*

1. Introduction

An important phenomenon in globalization since the early 1990s is international trade and multinational production via global value chains (GVCs). We primarily concern that more exporting or globally producing firms tend to be more reliant on both the dominant currency pricing and the imported input use in production. Based on the observations where imports of non-US countries are more responsive to the value of a country's currency relative to the dollar as compared to US imports and the dollar depreciation equally against all other currencies leads to a rise in global trade excluding the US (Gopinath et al., 2020), this study investigates the longitudinal real effects of exchange rates on value-added exports within major demanded countries.

Traditionally, exchange rates have the strong effects on exports and imports. Classical model holds that domestic currency depreciation increases the net exports. This indicates that the rise price competitiveness for the periphery countries increases exports in the case of producer currency pricing. An elasticity approach introduces the value effect in the short-run and the volume effect in the long-run with the J-curve phenomenon. In the conventional estimates, price elasticities are important for assessing the effects on exports of changes in relative prices, exchange rates, and tariffs. Thus, the effect of exchange rates on international trade depends on the economic characteristics in the short-run and on the market distortions in the long-run (Auboin and Ruta, 2011; Anderson et al.,

2016). Also, the exchange rates affect resource allocations relying on the trade structure and the invoice currency (Magee, 1973; Staiger and Sykes, 2010).

Recently, it is argued that exchange rates affect less than they used to for exports and imports due to the intermediary trades within GVCs, which become dominant in international trade (IMF, 2015). Regarding GVCs, Costinot et al. (2013) explain how vertical specialization shapes the interdependence of nations, and Hummels et al. (2001) formulate the vertical specialization in trade. For value-added trade statistics in GVCs, Koopman et al. (2014) and Johnson and Noguera (2012) measure value-added exports in accounting to avoid the double counting problem raised from gross exports. Choi (2020) and Choi et al. (2019) use them to explain how the exchange rate effects on the value-added trade are different from those on the gross trade due to the increase of intermediary trades.

Also, it is argued that changes in the value of dominant currencies can affect the global trade as international prices are set in just a few currencies. Choi (2017) distinguishes the value and volume effects of major currencies which are defined as the currency traded in very liquid markets (Choi, 2010) from those of other currencies. A depreciation of dominant currencies to non-dominant currencies increases imports in the periphery countries with an increase in exports to dominant currency markets, thus leading to an increase in global trade, while an appreciation of dominant currencies negatively impacts global exports and trade. In the global economy where the settlement currency of the US dollar significantly affects relative prices and trade flows (Goldberg and Tille, 2008), Bruno and Shin (2020) find that the depreciation of the dollar increases the credit supply to exporters' working capital level, and thus serves to increase trade flows, while the appreciation of the dollar decreases the global liquidity, and leads to a negative effect on trade, as it outweighs the effect of improving the trade competitiveness in the developing countries.

In addition, international investment over trade flows explains the structure of global business and multinational production. A firm would choose to enter a foreign market via foreign direct investment (FDI) for ownership, internalization, and location advantages. When factors influencing FDI are divided into supply, demand, and political factors, horizontal FDI of Markusen (1984) is an investment that produces final goods and sells them abroad to avoid trade barriers, and vertical FDI of Helpman (1984) is an investment for production division that creates trade in intermediate goods. Accordingly, international trade and FDI become closer linked with cross-border activities of multinational enterprises. Their relationship is complementary (OECD, 2018) and feedback (Aizenman and Noy, 2006; Makki and Somwaru, 2004).

From above perspectives where trade and FDI become increasingly related to GVCs, this study investigates the key question on how value-added exports to top three main importing countries averagely adjust to changes in exchange rate, claiming that a dominant currency pricing holds. We adopt the bilateral trade model in a value-added form and analyze two-dimensional panel data to check variability focusing on multiple individuals at dynamic time intervals. Our findings will make a specific contribution to the implication on trade policies, which would be update with respect to the existing literature.

