Trade and Growth in the Age of Global Value Chains

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Introduction

- International trade and economic growth are positively related.
- Assessing the causal impact of trade on growth is difficult, due to endogeneity.
- Since the seminal paper of Frankel and Romer (1999) several IV attempts.
  (e.g. Feyrer, 2009; Felbermayr and Groschl, 2013; Pascali, 2014)
- However, none of these studies considers the increasing role of Global Value Chains:

$\Rightarrow$ they exploit historical shocks for identification, dating before the surge of GVCs;

$\Rightarrow$ they focus solely on gross exports data, which are not informative of the value added contribution of each country to trade.

In this paper

We make 3 contributions:

1. We develop a new geography-based, time-varying instrument for trade, exploiting:
   (a) A transport technology shock: sharp increase in the maximum size of container ships in 1995-2007...
   (b) ... that impacted bilateral trade flows asymmetrically, depending on the presence of Deep Water Ports (DWPs) across countries.
2. We exploit this novel instrument to investigate the impact of trade on economic growth and its channels (i.e. productivity and capital deepening).
3. We study whether differences in the value-added composition of exports have implications on growth.

Main findings

Using WIOD data for 40 countries and 34 industries, over 1995-2007, we find that:

- Our novel instrument is a good predictor of exports.
- Exports have a positive effect on income per capita growth, through both productivity and capital deepening.
- Higher growth effects for:
  - (a) countries upgrading their *positioning* in GVCs;
  - (b) countries increasing their *participation* to GVCs.

$\Rightarrow$ **Key message**: the extent and modalities through which a country participates to GVCs matter for the trade-growth nexus.

Related literature

- Studies on the relationship between trade and growth.

  [Frankel and Romer (1999); Rodriguez and Rodrik (2001); Feyrer (2009); Felbermayr and Groschl (2013); Pascali (2014)]

- Literature on GVCs, especially export decomposition and applications.

  [Johnson and Noguera (2012); Koopman et al. (2014); Wang et al. (2013); Nagengast and Stehrer (2015); Johnson (2014)]

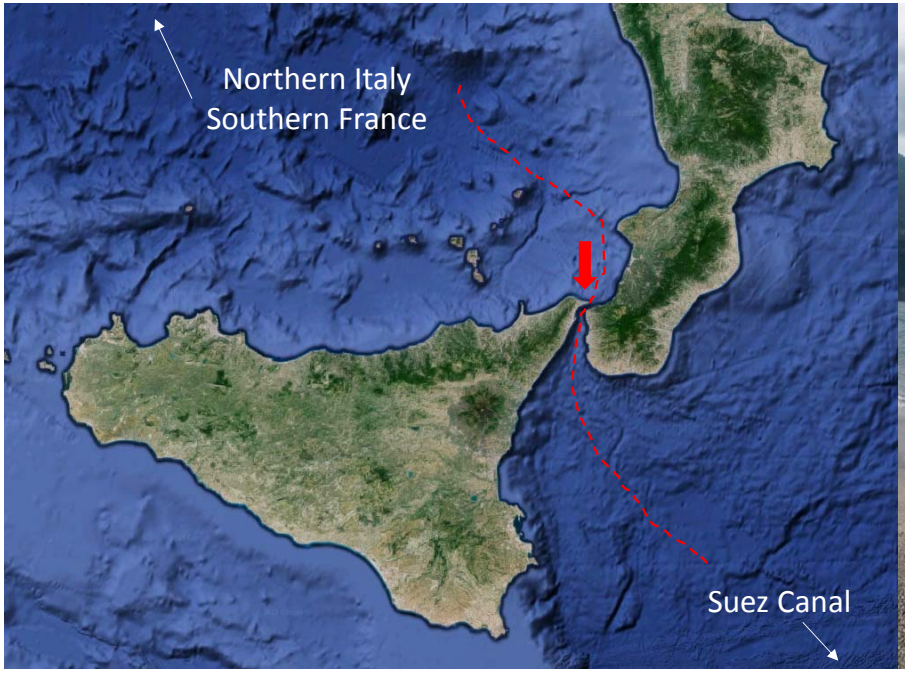
Identification

Overview of the identification issue

- Frankel and Romer (1999): use geographic variables as IVs in a gravity framework. Intuition: isolating the variation in bilateral export flows due to exogenous geographic characteristics.
- Critique (Rodriguez and Rodrik, 2001): geography may affect income through channels other than trade => violation of the exclusion restriction.
- Solution: develop time-varying instruments for trade, since fixed effects allow to control for time invariant determinants of income.
- Recent panel studies exploit exogenous shocks to transportation technology, which have an asymmetric impact on different trade flows, due to geographic characteristics (Feyrer, 2009; Pascali, 2014).
- Our novel instrument for trade follows a similar strategy.

