LABORATORY OF INDUSTRIAL & ENERGY ECONOMICS
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Sector Specialization in GVCs: The role of Intangibles and Innovation for the EU's manufacturing industries

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The scope of the study

- To study patterns of intangibles utilization in the EU's manufacturing industries utilizing data from the **GLOBALINTO Input-Output Database (GIOID)**
- To identify the determinants of sector specialization for the EU's manufacturing industries in GVCs with special focus on:
  - ✓The role of intangibles
  - ✓Innovation
  - ✓Backward participation in GVCs
  - ✓Sector and country specific characteristics
- To draw meaningful, evidence-driven policy remarks at the national and the EU level.

A glance at the theoretical background

A global economy in transition

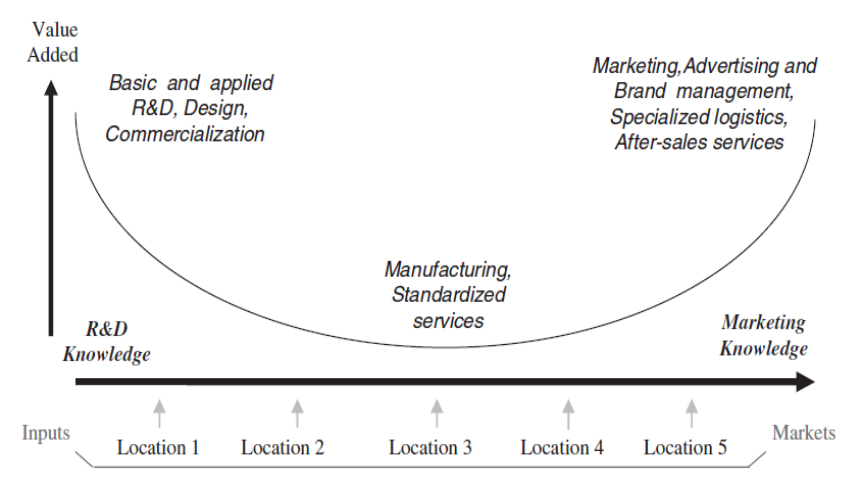
- The global economy is transitioning towards the concept of the "*knowledge economy*"
- Countries are repositioning themselves in the global production network based on newly developed capabilities
- Technological change upgrades the role of 'Factory Asia'
  - ✓Rep. of Korea and China are upgrading to more lucrative stages of the GVCs
  - ✓Increasing knowledge content and technological complexity of production
- Structural change in global trade and power shift along the value chains

Why focus on intangibles?

- Intangibles are knowledge based assets - alternatively known as knowledge-based capital (OECD, 2018)
- They are placed in the epicentre of this transition as they represent the "**knowledge content of production**" (Corrado et al., 2018; Jona-Lasinio et al., 2019)
- Especially for the EU:
  - Intangibles have been identified as key elements for growth (Corrado et al., 2018; Piekkola, 2018; Roth, 2020)
  - Do they provide the answer to competitiveness and the threat of emerging economies?
  - Is this solution the "***holy grail***" of competitiveness that applies to every country?
  - In "***the most regionalized region of the world***", does the trade of intermediates encompasses trade in intangibles as well?

The prominent role of intangibles in GVCs

The famous 'smiling curve'



Source: Mudambi, 2008

- The accumulation of intangibles secures dominant position in global markets (Mudambi, 2008; WIPO, 2017)
- Value accumulation along the value chain is concentrated in the upstream and downstream activities (OECD, 2013)
  - The U-shaped "smiling curve" with traditional manufacturing in the center
- These activities are dominated by services and intangible assets
- How does traditional manufacturing respond to that?
- What is the case for advanced economies and their manufacturing industries?

An ongoing *servicification*

- Manufacturing is under '**servicification**' (Miroudot and Cadestin, 2017; National Board of Trade, 2016)
  - Complementary production services
  - Bundled products (complements and substitutes)
  - In-house supporting activities
- Towards a unified goal: ***Increase the shares of value added in global networks***
- Advanced economies undertake knowledge and technology intensive manufacturing activities to secure their shares in the VA accumulation
- How is this related with intangibles?