This study is organized as follows: In Section 2, we explain our empirical model and panel data. Section 3 provides the testing results and summarizes findings for policy implications. We conclude the study in Section 4.

2. Empirical Model

This section presents our panel econometric model for value-added exports. Recent years, analyzing the value-added trade structure in the globally value-chained economies is a useful task. We identify the impacts of exchange rates on the GVC activity where a world economy is composed of multiple goods, indexed by intermediate and final goods and services along the supply chain.

We start reviewing the value-added exports from the gross exports to cover the participation in GVCs for vertical specialization. A country's total value-added exports for a given industry is the

domestic value-added content of exports which is calculated by the exported value added in the domestic economy:

$$VX_d = \Sigma_f X_{d,f} - \Sigma_f FX_{d,f} \quad (1)$$

Where VX indicates value-added exports, X indicates the gross exports which are the sum of both the exports in intermediate goods and services and the exports of final goods and services, FX indicate foreign the value-added content of domestic exports which is calculated by the exported value-added that is generated within foreign economies, d represents a domestic country, f represents all foreign countries, f = 1, ..., n and f ≠ d. The value-added exports are divided into direct domestic value-added, indirect domestic value-added, and re-imported domestic value-added. Additionally, a country's value-added imports are measured using the similar method.

In order to analyze the sensitivity of value-added exports to exchange rate movements, we estimate the standard bilateral demand export model, which we modify by adding in measures of exports-FDI nexus.

$$VX_{d,f,t} = f(S_t, Y_{f,t}, F_t) \quad (2)$$

Where $VX_{d,f,t}$ is bilateral value-added exports between exporting country d and major export-demanding country f at time t; S_t is the exchange rate between the currencies of countries d and f or the real effective exchange rate of home country d at t; $Y_{f,t}$ is foreign country f' income at t; F_t of the value-added exports-FDI nexus between county d and f at t; and f(.) represents a functional form.

DeRosa (2008) finds that the panel approach makes reliable estimated coefficients for both time-invariant and time-varying explanatory variables, and Dell'ariccia (1999) identifies that one advantage of using panel data is the ability to control for unobservable country-pair individual effects. So, we estimate the parameters for bilateral exports using panel data to minimize the serious consequence of possible bias and inconsistency in the regressors of the trade model that arise from missing or unobservable variables in applying the panel method to the trade model.

We employ the following explicit panel equations coming from the implicit function (2) to estimate the panel effects on value-added exports, mainly focusing on the interactions of trade with FDI and the changes in exchange rates between the US dollar and other major currencies.

$$VX_{d,f,t} = \alpha + \beta_1 S_t + \beta_2 Y_{f,t} + \beta_3 F_t + \beta_4 C_t + \mu_t \quad (3)$$

Where C_t is the control variables which represent the regional free trade agreement and the distance between county d and f at t. The coefficients of α and β are estimated from the regression, and μ_t is the error term.

Our interest is in exploring the panel effects of major exchange rates on intermediate goods exports and value-added exports for different sets of OECD countries. Usually, panel data contain more degree of freedom than cross-sectional and time-series data, and hence improve the efficiency of estimates focusing on multiple individuals at multiple time intervals. An advantage of panel data regression is that we can control dependencies of unobserved independent variables on a dependent variable, which may lead to biased estimators in traditional linear regression.

Plainly, when trade in parts and components is important, we estimate the value-added panel effects on the top three main importers for each exporting country: The major US export-demanding countries are China, Canada, and Mexico, and the major countries of UK exports are the US, Germany, and China. Germany's major export-demanding countries are the US, China, and France; France's are Germany, the US, and China; Italy's are Germany, France, and China; Japan's are China, the US, and Korea; Australia's are China, the US, and Japan; and Korea's are the US, China, and Japan.

For empirical analysis, the yearly panel datasets aggregately covering about 2,520 bilateral exports of four trade types and FDI are used for the period from 1995 to 2015. We obtained annual value-added trade statistics from OECD-WTO TiVA. And we use CEPII for geographic distance statistics and Federal Reserve Economic Data for the other economic statistics. We confirm that the panel data set is not the distortion without measurement errors.

