Globalisation or Regionalisation?
A New Approach to Measure the International Fragmentation of Value Chains

Bart Los, Marcel Timmer and **Gaaitzen de Vries**
(University of Groningen)

Workshop "The Wealth of Nations in a Globalizing World"

Groningen, July 18-19, 2013

[the authors blame each other for any mistakes]

Motivation

- Rapid increase in international fragmentation of production

    International Trade Theory: Grossman and Rossi-Hansberg, 2008; Costinot et al., 2013

    Empirical work: Feenstra and Hanson, 1999; Hummels, Ishii and Yi, 2001; Johnson and Noguera, 2012a,b; Koopman et al., 2013; Baldwin and Lopez-Gonzalez, 2013

- To what extent is this international fragmentation of production regional or global?

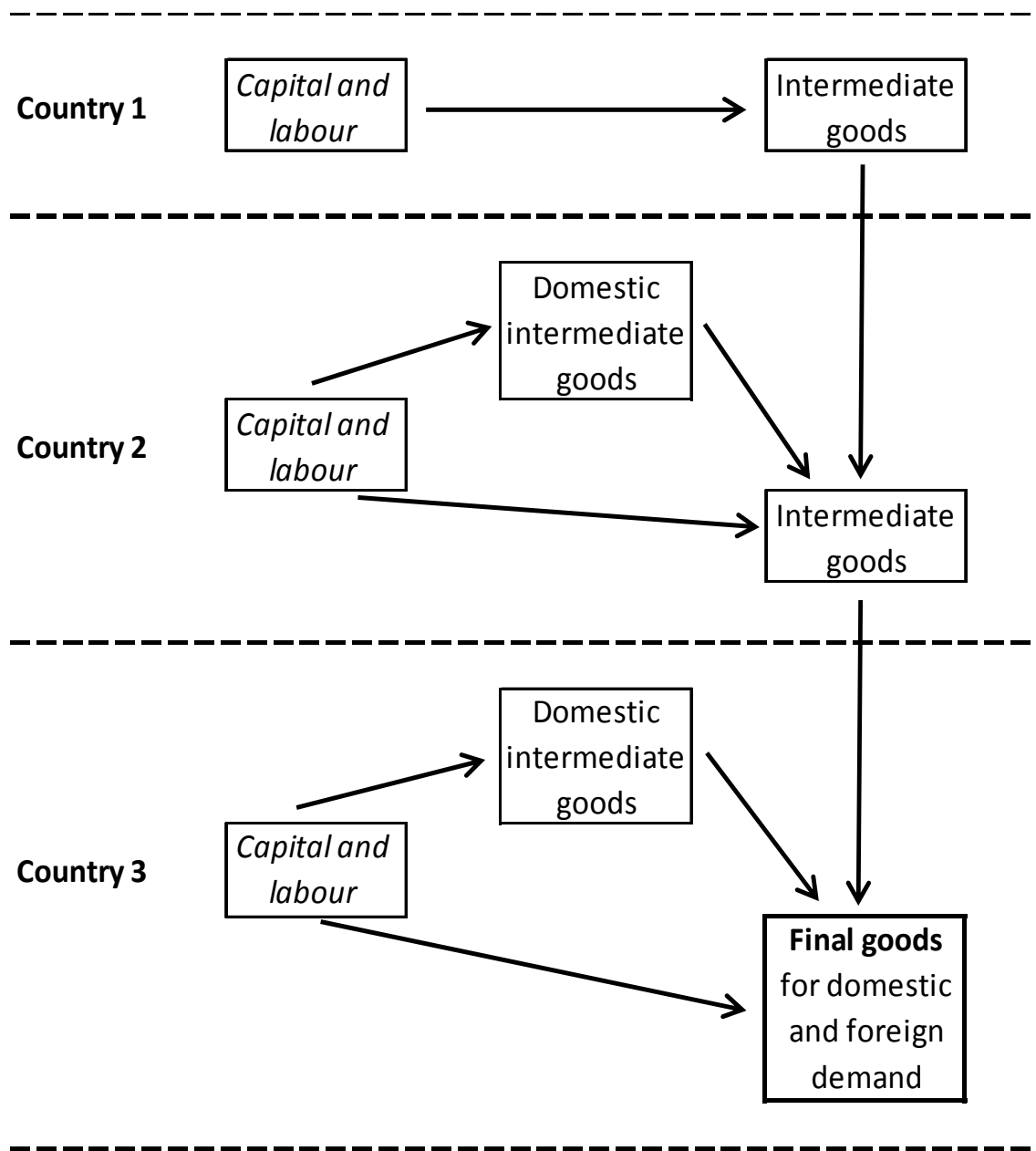   Johnson and Noguera, 2012b; Baldwin and Lopez-Gonzalez, 2013

This paper

- Systematic evidence on trends in the international fragmentation of value chains
- Extend the Feenstra and Hanson (1999) fragmentation measure using global input-output tables
- Main finding: both global and regional fragmentation, but global fragmentation trumps regional fragmentation after 2000s.

