The Value Added-Exports Puzzle and Global Value Chains

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Summary

"Value added-exports puzzle"

- Bergoeing et al. (2004) documented the puzzle that while most OECD countries experienced declines in manufacturing value added relative to GDP over 1970-2001, they have experienced increases in manufacturing exports relative to GDP during the same period.

Research question

- Can vertical specialization, or global value chain (GVC) participation, explain the puzzle?

Data for regression

- 22 OECD countries and 17 manufacturing industries from 1995-2018

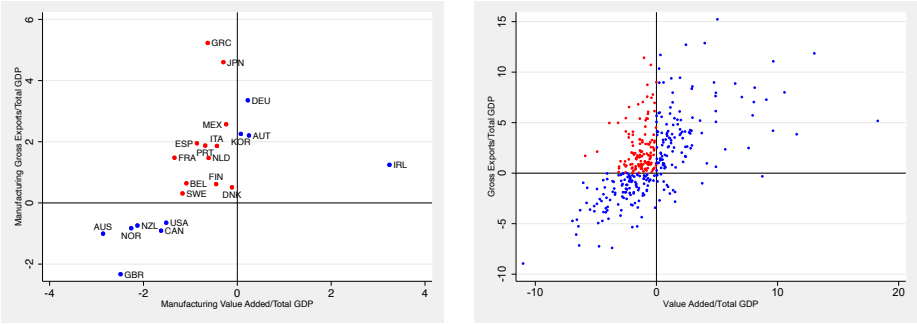
Main findings

1. The GVC backward linkage and less upstreamness (more downstreamness) significantly increase gross exports and decrease value added at the country-industry level; however, the GVC forward linkage has the opposite significant effects.
2. The increases in the backward linkage and downstreamness are larger and the increase in the forward linkage is smaller for the puzzle country-industry pairs than for the non-puzzle country-industry pairs.

Motivation

We extend Bergoeing et al.'s data in two ways.

1. We use more recent data from 1995-2018.
2. We investigate the puzzle at the country-industry level besides the country level.



(a) Country level (b) Country-industry level

Figure 1: Average annual changes of value added and gross exports (1996-2018)

Motivation

1. Panel (a): The puzzle holds only in 12 OECD countries but does not hold in the other 10 OECD countries from 1996-2018.

2. Panel (b): The puzzle holds for many country-industry pairs but does not hold for many over 1996-2018.

Question

Question

- What can explain the value added-exports puzzle from 1996-2018?

Possible answers

- As Bergoeing et al. (2004) suggested, we consider vertical specialization, or GVC participation, as one of the possible factors that can explain the above observations.
- We consider not only the vertical specialization measure (VS) in Hummels et al. (2001), that is, GVC backward linkage, but also the alternative measure (VS1), that is, GVC forward linkage.
- We also consider GVC position (up/downstreamness).

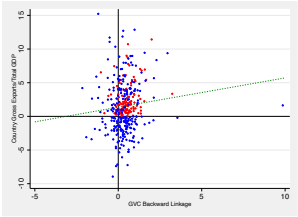
Three measurements of GVC

- Three measurements of GVC:
  1. GVC **backward** linkage is defined as foreign value added content of gross exports (from the import perspective).
  2. GVC **forward** linkage is defined as the domestic value added in gross exports that are further re-exported to third countries (from the export perspective).
  3. GVC **position** (up/downstreamness) is defined as the ratio of the GVC forward linkage to backward linkage.

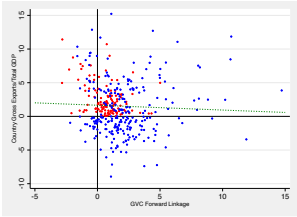
- Data suggest that these three measurements that are measured at the country-industry level are candidates for factors that can explain the puzzle.