3. Testing Results

In this section, we report econometric procedures and summarize our testing results. According to the panel testing procedures, first, we demonstrate that multicollinearity is not a big concern in our data; All countries except for the UK and Italy met the accepted variance inflation factor (VIF) guideline less than 10.

In addition to the above work, we confirm a structural break by using cumulative sum of recursive residuals (CUSUM) and CUSUMSQ. The test results show that most series are stable over time although weak problems are indicated near the end of the data for Germany, Italy, and Japan.

Next, we check a series stationarity by using a panel unit-root test. We perform Hadri (2000)'s Lagrange multiplier testing for panel unit roots where the null rejection reflects strong evidence of non-stationarity. Table 1-1 shows that all the level variables of selected important variables are non-stationary, but that five of the first-difference variables are stationary.

Table 1: Panel Unit Root Tests

	Level Variables				First Difference Variables			
	VX	**S**	**Y**	**F**	**VX**	**S**	**Y**	**F**
US	152.6 (0.0)	61.9 (0.0)	151.7 (0.0)	73.3 (0.0)	44.8 (0,0)	19.8 (0.0)	100.4 (0.0)	1.11* (0.13)
UK	134.2 (0.0)	70.2 (0.0)	158.7 (0.0)	13.6 (0.0	18.8 (0.0)	7.23 (0.0)	137.7 (0.0)	2.12 (0.01)
Germany	155.6 (0.0)	106.6 (0.0)	158.9 (0.0)	20.1 (0.0)	39.0 (0.0)	24.8 (0.0)	140.9 (0.0)	1.98 (0.02)
France	143.9 (0.0)	77.3 (0.0)	158.7 (0.0)	18.7 (0.0)	24.1 (0.0)	20.3 (0.0)	106.0 (0.0)	1.10* (0.13)
Italy	116.9 (0.0)	37.1 (0.0)	151.1 (0.0)	9.11 (0.0)	11.6 (0.0)	5.41 (0.0)	139.8 (0.0)	0.07* (0.46)
Japan	153.1 (0.0)	105.6 (0.0)	167.8 (0.0)	60.3 (0.0)	3.64 (0.0)	21.3 (0.0)	81.7 (0.0)	5.06 (0.0)
Australia	146.3 (0.0)	116.4 (0.0)	157.3 (0.0)	6.86 (0.0)	12.6 (0.0)	4.85 (0.0)	77.7 (0.0)	0.29* (0.38)
Korea	158,2 (0.0)	6.43 (0.0)	157.2 (0.0)	110.1 (0.0)	92.9 (0.0)	1.58* (0.06)	120.5 (0.0)	12.2 (0.0)

Notes: VX= value-added exports, S= real effective exchange rate, Y= GDP of export-demanded country, F= nexus between value-added exports and FDI. Parentheses indicate the critical value. * = stationarity significance at 5%. ^ = stationarity significance at 10%.

We again perform Breitung (2000)'s tests for panel unit roots where the null is non-stationarity, and rejection of the null strongly indicates stationarity. Table 1-2 shows that most level variables of selected important variables are non-stationary, but that overall, all the panel data except for the value-added exports-FDI nexus in the UK and the value-added exports in France are first-stationary.

Table 2: Panel Unit Root Tests

	Level Variables				First Difference Variables			
	VX	**S**	**Y**	**F**	**VX**	**S**	**Y**	**F**
US	1.66 (0.95)	-1.05 (0.14)	-0.43 (0.33)	-1.72* (0.04)	-2.12* (0.02)	-1.29^ (0.09)	-1.62* (0.05)	-5.10* (0.0)
UK	-2.24* (0.01)	-2.27* (0.01)	2.65 (0.99)	37.9 (0.99)	-3.13* (0.0)	-4.20* (0.0)	-1.74* (0.04)	-0.58 (0.28)
Germany	2.07 (0.98)	1.18 (0.88)	2.58 (0.99)	-4.15* (0.0)	-4.45* (0.0)	-4.62* (0.0)	-1.70* (0.04)	-4.47* (0.0)