Distinguish from:
- Johnson and Noguera (2012a) extend the Hummels, Ishii and Yi (2001) measure of vertical specialization in trade to focus on the position of countries in production networks
- Instead, we focus on the international fragmentation of production processes (think of the Porsche factory in Leipzig)

Methodology

- Feenstra and Hanson (FH, 1999) measure
    - * is in principle silent on origin of imported inputs
    - * can be affected by the substitution of domestic value added for intermediates
    - * disregards back and forth trade in intermediates

- Our measure is based on final output values, it takes into account multiple rounds of production and traces the geographical origin of value added.

Country 1

Capital and labour	$\longrightarrow$	Intermediate goods

Country 2

Domestic intermediate goods

Capital and labour $\longrightarrow$ Intermediate goods

Country 3

Domestic intermediate goods

Capital and labour $\longrightarrow$ **Final goods** for domestic and foreign demand

More formally

- We define the global value chain of a final product from industry i located in a specific country j as the activities in industries $s=1,...,S$ in each of the countries $n=1,...,N$ required to produce it. We will label (i,j) the "country-industry-of-completion"
- To decompose its value, we start with the levels of gross output associated with the production of (i,j).

- Global input-output tables contain information on the values of intermediate input flows among all country-industries in the world, as well as on the values of flows from each of these country-industries to final use in each of the countries.
- These tables also contain information on value added generated in each of the country-industries.

Foreign Value Added (FVA)

$$\mathbf{g} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}(\tilde{\mathbf{F}}\mathbf{e})$$

g is the vector of value added created in each of the *SN* country-industries within a global value chain.

$\tilde{\mathbf{F}}$ is the matrix of final output delivered for household consumption and investment demand.

> *only the row representing final demand for country-industry (i,j) have their actual value and all other final demand is set to 0*

e is a summation vector.

(I-A)$^{-1}$ is the well-known Leontief inverse, the use of which ensures that value added contributions in all tiers of suppliers are taken into account.

v is a vector with value added over gross output ratios, for each of the country-industries.

Foreign Value Added (FVA)

Denote the value of final product (i,j) by VA(i,j) and the value added by country k in its production by VA(k)(i,j). The vector **g** contains for each (i,j) the matching VA(k)(i,j)'s such that

$$VA(i,j) = \sum_k VA(k)(i,j)$$

Summed over all countries, the value added contributions to the production of (i,j) is equal to the final output value of (i,j).

We define our measure of foreign value added as all value added outside the country-of-completion of product (i,j):

$$FVA(i,j) = \sum_{k \neq j} VA(k)(i,j) = VA(i,j) - VA(j)(i,j)$$

FVAs(i,j) = FVA(i,j)/VA(i,j)

Main characteristics of WIOD

- Time-series (1995-2011) benchmarked on NA data
- National supply and use tables as the point of departure
- Based on detailed accounts of trade in goods and services
- Improved allocation of imports of goods to use categories (modified BEC)
- Based on official statistics with maximum of transparency in calculations
- Fully compatible satellite accounts with data on use and remuneration of production factors (capital and labour of three skill levels)

A stylized world input-output table

	Intermediate use (S columns per country)			Final use (C columns per country)			Total
	1	...	N	1	...	N	
S Industries, country 1	Z^{11}	$Z^{1.}$	Z^{1N}	F^{11}	$F^{1.}$	F^{1N}	x^1
...	$Z^{.1}$	$Z^{..}$	$Z^{.N}$	$F^{.1}$	$F^{..}$	$F^{.N}$	$x^.$
S Industries, country N	Z^{N1}	$Z^{N.}$	Z^{NN}	F^{N1}	$F^{N.}$	F^{NN}	x^N
Value added	$(v^1)'$	$(v^2)'$	$(v^N)'$				
Output	$(x^1)'$	$(x^2)'$	$(x^N)'$				