GVC and value added-exports puzzle

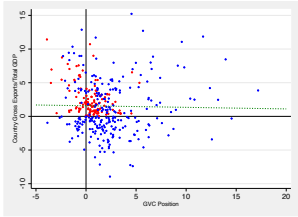
Gross exports



(a) Backward

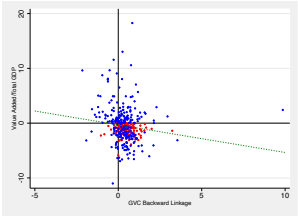


(b) Forward

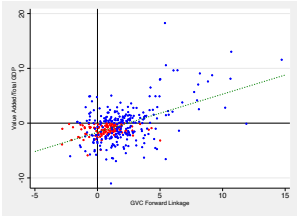


(c) Position

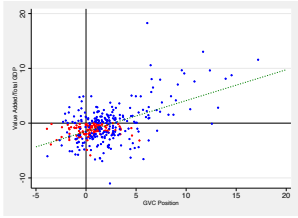
Value added



(d) Backward



(e) Forward



(f) Position

Figure 2: GVC and value added-exports puzzle at country-industry level

The purpose of this paper

- Using the 1995-2018 data for 22 OECD countries and 17 manufacturing industries, we measure the GVC participation and position at the country-industry level.
- We empirically investigate whether they can explain the value added-exports puzzle.

Literature on manufacturing trade and/or value added

- One set of studies focused on the increased manufacturing trade/exports.
  - Bridgman (2012): a trade cost reduction & vertical specialization
  - Dalton (2013): Just-in-Time inventories
- Another set of studies focused on the decreased manufacturing value added.
  - Saeger (1997): 23-country panel; manufacturing imports from developing countries
  - Pilat et al.(2006): OECD countries; price effects & relatively slow growth in demand for manufacturing products
  - Cruz (2015): Mexico; the evolution of income, capital accumulation, labor manufacturing productivity, trade openness, & the exchange rate
- Bergoeing et al. (2004) linked both the increased manufacturing exports and the decreased manufacturing value added and argued that this is puzzling.
- Our paper now provides an empirical test for the puzzle on the basis of vertical specialization and upstreamness, or GVC participation and position.

Literature on vertical specialization

- Hummels et al. (1998) and Hummels et al. (2001) empirically measured vertical specialization as the use of imported inputs in producing goods that are exported (VS), that is, GVC backward linkage.
- Another measure (VS1), that is, GVC forward linkage was also mentioned by Hummels et al. (2001) and developed by Borin and Mancini (2019): it is measured as the domestic value added in gross exports that are further re-exported to third countries.
- Yi (2003) developed a dynamic Ricardian trade model and quantitatively showed that tariff reductions propagate trade via increased vertical specialization.
  - He compared the increase in vertical specialization in the model with that in the data measured as the increase in the GVC participation (VS plus VS1), and found that the model accounts for much of the data.
- Our paper now relates the GVC backward linkage (VS), the GVC forward linkage (VS1), and the GVC position (upstreamness) to the puzzle.

GVC backward linkage definition

- GVC backward linkage ($FVAsh$):

$$FVAsh_{ij} = 1 - \frac{Exgrddc_{ij}}{Exgr_{ij}} \tag{1}$$

  where $Exgrddc_{ij}$ is the direct domestic industry value added content of gross exports of industry j of country i and $Exgr_{ij}$ is the gross exports of industry j of country i.

- The indicator captures how much the gross exports of industry j of country i use foreign and other domestic industries' value added.

GVC forward linkage definition

- GVC forward linkage ($DVAFXsh$):

$$DVAFXsh_{ij} = \frac{Dvafx_{ij}}{Exgr_{ij}} \tag{2}$$

where $Dvafx_{ij}$ is the domestic value added of industry j of country i in gross exports of country i that is further re-exported to third countries.

- While $FVAsh_{ij}$ is defined from the import perspective of industry j of country i, $DVAFXsh_{ij}$ is defined from its export perspective.