	Level Variables				First Difference Variables			
	VX	S	Y	F	VX	S	Y	F
France	2.11 (0.98)	0.54 (0.70)	2.65 (0.99)	-2.63* (0.0)	0.20 (0.58)	-3.23* (0.0)	-1.74* (0.04)	-4.52* (0.0)
Italy	0.91 (0.81)	-1.50^ (0.06)	-1.42^ (0.07)	-2.95* (0.0)	-1.41^ (0.07)	-4.99* (0.0)	-1.21^ (0.10)	-5.10* (0.0)
Japan	0.23 (0.59)	0.86 (0.81)	3.52 (0.99)	-2.88* (0.0)	-4.82* (0.0)	-3.27* (0.0)	-4.32* (0.0)	-
Australia	-1.05 (0.14)	-1.78* (0.04)	2.18 (0.98)	-3.00* (0.0)	-1.27^ (0.10)	-1.49^ (0.06)	-2.07* (0.02)	-3.43* (0.0)
Korea	1.71 (0.95)	-3.06* (0.0)	2.20 (0.98)	-	-2.32* (0.01)	-5.57* (0.0)	-2.10* (0.01)	-

Hence, we confirm whether there is a long-run relationship for the value-added exports by using Pedroni (1999)'s heterogeneous panel co-integration test. Table 2 show that the null hypothesis of no co-integration is not rejected at the significance level. The evidence indicates that to evaluate the long-run relationships between the variables in question, we cannot conduct the fully modified OLS procedures by Phillips and Hansen (1990) or Dynamic OLS.

Table 3: Panel Cointegration Tests

	Within-dimension		Between-dimension	
	Panel PP-stat	Panel ADF-stat	Group PP-stat	Group ADF-stat
US	2.37	3.71	3.30	4.14
UK	0.39	2.80	0.81	6.87
Germany	0.14	4.49	0.03	6.13
France	0.03	3.95	-0.57	4.56
Italy	-0.29	4.23	0.02	5.84
Japan	1.73	3.00	2.69	3.05
Australia	-1.06	5.41	-1.12	6.64
Korea	2.42	-	3.11	8.04

Notes: We could reject non-cointegration in the left tail (e.g., with a large negative number), and * indicates s stationarity at the 5% significance level.

Finally, we perform panel regressions to explore the long-run relationships between value-added exports and their determinants. We use the first-difference stationary variables except for the dummy variables that are constant over time such as distance and free trade agreement to estimate the extended panel gravity model.

The testing results in Table 3 represent the effects of explanatory variables on value-added exports, gross exports, final goods exports, intermediate goods exports, and net FDI where these four exports are the bilateral exports of the exporting country to its three major importers, and net FDI is the bilateral FDI inward and outward between investing country and its host countries. We estimate the panel regression by selecting a random effect method which is more efficient than a fixed effect according to the Hausman test.[1]

[1] *Additionally, a random effect method refers to regression model where the group means are a random sample from a population as opposed to a fixed effect method in which the group means are fixed. And a random effect is estimated using GLS, which has smaller variance than that of a fixed effect estimated using OLS.*