Intuition

Messina Strait, between Sicily and Calabria



Ports in the area (20 km)

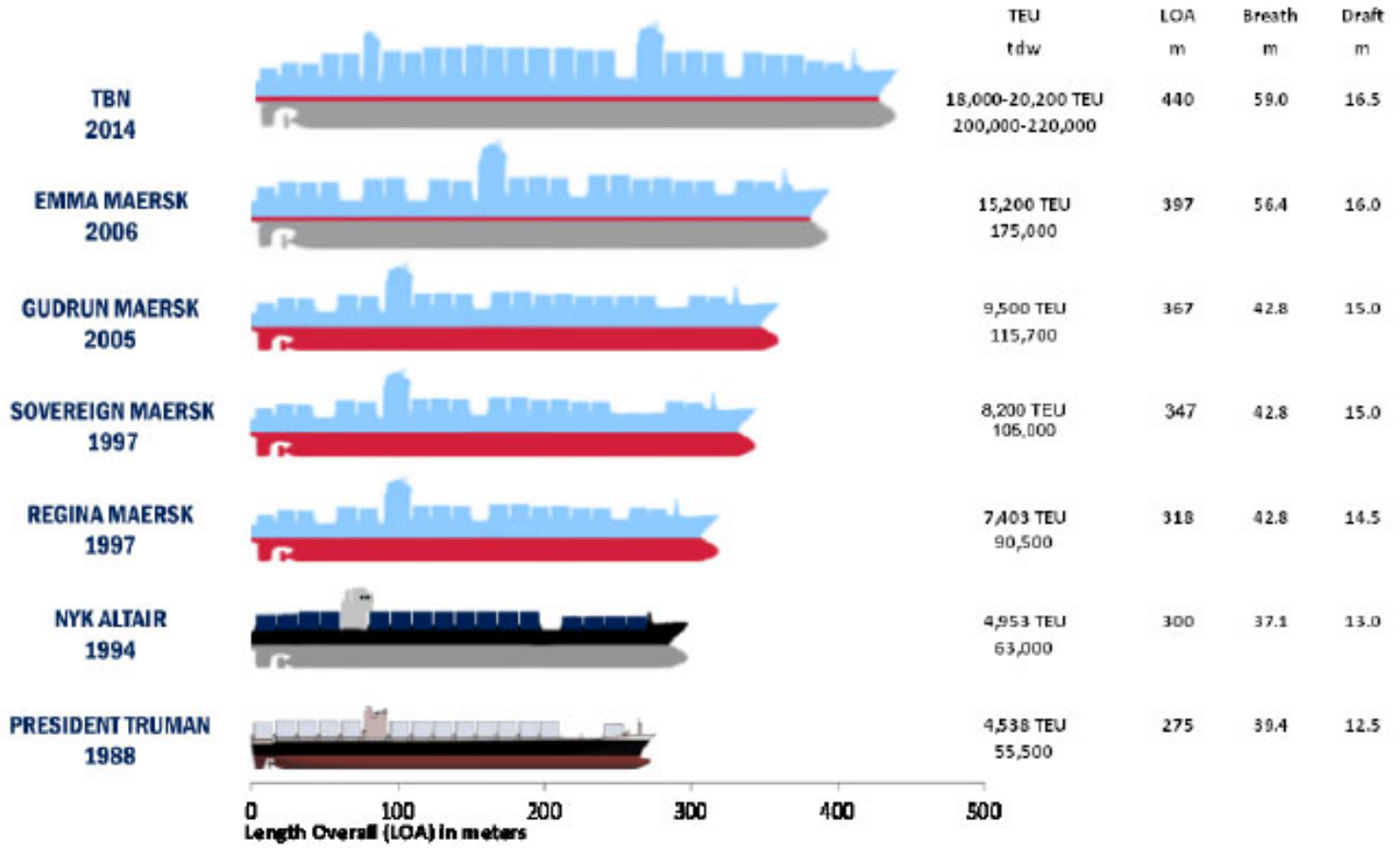
Intuition

Possible ports of call: Messina, Gioia Tauro

Possible port of call: Gioia Tauro

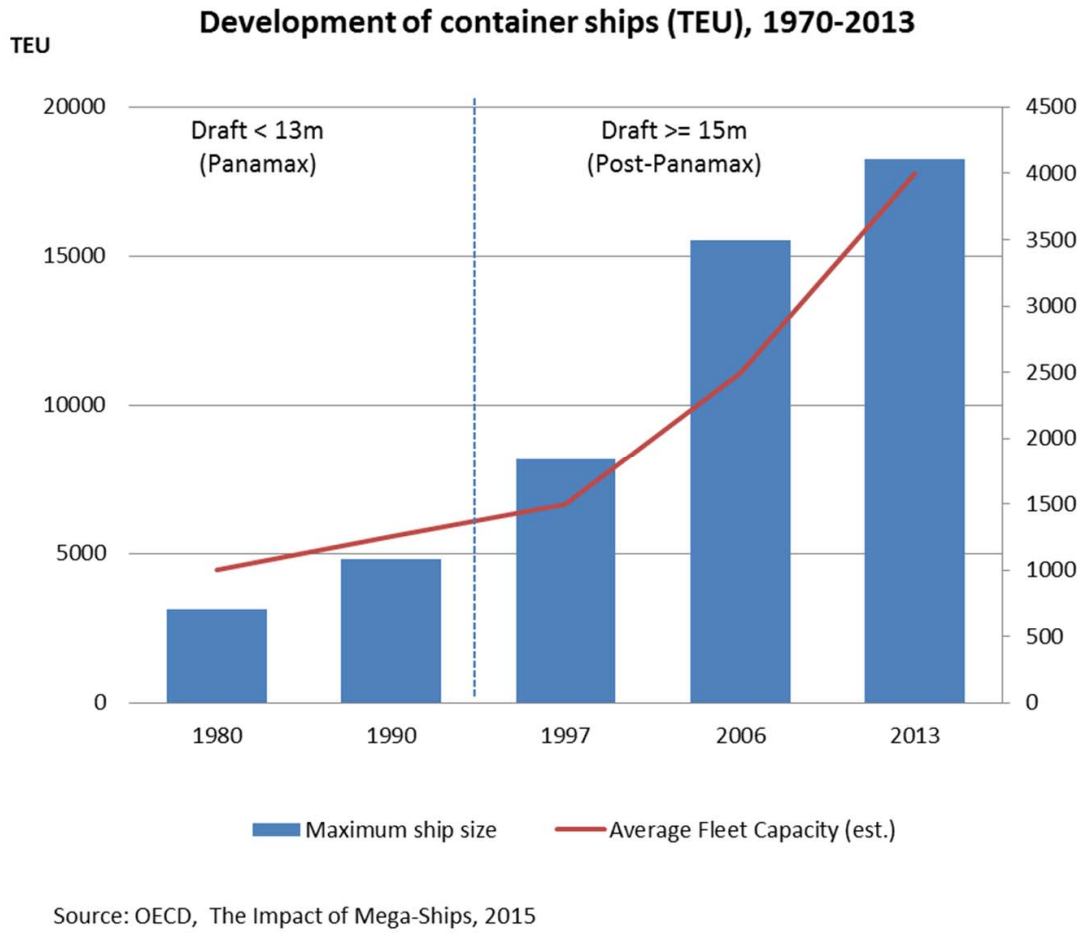
The instrument

The transportation shock is the sharp increase (more than doubling) in the maximum size of container ships between the mid-1990s and the mid-2000s.



The instrument

New larger ships are widely adopted: the average capacity of the world cargo fleet doubles between 1995 and 2007.