Intangibles as producer's services: The GIOID approach

- Identification of intangibles as knowledge-intensive producer services
- Provided by KIBS industries as production inputs

- **Novel dynamics:**
  - ✓An origin dimension
  - ✓Intangibles as intermediate inputs → when they cross borders for production purposes, they can be considered as GVC activities.
- For manufacturing sectors: upstream and downstream service components that secure higher shares of value-added
- Is this true for all manufacturing industries?

A paradoxical pair of concerns

Advanced and innovative manufacturing

- A priori knowledge and technology intensive
- Engaged in upstream and downstream manufacturing activities
- Knowledge inputs define sector specialization

Traditional large-scale manufacturing

- Pre-occupied with traditional activities (assembly, fabrications etc.)
- Positioning at the middle part of the value chain
- Labor inputs and large-scale production capabilities define sector specialization

- Knowledge inputs are key elements of advanced and innovative manufacturing
- Increased knowledge content in production leads to higher gains from participation in GVCs

Are these gains relevant when the manufacturing industry is specialized in traditional activities?

Methodological framework and data description

Basic stages of the empirical strategy

1. Monitoring of intangibles' intensity growth for the EU and the UK's manufacturing industries at the NACE Rev.2 2-digit level utilizing data from the GIOID.
2. Exploration of the linkages between intangible inputs, innovation, participation in GVCs and sector specialization using pair-wise correlation statistics.
3. A refinement of the sample using GIOID data to account for *Innovators* and *Assemblers*.
4. Simple panel regressions to identify the determinants of sector specialization for the two groups

- **Data sources:** GIOID and the World Input-Output Database (WIOD) (Timmer et al., 2015)
- **Sector coverage:** 19 NACE Rev. 2 2-digit manufacturing sectors from the EU and the UK
- **Time frame:** 2000-2014

EU-27 and UK manufacturing sectors covered in the analysis

Sector Acronym	Detailed description
C10-C12	Mn. of food products, beverages and tobacco products
C13-C15	Mn. of textiles, wearing apparel and leather products
C16	Mn. of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Mn. of paper and paper products
C18	Printing and reproduction of recorded media
C19	Mn. of coke and refined petroleum products
C20	Mn. of chemicals and chemical products
C21	Mn. of basic pharmaceutical products and pharmaceutical preparations
C22	Mn. of rubber and plastic products
C23	Mn. of other non-metallic mineral products
C24	Mn. of basic metals
C25	Mn. of fabricated metal products, except machinery and equipment
C26	Mn. of computer, electronic and optical products
C27	Mn. of electrical equipment
C28	Mn. of machinery and equipment n.e.c.
C29	Mn. of motor vehicles, trailers and semi-trailers
C30	Mn. of other transport equipment
C31_C32	Mn. of furniture; other manufacturing
C33	Repair and installation of machinery and equipment

Intangibles' intensity and the GIOID

- Using Intangible inputs data from GLOBALINTO I-O Intangibles Database
  - *Provided by* NACE Rev. 2 KIBS sectors: J62-J63 -Computer programming, consultancy and related activities; M72 - Scientific R&D; M73 Advertising and market research; N Administrative and support service activities;
  - *Made in* 42 countries (all EU members included) and RoW; Aggregates for BRIC, EA, EU28 aggregates
  - *Used by* 56 2-digit NACE Rev.2 sectors in each EU country
  - *Time coverage*: 2000 – 2014
- Account for purchased intangible capital and not in-house production
- Relative to sector intermediate consumption to account for intangible inputs intensity
- **Key novelty:** The origin dimension (domestic and imported intangibles)

Intangibles' intensity (2)

- Domestic intensity

$$d_{i,c}^{INTAN} = \frac{domestic\ intangible\ inputs_{i,c}}{total\ intermediate\ consumption_{i,c}}$$

- Imported intensity

$$i_{i,c}^{INTAN} = \frac{imported\ intangible\ inputs_{i,c}}{total\ intermediate\ consumption_{i,c}}$$

- Total intensity

$$t_{i,c}^{INTAN} = \frac{total\ intangible\ inputs_{i,c}}{total\ intermediate\ consumption_{i,c}}$$

- These indicators capture the '***knowledge content of production***'.
- They account for **origin**.
- Provide measures of the share of intangibles compared to other intermediates.
- Diminish the effects of an increase (or decrease) in the overall intermediate consumption and focus only on intangibles.