Table 4: Panel Regression Tests for Value-added Exports>

	Real Effective Exchange Rate	Foreign Income	Exports-FDI Nexus	Geographical Distance	Free Trade Agreement
US	-714 (0.10)^	0.02 (0.0)*	0.00 (0.20)	-0.28 (0.83)	3,550 (0.77)
UK	144.8 (0.02)*	0.006 (0.0)*	0.00 (0.61)	-0.52 (0.51)	-959 (0.85)
Germany	361 (0.08)^	0.014 (0.0)*	0.00 (0.62)	0.30 (0.88)	6,686 (0.64)
France	292.1 (0.04)*	0.007 (0.0)*	0.00 (0.97)	0.17 (0.86)	4,239 (0.55)
Italy	188.1 (0.09)^	0.007 (0.0)*	0.000002 (0.0)*	-8.93 (0.87)	-60,104 (0.87)
Japan	58.7 (0.68)	0.03 (0.0)*	0.00 (0.20)	-2.11 (0.20)	0.0 (0.0)*
Australia	260.5 (0.0)*	0.006 (0.0)*	0.00 (0.99)	-0.21 (0.33)	-3,626 (0.06)^
Korea	82.57 (0.05)*	0.006 (0.0)*	0.00001 (0.0)*	-0.24 (0.25)	-2,252 (0.21)

Notes: The panel regression with individual is estimated, and the panel regression with both individual and time is estimated for the US and Korea. P is in parentheses: *, significant at 5%; ^, at 10%.

In the case of value-added exports to major importers in Table 3-1, currency depreciation in the US has a strong positive effect on value-added exports while currency appreciation in the UK, Germany, France, Italy, Australia, and Korea has strong positive effects. The foreign income of import country also has a significantly positive effect on value-added exports in all countries as we expected. However, the positive feedback effect of value-added exports-FDI is significant in Japan only.

Table 5: Panel Regression Tests for Gross Exports

	Real Effective Exchange Rate	Foreign Income	Exports-FDI Nexus	Geographical Distance	Free Trade Agreement
US	-1,149 (0.05)*	0.022 (0.0)*	0.00 (0.18)	-0.20 (0.88)	4,989 (0.72)
UK	207.9 (0.0)*	0.008 (0.0)*	0.00 (0.71)	-0.65 (0.62)	-146 (0.98)
Germany	352.4 (0.25)	0.019 (0.0)*	0.00 (0.63)	0.34 (0.91)	9,124 (0.66)
France	337.7 (0.12)	0.01 (0.0)*	0.00 (0.90)	0.19 (0.89)	5,853 (0.58)
Italy	188.4 (0.25)	0.009 (0.0)*	0.000002 (0.0)*	-10.5 (0.89)	-70,172 (0.89)
Japan	-20.1 (0.91)	0.037 (0.0)*	0.00 (0.13)	-2.40 (0.21)	0.0 (0.0)*
Australia	285.8 (0.0)*	0.007 (0.0)*	0.00 (0.97)	-0.25 (0.29)	-3,955 (0.06)^
Korea	124.3 (0.13)	0.012 (0.0)*	0.00001(0.0)*	-0.36 (0.21)	-6,473(0.06)^

In the case of gross exports to major importers in Table 3-2, currency depreciation in the US has strong positive effects on gross exports while appreciation of the UK and Australia has strong positive effects. Importing country foreign income also has a significantly positive effect on gross exports in all countries. However, the positive feedback effect of gross exports-FDI is significant in Italy and Korea only. We also note that the lack of regional free trade agreement may decrease the gross exports to major importers in Australia and Korea.

Table 6: Panel Regression Tests for Final Goods Exports

	Real Effective Exchange Rate	Foreign Income	Exports-FDI Nexus	Geographical Distance	Free Trade Agreement
US	-495 (0.07)^	0.012 (0.0)*	0.00 (0.17)	-0.39 (0.71)	1,187 (0.91)
UK	70.0 (0.02)*	0.004 (0.0)*	0.00 (0.79)	-0.48 (0.26)	-2,180 (0.46)
Germany	137.3 (0.39)	0.009 (0.0)*	0.00 (0.53)	-0.33 (0.82)	1,074 (0.91)
France	163.8 (0.13)	0.005 (0.0)*	0.00 (0.29)	-0.11 (0.83)	930.8 (0.81)
Italy	125 (0.10)^	0.004 (0.0)*	0.000002 (0.0)*	-15.05 (0.67)	-103,944 (0.67)
Japan	-15.4 (0.85)	0.019 (0.0)*	0.00 (0.22)	-0.98 (0.21)	0.0 (0.0)*
Australia	19.02 (0.04)*	0.001 (0.0)*	0.00 (0.58)	-0.01 (0.72)	-359 (0.15)
Korea	34.1 (0.15)	0.004 (0.0)*	0.00001(0.03)*	-0.001 (0.99)	-2,629 (0.06)^