Source: OECD, The Impact of Mega-Ships, 2015

The instrument

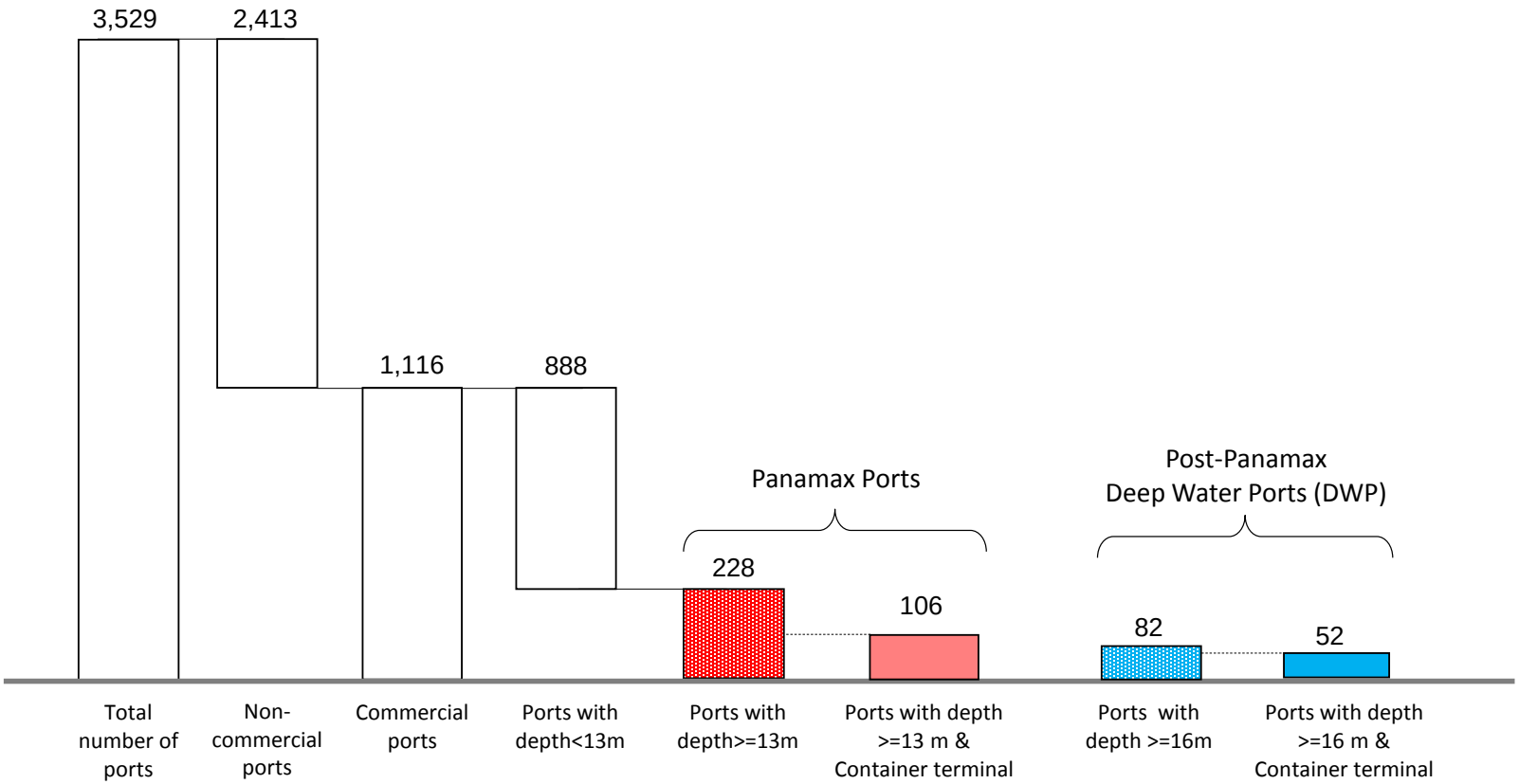
- The transportation shock affects exports towards different partner countries in a different way.
- After 1997, the new larger ships (draft>=15m) can only access ports with depth>=16m, i.e. Deep Water Ports (DWPs).
- Thus, the transport shock increases exports relatively more towards partner countries that are more endowed with DWPs.
- Notice: the number of DWPs in each country is fixed over time in our sample, i.e. a time-invariant geographical feature.

The instrument

- We build up our instrument by interacting the maximum size of container ships operating in each year, with the number of DWPs in each partner country (normalized over the number of km. of coastal line).
- To ensure the validity of the exclusion restriction, we employ the presence of DWPs *only* in foreign countries.
- Identifying assumption: conditional on controls, the presence of DWPs in foreign countries affects domestic GDP growth in the exporting country only through the trade channel.
- Relevance of the instrument: seaborne containerized trade is the fastest growing and largest modality of seaborne trade, accounting for some 40% of world trade value, pivotal for GVCs.

The instrument

As a result of the shock, from the mid 90s a restricted group of less than 100 ports (DWPs) has become increasingly relevant for world trade flows.