Innovation

- Approximation via a standard innovation metric: patent applications
  - ➢ Patent applications to the European Patent Office: data for 19 (manufacturing) sectors and years 2000 - 2013
- Treatment for the model application:
  1. Projection of the time series to account for 2014
  2. Utilization of their annual intensity (i.e., applications relative to total output for each industry)

❖ Patent statistics also provide evidence of innovative property → another dimension of intangibles to be accounted in the model

Participation in GVCs

- Backward participation in GVCs is the most commonly used index of GVC participation (i.e. Baldwin and Lopez-Gonzalez (2015), OECD (2013), Amador et al. (2015))
- It measures roughly the import content of exports
- Calculations based on the Hummels et al. (2001) Vertical Specialization (VS) indicator approach:

$$B_{i,c}^{GVC} = \frac{FVA\ embodied\ in\ \ gross\ exports_{i,c}}{gross\ exports_{i,c}}$$

**where FVA embodied in gross exports and gross exports are calculated at the 2-digit NACE Rev.2 sector level for each manufacturing sector i in each country c using relevant I-O data for the EU27 and UK's manufacturing sectors from WIOD*

Sector Specialization

- A relative indicator from the GIOID
- Accounts for each sector's own contribution (i.e., VA) to its production value compared to the rest of the intermediates the sector uses.
- Also interpreted as a ***downstreamness*** indicator (*a la* Antrás and Chor, 2019)

$$Sp_{i,c} = \frac{VA_{i,c}}{gross\ output_{i,c}} \Bigg/ \frac{VA_{i,glob}}{gross\ output_{i,glob}}$$

- ***Higher shares of VA*** compared to the shares of the average world sector imply ***higher degree of specialization*** to the corresponding manufacturing activity.