In the case of final goods exports to major importers in Table 3-3, currency depreciation in the US has strong positive effects on final goods exports while appreciation of the UK, Italy and Australia has strong positive effects. Import country foreign income also has a significantly positive effect on final goods exports in all countries. However, the positive feedback effect of final goods exports-FDI is significant in Italy and Korea only. Moreover, the lack of regional free trade agreement may decrease the final goods exports to major importers in Korea.

Table 7: Panel Regression Tests for Intermediate Goods Exports

	Real Effective Exchange Rate	Foreign Income	Exports-FDI Nexus	Geographical Distance	Free Trade Agreement
US	-614 (0.07)^	0.010 (0.0)*	0.00 (0.17)	0.20 (0.71)	4,138 (0.43)
UK	100.8 (0.09)^	0.004 (0.01)*	0.00 (0.55)	-0.17 (0.78)	982.4 (0.81)
Germany	218.4 (0.22)	0.009 (0.0)*	0.00 (0.25)	0.70 (0.68)	8.207 (0.47)
France	177.3 (0.19)	0.006 (0.0)*	0.00 (0.51)	0.31 (0.74)	4,922 (0.46)
Italy	63.3 (0.52)	0.004 (0.0)*	0.000003 (0.0)*	4.53 (0.91)	33,775 (0.91)
Japan	-5.69 (0.95)	0.016 (0.05)*	0.000004 (0.0)*	-1.31 (0.21)	0.0 (0.0)*
Australia	265.6 (0.0)*	0.006 (0.0)*	0.00 (0.94)	-0.24 (0.29)	-3,582 (0.08)^
Korea	90.4 (0.16)	0.007 (0.0)*	0.00001(0.0)*	-0.35 (0.23)	-4,272 (0.08)^

In the case of intermediate goods exports to major importers in Table 3-4, currency depreciation in the US has strong positive effects on intermediate goods exports while appreciation of the UK and Australia has strong positive effects. Import country foreign income also has a significantly positive effect on intermediate goods exports in all countries. However, the positive feedback effect of intermediate goods exports-FDI is significant in Italy, Japan, and Korea only, and the lack of regional free trade agreement may decrease the intermediate goods exports to major importers in Australia and Korea.

Table 8: Panel Regression Tests for Foreign Direct Investment[2]

	Real Effective Exchange Rate	Foreign Income	Exports-FDI Nexus	Geographical Distance	Free Trade Agreement
US	27.8 (0.80)	0.00 (0.97)	0.00001 (0.0)*	0.09 (0.81)	691 (0.85)
UK	-40.0 (0.88)	-0.01 (0.24)	0.00002 (0.0)*	-0.18 (0.92)	-5,224 (0.71)
Germany	-9.23 (0.93)	-0.00 (0.63)	0.00001 (0.0)*	0.32 (0.52)	2,131 (0.53)
France	-49.0 (0.56)	-0.00 (0.82)	0.00002 (0.0)*	0.05 (0.82)	269.2 (0.87)
Italy	15.2 (0.73)	-0.00 (0.84)	0.00002 (0.0)*	-0.28 (0.97)	-2,033 (0.97)
Japan	-11.5 (0.45)	-0.002 (0.05)*	0.00001 (0.0)*	0.15 (0.21)	0.0 (0.0)*
Australia	-64.3 (0.0)*	-0.00 (0.62)	0.00009 (0.0)*	0.00 (0.99)	332 (0.59)
Korea	4.49 (0.33)	-0.0003 (0.04)*	0.00001(0.0)*	0.03 (0.24)	-458 (0.06)^

Notes: The panel regression for FDI is performed by including the value-added exports-FDI nexus.