FVA shares by selected products

Industry	ISIC rev. 3 code	Foreign value added share			Global final output in 2008
		1995	2008	Change 1995-2008	
Electronic products	30-33	18.3	29.1	10.8	1,405,650
Transport products	34,35	20.4	30.3	9.9	1,834,003
Food products	15,16	12.1	16.9	4.8	2,438,968
Textile products	17,18	16.7	20.4	3.7	577,356

Weighted average of foreign value share in final output. Last column shows total final output in world in millions of current US dollars at market exchange rates, in 2008.
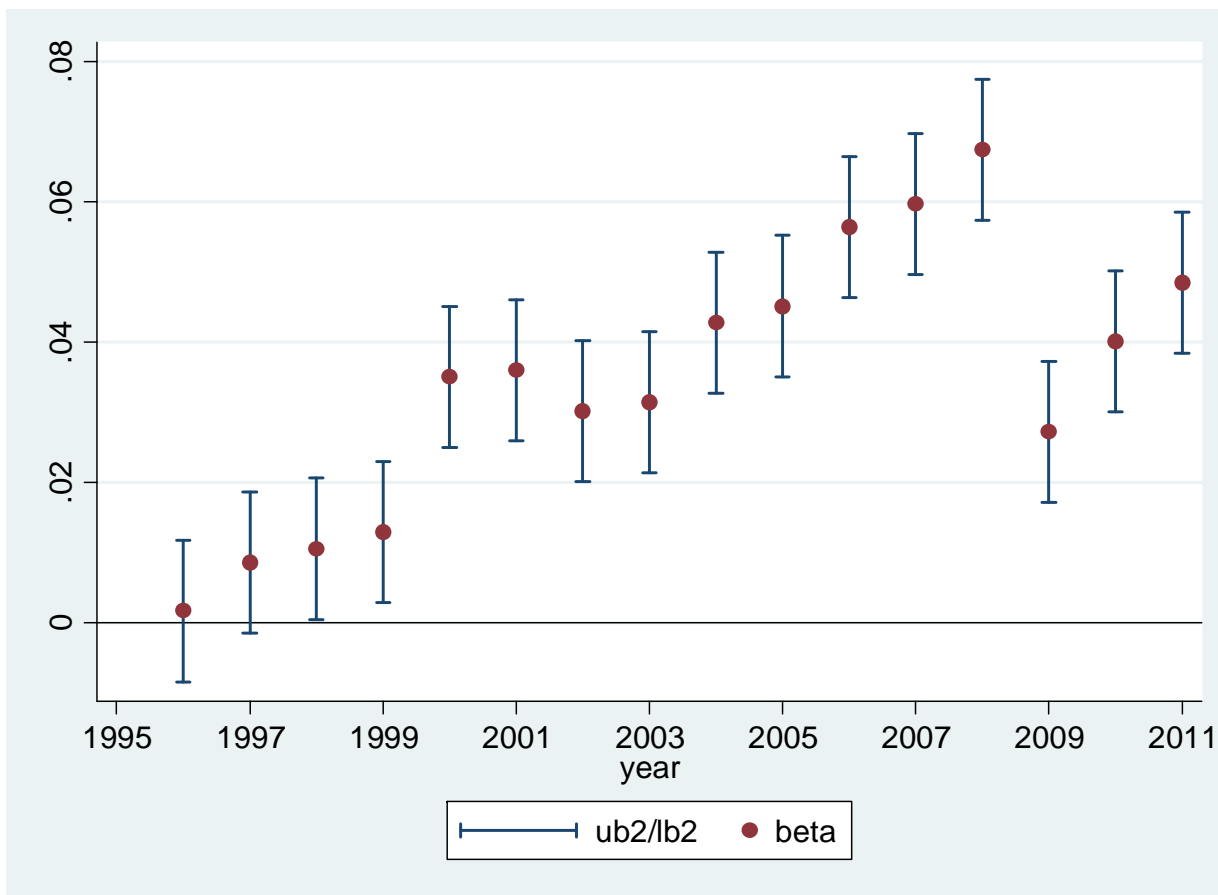
Regression of shares of foreign value added in output of final manufactures on country-of-completion dummies, industry-of-completion dummies and year dummies. The figure provides estimated coefficients and 95 percent confidence intervals of year dummies. The observations (6,351) are weighted by final output.