Source: authors' elaboration on data from *Worldportsource.com* and secondary sources

DWPs with container terminal across countries

Country	DWPs	Country	DWPs
AUS	2	IRL	0
AUT	0	ITA	3
BEL	1	JPN	2
BGR	0	KOR	3
BRA	1	LTU	0
CAN	1	LUX	0
CHN	9	LVA	0
CYP	0	MEX	2
CZE	0	MLT	0
DEU	2	NLD	1
DNK	0	POL	0
ESP	8	PRT	0
EST	1	ROM	1
FIN	0	RUS	0
FRA	3	SVK	0
GBR	1	SVN	0
GRC	1	SWE	0
HUN	0	TUR	0
IDN	0	TWN	3
IND	3	USA	4

Empirical strategy

Empirical strategy

Our empirical strategy has three steps:

1. We estimate gravity equations for exports from country i to country j in sector z at time t ($T_{ijz,t}$),

   including $DWP_j \times ln(MaxSize_t)$ **on the RHS**.

2. We then aggregate up at the exporting-country level to obtain the instrument: $PredictedTrade_{i,t}$.

3. We use $PredictedTrade_{i,t}$ as an IV in the income regressions.

Step 1a - Gravity à la Frankel and Romer (1999)

Separately for each industry z, we estimate:

$$\ln T_{ij,t} = \beta_0 + \beta_1 \ln Dist_{ij} + \beta_2 Contig_{ij} + \beta_3 Landlock_{ij} + \beta_4 \ln Pop_{i,t} + \beta_5 \ln Pop_{j,t} + \beta_6 DWP_j * \ln MaxSize_t + Z_{ij,t}\delta' + \alpha_i + \alpha_j + \alpha_t + \epsilon_{ij,t}$$

Where:

- $T_{ij,t}$: bilateral trade flow from exporting country i to importing country j, in year t.
- $Dist_{ij}$: bilateral distance.
- $Contig_{ij}$: dummy equal 1 for countries sharing common border.
- $Landlock_{ij}$: dummy equal 1 if one country in the pair is landlocked.
- $Pop_{i,t}$, $Pop_{j,t}$: home country and partner country population in year t
- $DWP_j * ln\ MaxSize_t = \frac{\#Deep\ water\ ports_j}{Km\ Coastal\ Line_j} * ln\ MaxSize_t$.
- $Z_{ij,t}$: vector of interactions between $DWP_j * ln\ MaxSize_t$ and: distance, contiguity, landlocked, population.
- α_i, α_j and α_t: exporter-industry, importer, and year fixed effects.

Step 1b - Gravity with Multilateral Resistance

Separately for each industry z, we estimate:

$$\ln T_{ij,t} = \beta_0 + \beta_1 \ln Dist_{ij} + \beta_2 Contig_{ij} + \beta_3 Landlock_{ij} + Z_{ij,t}\delta' + \alpha_{it} + \alpha_{jt} + \epsilon_{ij,t}$$

Where:

- $Z_{ij,t}$: vector of interactions between $DWP_j * ln\ MaxSize_t$ and: distance, contiguity, landlocked, population.
- α_{it} and α_{jt}: exporter-year and importer-year fixed effects.

Notice: here $DWP_j * ln\ MaxSize_t$ (like population) is absorbed by α_{jt}. Only the interactions are left.

Step 2 - Aggregation

We retrieve the instrument for trade at the country level as follows:

$$PredictedTrade_{i,t} = \sum_{j} \sum_{z} (\widehat{T}_{ijz,t})$$

Notice: In constructing the IV, one can keep or exclude fixed effects. We do both.

Step 3 - Income regressions

- Baseline specification as in Feyrer (2009):

$$\ln GDPpc_{i,t} = \beta_0 + \beta_1 \ln GrossExports_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t}$$

Where:

- $GDPpc_{i,t}$: GDP per capita of country i in year t.
- $GrossExports_{i,t}$: gross exports of country i in year t, instrumented with predicted exports from the gravity.
- α_i and α_t are country and year effects.

Results

Data

- Bilateral export data from WIOD (Timmer et al., 2015).
- Data cover 40 countries (and 34 industries), accounting for around 85% of global trade.
- Value added decomposition from Wang, Wei and Zhu (2013).
- Time-span: 1995-2007.

Gravity estimation à la Frankel and Romer (1999)

Table 1 - Gravity regressions, summary statistics on selected coefficients

Dependent Variable: ln(export)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Depth of ports considered:	Ports >=16 m.		Ports >=16 m.		Ports >=13 m.		Ports >=16 m.	
Only with container terminal:	yes		no		yes		yes	
Sectors considered:	Manufacturing		Manufacturing		Manufacturing		All Sectors	
	Avg.	Med.	Avg.	Med.	Avg.	Med.	Avg.	Med.
Importer's DWPs * ln(MaxSize)	1.613	1.569	0.201	0.156	0.584	0.475	0.845	1.138
Distance	-1.669	-1.649	-1.647	-1.630	-1.669	-1.648	-1.321	-1.304
Distance * Importer's DWPs * ln(MaxSize)	0.005	0.005	0.001	0.001	0.003	0.003	0.005	0.005