Additionally, in the case of FDI to major export-demanding countries in Table 3-5, currency appreciation in Australia has strong negative effects on FDI; import country foreign income of import country also has significantly negative effects on FDI in Japan and Korea. However, the positive feedback effect of value-added exports-FDI is significant in all countries. Again, the lack of regional free trade agreement may decrease FDI to major importers in Korea.

[2] *In addition, the testing model for FDI is applied by the same explanatory variables as the model for exports in order to compare their powers by using the bilateral FDI inward and outward between investing country d and its host country f at t.*

4. Conclusion

This study investigates the panel effects of exchange rate changes on intermediate goods and value-added bilateral exports to top three main importers holding a large majority destinations, with the objective of identifying why there are any significant differences between both gross and value-added exports or final and intermediary goods exports, mainly focusing on the experience of pricing in a dominant currency.

The key results distinguish the positive panel effect of US dollar depreciation from the negative panel effects of other currencies depreciations. This might be explained by the global dollar liquidity effect on the positive impact of dollar depreciation and the intermediate goods import effect on the negative effects of other currencies depreciations. The detailed results also indicate that the panel effect of currency depreciation on value-added exports is smaller than gross exports, and the panel effect of depreciation on intermediary goods exports is bigger than final goods exports. This implies that the exchange rate effects on value-added and intermediate goods exports, mostly become more important due to the impacts of intermediary imports.

Concrete results on the exports to a country's three main importers, represent that a vehicle currency depreciation in the US has strong positive effects on gross, value-added, intermediate goods, and final goods exports while the appreciation of a major currency or a non-major currency in the other developed countries has strong positive effects on them due to increased intermediate goods trade. For instance, currency appreciation of the UK, Germany, France, Italy, Australia, and Korea has strong positive effects on value-added exports, and appreciation of the UK and Australia has strong positive effects on gross, final goods, and intermediate goods exports.

Specifically, the largest exchange rate effects of the US to major importers are gross exports, value-added exports, intermediate goods exports, and final goods exports. For the exchange rate effects of the UK to major importers, the largest are gross exports, value-added exports, intermediate goods exports, and final goods exports; to Australia, the largest are gross exports, intermediate goods exports, value-added exports, and final goods exports. This implies that the panel effect of depreciation on value-added exports is smaller than gross exports, and the panel effect of depreciation on intermediary goods exports is bigger than final goods exports.

For the panel effect of foreign income on the exports to three main importers, all countries show positive effects of importing country income on value-added, gross, final goods, and intermediate goods exports. As we expect, the greater the foreign GDP, the greater the exports growth. Specifically, for all countries, the largest income effects to their major importers are gross exports, value-added exports, and intermediate goods exports or final goods exports.

For the exports-FDI feedback panel effect on the bilateral exports to three main importers which enriches the relationship between trade flows and foreign investment, Japan shows positive effects of the exports-FDI nexus on value-added and intermediate goods exports while Italy and Korea have positive effects of the same nexus on gross, final goods, and intermediate goods exports.

However, we note that the lack of regional free trade agreement may decrease the gross and intermediate goods exports to major importers in Australia and Korea. In Australia, a FTA with the US and China took effect in 2015, as did an EPA with Japan. A FTA between Korea and the US took effect in 2012, and there was a FTA with China in 2015, but Korea has no such a FTA with Japan. Additionally, we find that all geographical distances are statistically insignificant because of the panel analysis.

Finally, in the case of FDI to main export-demanding countries, currency appreciation in Australia has negative effects on FDI, and importing country income in Japan and Korea has negative effects as well. All countries, however, show positive feedback effects of the value-added exports-FDI nexus on exports.

The recent findings of this paper enforce further insights of direct relevance for current policy discussions which emphasize the relationship between exchange rates, trade flows, and FDI in global value-chained economies. They also provide a practical suggestion for economies to promote international trade. We acknowledge that the datasets on value added trades are limited, not widely available and largely incomplete, and therefore future research would benefit from a larger and more recent database.

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