Global or regional fragmentation?

Based on the measures of foreign value added, we can easily define regional and global fragmentation. We measure regional value added (RVA) in the value of product *i* with country *j* as country-of-completion as the value added contribution of other countries in the region to which country *j* belongs, as follows:

$$\text{RVA}(i, j) = \sum_{k \in region\ of\ j} \text{VA}(k)(i, j) - \text{VA}(j)(i, j)$$

If the change in RVA is positive we say that the VC of this product is regionally fragmenting. Along the same lines, we measure global value added in this VC as the value added contribution of all countries outside the region of country *j*, as follows:

$$\text{GVA}(i, j) = \sum_{k \in outside\ region\ of\ j} \text{VA}(k)(i, j)$$

and we say that a VC is globally fragmenting when the change in GVA is positive.

Note: FVA(i,j) = RVA(i,j) + GVA(i,j)
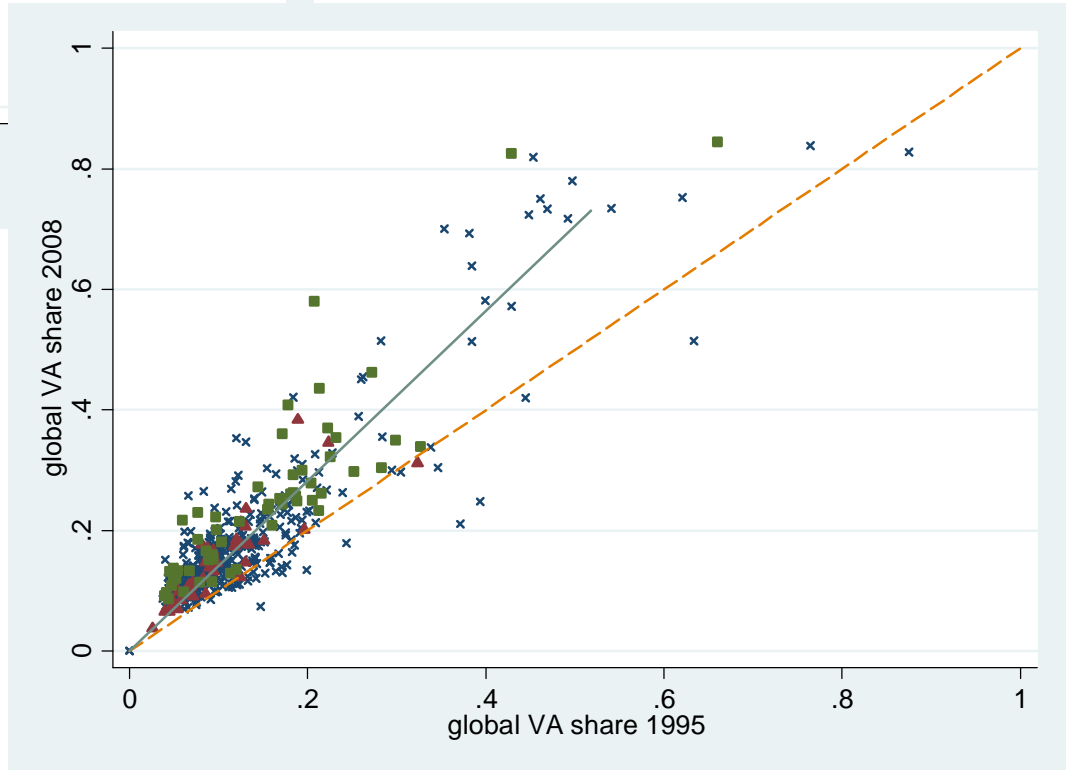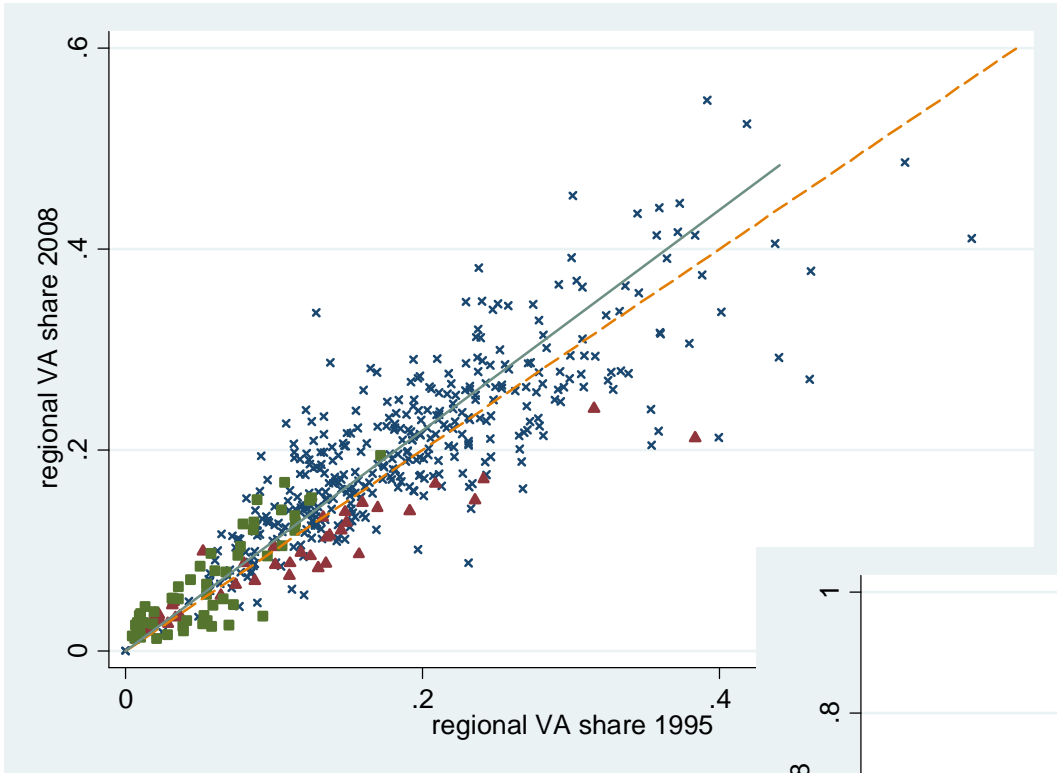
Foreign value added originating in- and outside the region in a country's VCs