Growth regressions - IV à la Frankel and Romer (1999)

Table 2 - Country growth regression

Dependent Variable: GDP p.c.	(1)	(2)
Gross exports	0.270***	0.347***
	[0.051]	[0.061]
Estimator	OLS	2SLS
Country effects	yes	yes
Year effects	yes	yes
Obs.	507	507
R2	0.82	-
First-stage results		0.642***
Predicted trade flows from country gravity	-	[0.092]
Kleibergen-Paap F-Statistic	-	49.23

Growth regressions - IV à la Frankel and Romer (1999)

Table 3 - Country growth regressions, robustness

Dependent Variable: GDP p.c.	Coeff.	Std. Err.	Obs.	KP F-Stat.
1) Baseline	0.347***	[0.061]	507	49.23
2) Helpman, Melitz, Rubinstein (2008)	0.412***	[0.059]	507	76.04
3) Excluding China	0.365***	[0.055]	494	57.12
4) Plain number of DWPs	0.342***	[0.062]	507	46.12
5) Home and partner DWPs	0.358***	[0.057]	507	51.64

Growth regressions - IV from gravity with MRT

Table 3 - Country growth regressions

Dependent Variable: GDP p.c.	Coeff.	Std. Err.	Obs.	KP F-Stat.
a) Including fixed effects in predicted trade				
1) Baseline	0.321***	[0.029]	507	570.7
2) PPML estimator	0.301***	[0.024]	507	1550
3) Helpman, Melitz, Rubinstein (2008)	0.355***	[0.033]	507	129.4
4) Excluding China	0.283***	[0.029]	494	581.9
5) Plain number of DWPs	0.312***	[0.029]	507	556.0
6) Home and partner DWPs	0.321***	[0.029]	507	572.4
b) Excluding fixed effects from predicted trade				
7) Baseline	0.354***	[0.079]	507	14.88
8) PPML estimator	0.389***	[0.086]	507	28.08
9) Helpman, Melitz, Rubinstein (2008)	0.244***	[0.079]	507	28.26
10) Excluding China	0.355***	[0.077]	494	15.85
11) Plain number of DWPs	0.294***	[0.043]	507	21.82
12) Home and partner DWPs	0.355***	[0.063]	507	28.56

Productivity regressions

Table 5 - Productivity regressions

Dependent Variable: VA per worker	(1)	(2)	(3)	(4)
IV based on gravity:		F & R (1999)	Proper	Proper
IV aggregation:		Including f.e.	Including f.e.	Excluding f.e.
Gross exports	0.584***	0.434*	0.551***	1.336***
	[0.195]	[0.255]	[0.112]	[0.349]
Estimator	OLS	2SLS	2SLS	2SLS
Country effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Obs.	507	507	507	507
R2	0.55	-	-	-
Kleibergen-Paap F-Statistic		56.37	566.4	14.64