GVC position definition

- GVC position (up/downstreamness):

$$GVCPO_{ij} = \frac{DVAFXsh_{ij}}{FVAsh_{ij}} \tag{3}$$

- The indicator is larger (smaller) when the GVC position is more upstream (more downstream).

Hypotheses

We set the three hypotheses regarding the GVC backward linkage, forward linkage, and position:

- **Hypothesis (a):** The GVC backward linkage increases gross exports and decreases value added at the country-industry level.
- **Hypothesis (b):** The GVC forward linkage has the opposite effects compared with the GVC backward linkage.
- **Hypothesis (c):** Less upstreamness, that is, more downstreamness increases gross exports and decreases value added at the country-industry level.

Intuition: GVC backward linkage

- As indicated by equation (1) the greater GVC backward linkage is compatible with the increase in gross exports and the decrease in value added.

Example: A change from domestic to backward

- Initially, country 1's industry j produced inputs and assembled them in country 1 and sold the finished products (= inputs + assembly) to the domestic market.
- Now, country 1's industry j imports inputs from country 2 and assembles them in country 1 and exports the finished products.
- It is possible that value added decreases and gross exports increase in country 1.

Intuition: GVC forward linkage

- As indicated by equation (2) the greater GVC forward linkage is compatible with the decrease in gross exports and the increase in value added.

Example: A change from backward to forward

- Initially, country 1's industry j imported inputs and assembled them in country 1 and exported the finished products.
- Now, country 1's industry j produces inputs in country 1 and exports them to country 2, and country 2 assembles them and exports the finished products.
- It is possible that value added increases and gross exports decrease in country 1.

Intuition: GVC position

- If a country-industry pair is on the less-upstream (more-downstream) stage, the forward GVC linkage is smaller and the backward GVC linkage is greater.
- It is possible that less upstreamness (more downstreamness) contributes to the puzzle.

Regression specifications

- To test the three hypotheses empirically, we run the following regressions.

$$Ex_{ijt} = \alpha_0 + \alpha_1 X_{ijt} + \alpha_2 EC_{ijt} + \lambda_{ij} + \theta_{it} + \eta_{jt} + \epsilon_{ijt}$$

$$VA_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 EC_{ijt} + \lambda_{ij} + \theta_{it} + \eta_{jt} + \epsilon_{ijt}$$

- Ex_{ijt} is the gross exports/GDP ratio of industry j in country i in year t. VA_{ijt} is the value added/GDP ratio. X_{ijt} is $FVAsh_{ijt}$ (the GVC backward linkage), $DVAFXsh_{ijt}$ (the GVC forward linkage) or $GVCPO_{ijt}$ (GVC position (up/downstreamness)).
- λ_{ij}, θ_{it}, and η_{jt} are country-industry pair, country-time and industry-time fixed effects, respectively.

Regression specifications

- We also control for the effect of China's export competition because Fluckiger and Ludwig (2015) observed a reduction in the export volumes of European countries due to increased Chinese export competition.
- We add the export competition for industry j in country i in year t denoted by EC_{ijt}.

$$EC_{ijt} = \frac{Ex_{cjt}}{\sum_{k \neq i} Ex_{kjt}} \in [0, 1] \tag{4}$$

- Ex_{cjt} is gross export from China in industry j in year t. $\sum_{k \neq i} Ex_{kjt}$ is the world gross exports except gross exports from country i.
- The larger the EC is, the more intensive competition from China the industry j in country i faces.

Regression specifications

- The coefficients that we are interested in are α_1 and β_1.
- When X_{ijt} is $FVAsh_{ijt}$ (the GVC backward linkage), the hypothesis (a) is supported if α_1 is positive and β_1 is negative.
- When X_{ijt} is $DVAFXsh_{ijt}$ (the GVC forward linkage), the hypothesis (b) is supported if α_1 is negative and β_1 is positive.
- When X_{ijt} is $GVCPO_{ijt}$ (GVC position (up/downstreamness)), the hypothesis (c) is supported if α_1 is negative and β_1 is positive.