	Value added inside region, but outside the country (% of final output)			Value added outside region (% of final output)		
	1995	2008	2008-1995	1995	2008	2008-1995
European Union						
Hungary	20.0	31.6	11.6	13.8	22.3	8.5
Latvia	16.1	21.2	5.1	11.4	13.4	2.0
Germany	10.1	14.4	4.4	8.0	15.7	7.7
France	13.0	14.8	1.8	8.8	16.4	7.7
NAFTA						
United States	2.5	4.2	1.8	9.8	16.0	6.2
East Asia						
Japan	1.0	2.9	1.9	5.5	16.4	10.9
China	5.9	4.9	-1.0	8.7	15.9	7.2

Weighted foreign value added shares of fourteen manufacturing product groups in final output of GVCs for which a country is the final stage of production. Shares are weighted with final output for each product group.

Concluding remarks

- Driven by rapid advances in information and communication technology and the opening up of China and Eastern Europe in the 1990s, companies increasingly moved parts of their production activities to benefit from location advantages of other countries.

- We generalized the Feenstra and Hanson (1999) measure to provide quantitative evidence

- Both regional and global fragmentation of value-adding activities, but especially global fragmentation

Thank you

Gaaitzen de Vries: g.j.de.vries@rug.nl

International Production Fragmentation (IPF) index

Our International Production Fragmentation (IPF) index is based on the Theil's Mean-log-deviation index which is a cross-entropy measure. It measures the distance between two country-distributions of the value of a particular product

1. the actual value distribution: the shares of countries in the value of a product

2. the value distribution in a world with no fragmentation costs. When all production factors are perfectly mobile, this would be equal to the shares of countries in world GDP

International Production Fragmentation (IPF) index

$$IPF^{tj} = \sum_{m=1}^{M} \sum_{n=1}^{N} \left(\frac{GDP_{mn}}{GDP_{world}} \right) ln \left(\frac{GDP_{mn}/GDP_{world}}{GVCI_{mn}^{tj}/GVCI_{world}^{tj}} \right)$$

t,j: "country-industry"-of-assembly of interest
*m,n*: macroregions and countries or regions

Theil's Mean-log-deviation index
Zero if global value chain income shares identical to GDP shares
 Goes down when fragmentation goes up
Can be decomposed, to study extent of "globalization" vs. "regionalization"