Capital deepening regressions

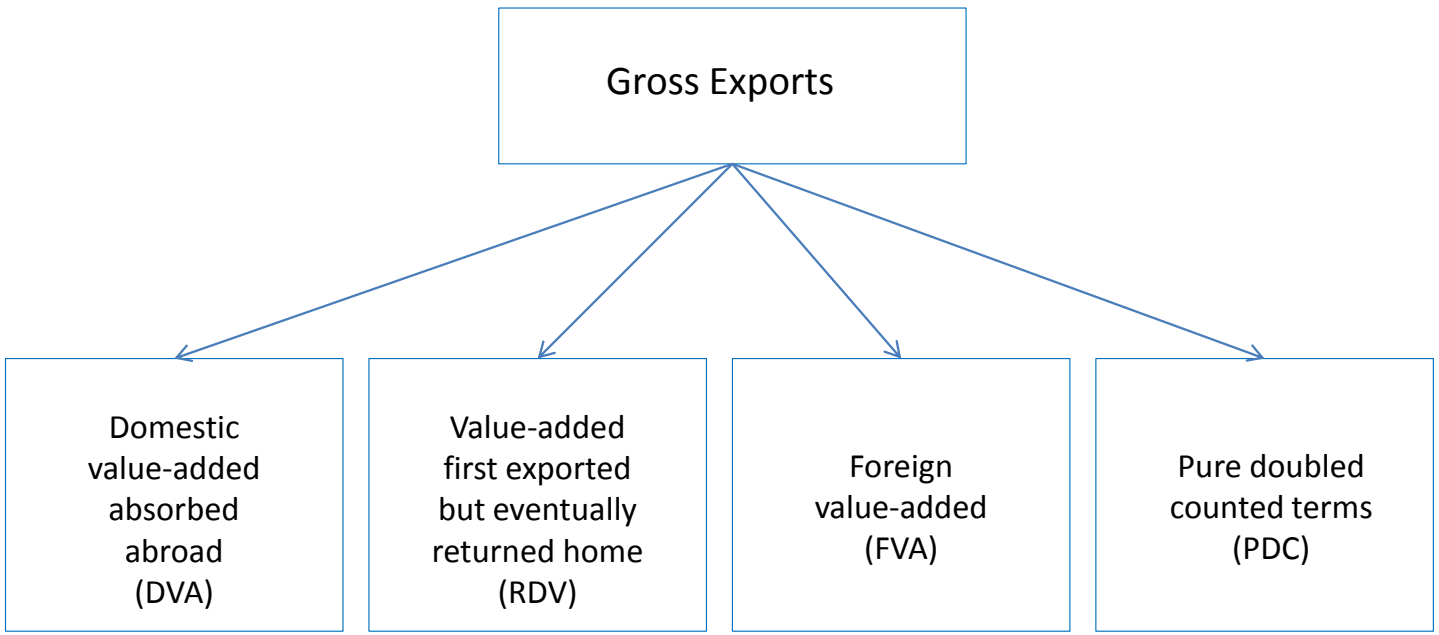
Table 6 - Capital deepening regressions

Dependent Variable: Inv. per worker	(1)	(2)	(3)	(4)
IV based on gravity:		F & R (1999)	Proper	Proper
IV aggregation:		Including f.e.	Including f.e.	Excluding f.e.
Gross exports	0.183**	0.318***	0.255***	0.511***
	[0.072]	[0.084]	[0.045]	[0.127]
Estimator	OLS	2SLS	2SLS	2SLS
Country effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Obs.	507	507	507	507
R2	0.72	-	-	-
Kleibergen-Paap F-Statistic		56.37	566.4	14.64

Value Added Trade

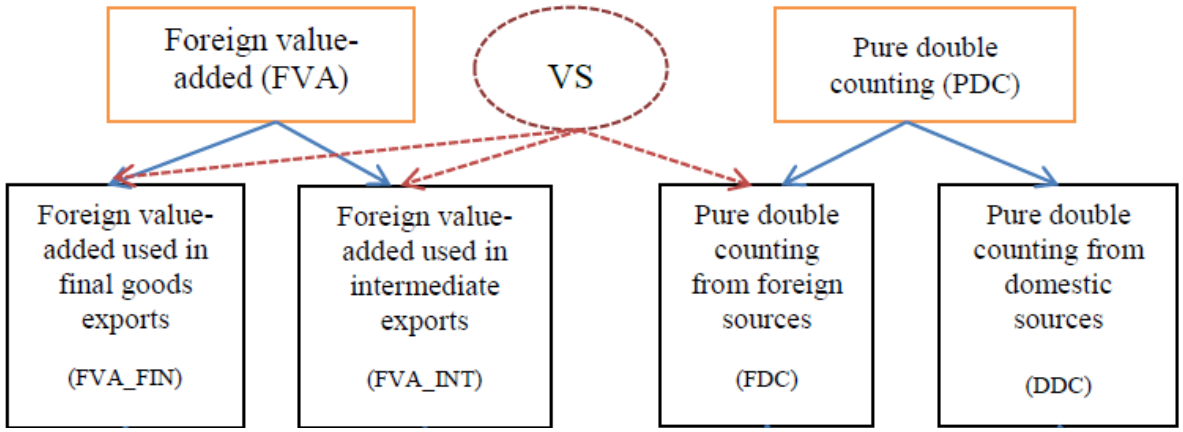
Export decomposition

Using Wang et al. (2013), we decompose each yearly gross export flow from each country -and each industry- to any partner country. Four main terms:



GVC covariates

In Wang et al. (2013) FVA and PDC can be further decomposed as:



We build 3 GVC-related covariates:

- *VS*/*GrossExport*: vertical specialization share, i.e. overall foreign value embodied in exports (Hummels, 2001).
- *FVA_INT*/*VS*: proxy for positioning, increasing as countries upgrade from simple assembling (Wang et al., 2013).
- *FDC*/*VS*: proxy for participation, increasing as countries get more embedded in GVCs (Wang et al., 2013).