Data

- The 2021 release of OECD Trade in Value Added (TiVA) database, which covers the years 1995 to 2018.
- The indicators in database are provided for 66 countries (including all OECD, European Union, ASEAN and G20 countries) and 45 industries.
- To be consistent with Bergoeing et al. (2004), we focus on 22 OECD countries and 17 manufacturing industries.
- The main indicators in TiVA database include gross output, value added, gross exports, gross imports, domestic and foreign value added content of gross exports/imports, etc.

Main results 1

Table 1: Gross exports, value added, and GVC

	(1)	(2)	(3)	(4)	(5)	(6)
	Gross exports			**Value added**		
FVAsh	0.00908**			-0.0249***		
	(0.00358)			(0.00153)		
DVAFXsh		-0.0138***			0.0101***	
		(0.00212)			(0.00106)	
GVCPO			-0.00502***			0.00584***
			(0.000950)			(0.000521)
EC	0.951***	0.929***	0.940***	0.335***	0.360***	0.355***
	(0.0849)	(0.0837)	(0.0837)	(0.0527)	(0.0549)	(0.0547)
Observations	7,854	7,854	7,854	7,854	7,854	7,854
R-squared	0.909	0.909	0.909	0.938	0.931	0.932
Country-industry FE	✓	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓	✓
Industry-year FE	✓	✓	✓	✓	✓	✓

Main results 2

Table 2: GVC differences between puzzle and non-puzzle country-industry pairs

	(1)	(2)	(3)
GVC	Puzzle country-industry	Non-puzzle country-industry	Difference (1)-(2)
Backward	0.507	0.333	0.174**
	(0.049)	(0.060)	(0.077)
Forward	0.712	2.202	-1.485***
	(0.113)	(0.156)	(0.192)
Position	0.516	2.452	-1.936***
	(0.135)	(0.206)	(0.247)
Observations	128	246	

Robustness checks: Non-OECD

Table 3: Gross exports, value added, and GVC (non-OECD)

	(1)	(2)	(3)	(4)	(5)	(6)
	Gross exports			**Value added**		
FVAsh	0.0167***			-0.0197***		
	(0.00216)			(0.00123)		
DVAFXsh		-0.00384***			0.00150***	
		(0.000789)			(0.000328)	
GVCPO			-0.00154***			0.00103***
			(0.000371)			(0.000232)
EC	0.0119	0.00694	0.00719	-0.00286	0.00261	0.00254
	(0.0157)	(0.0158)	(0.0158)	(0.00430)	(0.00472)	(0.00471)
Observations	7,845	7,845	7,844	7,845	7,845	7,844
R-squared	0.933	0.933	0.932	0.975	0.972	0.972
Country-industry FE	✓	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓	✓
Industry-year FE	✓	✓	✓	✓	✓	✓

Conclusion

- Using the country-industry level data for 22 OECD countries and 17 manufacturing industries over 1995-2018, we have empirically investigated whether the GVC participation and position can explain the value added-exports puzzle.
- Our main findings are twofold.
  1. The GVC backward linkage and less upstreamness (more downstreamness) significantly increase gross exports and decrease value added at the country-industry level; however, the GVC forward linkage has the opposite significant effects.
  2. The increases in the backward linkage and downstreamness are larger and the increase in the forward linkage is smaller for the puzzle country-industry pairs than for the non-puzzle country-industry pairs.
- We have provided a GVC-based explanation for the difference between the puzzle and non-puzzle country-industry pairs.

Future work

1. Show how much important the GVC backward linkage and less upstreamness are for the puzzle compared with other factors that can contribute to the puzzle.

2. Investigate why some countries have changed from the puzzle country to the non-puzzle country.

3. Investigate factors that affect the GVC participation and position.
   - Fernandes et al. (2020) examined the determinants of GVC participation.