Fragmentation: 1995 – 2011

International Production fragmentation, Manufacturing only

Note: all countries, manufacturing industries only
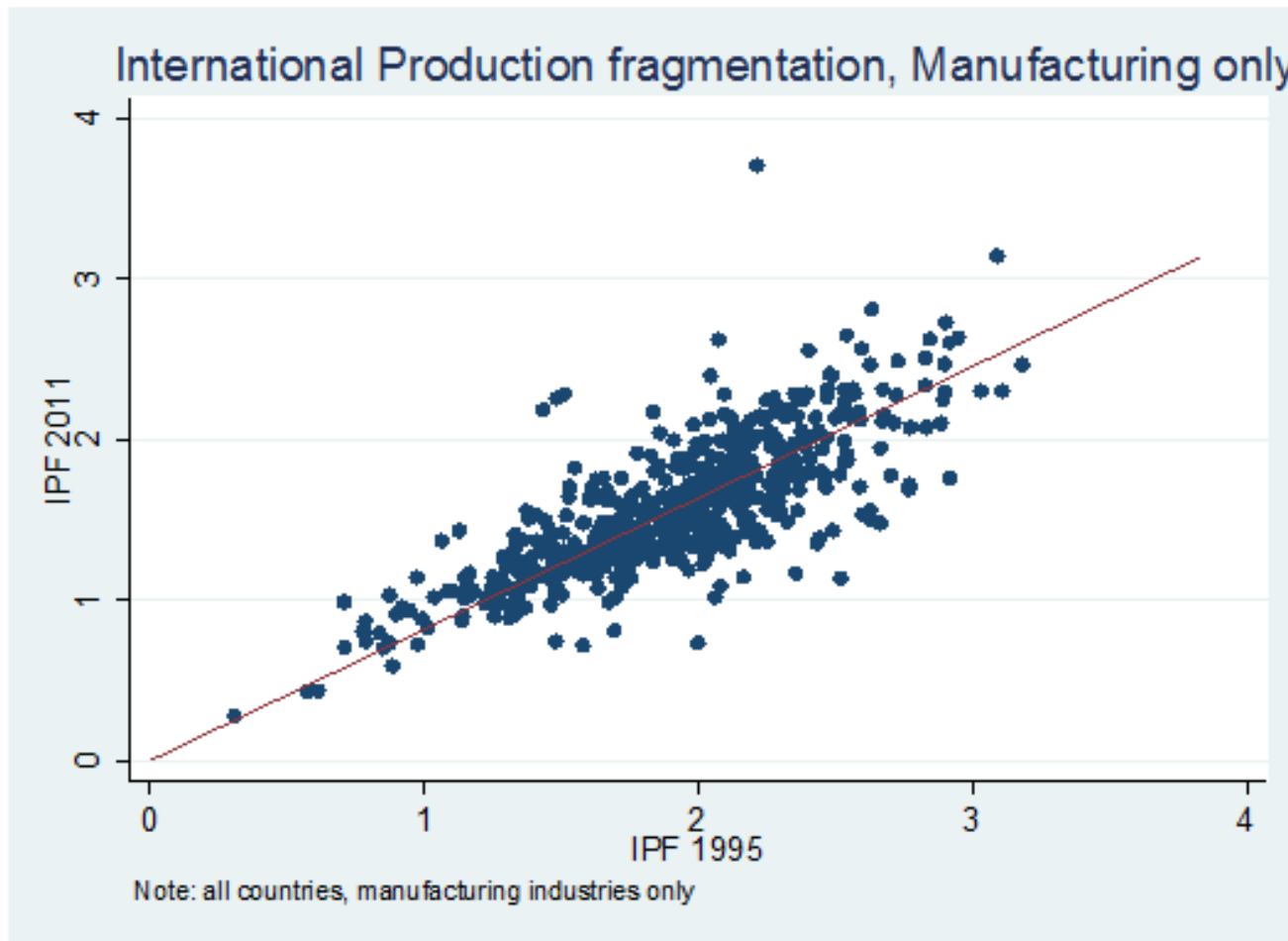
Slope: 0.81

Production fragmentation has increased

Fragmentation heterogeneity across Product groups

IPF index, 2011

Product group	IPF index
Electronic products	
Transport products	
Basic and fabricated metals	
Rubber and plastics	
Chemical products	
Machinery, n.e.c.	
Textile products	
Manufacturing n.e.c.	
Petroleum products	
Leather products	
Food products	
Other non-metallic minerals	
Wood products	
Paper and printing products	

0   .5   1   1.5   2