GVC covariates

- We also construct a demand-side indicator of a country's role in GVCs, based on the *upstreamness* measure (the distance, measured in productive "steps", between each industry and the final consumer, Antras and Chor, 2013).
- Index ranges between 0 and 1, with the latter indicating 'downstream' industries, i.e. close to the final consumer.
- We use upstreamness measures at the country-industry-year level for the WIOD sample as provided by Miller and Temurshoev (2015).
- Since we are estimating income regressions at the exporting-country level, we build weighted aggregates of these upstreamness measures across sectors to get a measure for each country.

- Our measure of upstreamness grows by about 8% over the sample for upgrading countries whose FVA INT/VS growth rate is above the sample average, whereas its growth rate gets halved (about 4%) when considering non-upgrading countries.

Augmented growth regressions

Table 7 - Growth and GVCs

IV Regressions - Gravity à la Frankel and Romer (1999)					
Dependent Variable: GDP p.c.	(1)	(2)	(3)	(4)	(5)
Gross exports	0.347***	0.419***	0.317***	0.512***	0.425***
	[0.061]	[0.085]	[0.093]	[0.112]	[0.085]
Gross exports * Dummy high growth of VS share		-0.067**	-0.067**	-0.094**	-0.077**
		[0.031]	[0.034]	[0.038]	[0.031]
Gross exports * Dummy increased participation (FDC/VS)			0.100***		
			[0.021]		
Gross exports * Dummy upgraded positioning (FVA_INT/VS)				0.138***	
				[0.044]	
Gross exports * Dummy increased upstreamness					0.046**
					[0.022]
Country and Year effects	yes	yes	yes	yes	yes
Obs.	507	507	507	507	507
Kleibergen-Paap F-Statistic	49.23	16.28	9.525	5.445	9.692

Where GVC dummies take value 1 if growth in a given indicator is above sample mean, at the country-level, between 1995 and 2007.

Augmented growth regressions

Table 8 - Growth and GVCs

IV Regressions - Proper gravity, including fixed effects					
Dependent Variable: GDP p.c.	(1)	(2)	(3)	(4)	(5)
Gross exports	0.321***	0.343***	0.291***	0.323***	0.333***
	[0.029]	[0.038]	[0.043]	[0.039]	[0.038]
Gross exports * Dummy high growth of VS share		-0.028	-0.043*	-0.021	-0.031
		[0.027]	[0.025]	[0.027]	[0.026]
Gross exports * Dummy increased participation (FDC/VS)			0.090***		
			[0.022]		
Gross exports * Dummy upgraded positioning (FVA_INT/VS)				0.094***	
				[0.028]	
Gross exports * Dummy increased upstreamness					0.051**
					[0.022]
Country and Year effects	yes	yes	yes	yes	yes
Obs.	507	507	507	507	507
Kleibergen-Paap F-Statistic	570.7	242	163.4	167.8	137.3

Augmented growth regressions

Table 9 - Growth and GVCs

IV Regressions - Proper gravity, excluding fixed effects					
Dependent Variable: GDP p.c.	(1)	(2)	(3)	(4)	(5)
Gross exports	0.354***	0.403***	0.336***	0.437***	0.335***
	[0.079]	[0.124]	[0.119]	[0.143]	[0.117]
Gross exports * Dummy high growth of VS share		-0.048	-0.053	-0.067	-0.036
		[0.048]	[0.047]	[0.056]	[0.048]
Gross exports * Dummy increased participation (FDC/VS)			0.078***		
			[0.027]		
Gross exports * Dummy upgraded positioning (FVA_INT/VS)				0.090*	
				[0.050]	
Gross exports * Dummy increased upstreamness					0.063**
					[0.027]
Country and Year effects	yes	yes	yes	yes	yes
Obs.	507	507	507	507	507
Kleibergen-Paap F-Statistic	14.88	5.7	3.8	2.5	4.3

Conclusion

Conclusion

- We have developed a new instrument for trade.
- This exploits a recent shock to transportation technology, pivotal for GVCs.
- We find a positive effect of trade on growth, through both productivity growth and capital deepening.
- The trade-growth nexus is moderated by the extent and modalities through which a country participates to GVCs.
- Controlling for domestic vs. foreign content of exports, stronger growth effect for countries upgrading their positioning and increasing their participation to GVCs.
- The instrument allows for a wide range of applications.
- Our results motivate further analysis on the economic effects of heterogeneous value-added trade flows.