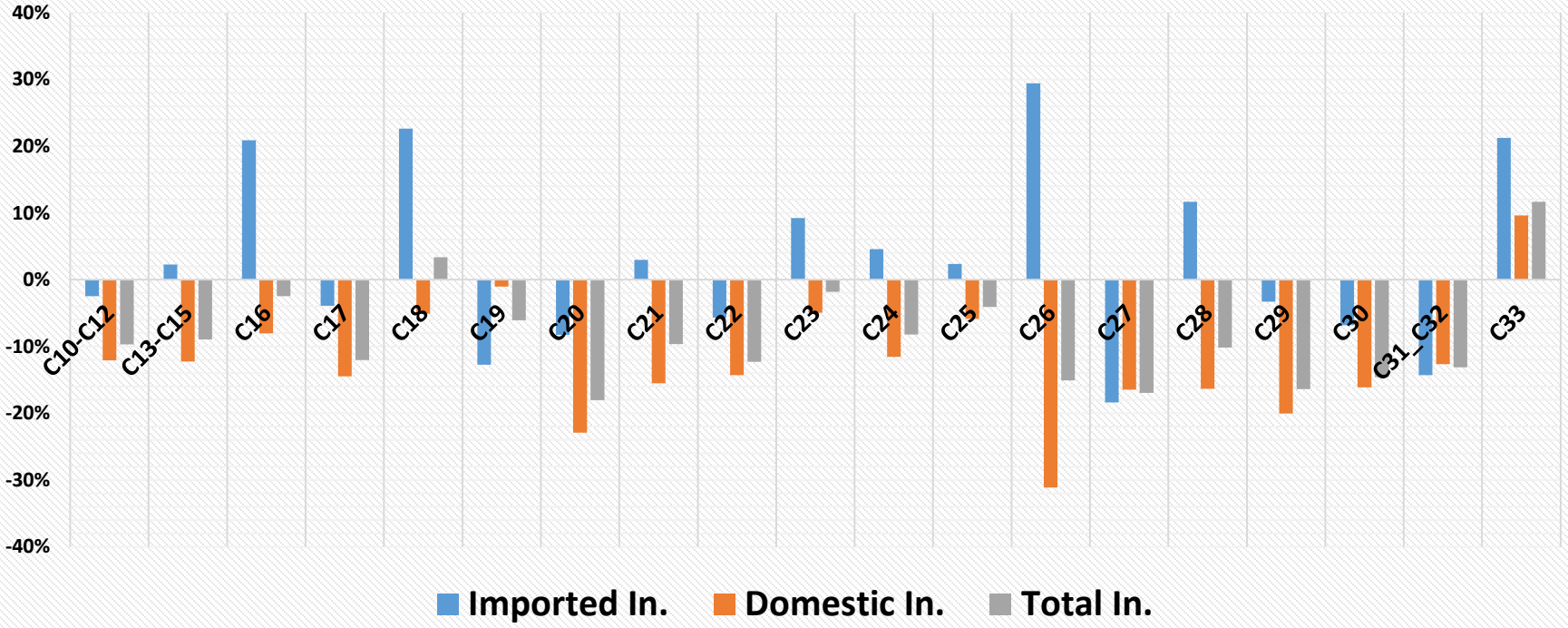
Descriptive statistics

Increasing imported intangibles before the crisis in all sectors (especially in low tech sectors)

Intangibles' intensity growth per (aggregate at the country level) sector (pre-crisis, 2000-2007)

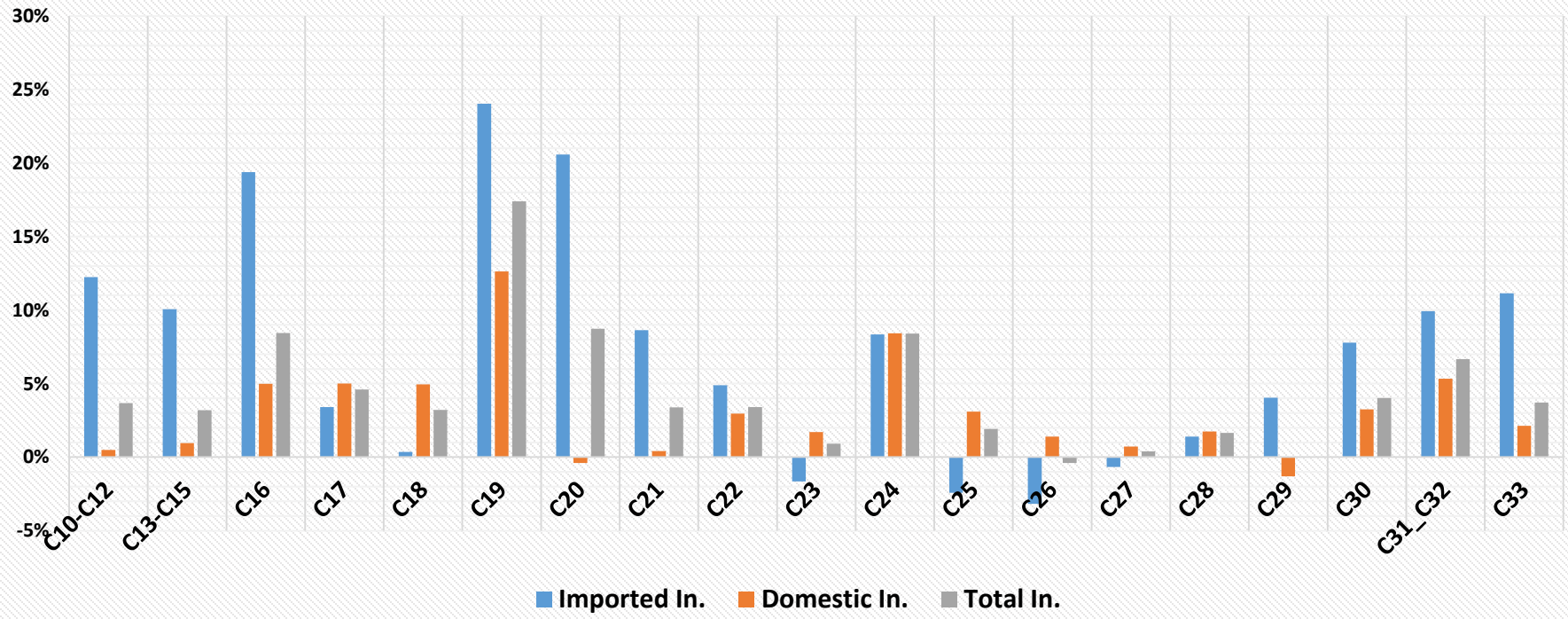
Decrease of intangibles during the crisis

Intangibles' intensity growth per sector (during the crisis, 2008-2010)



Rebound of intangibles, especially imported

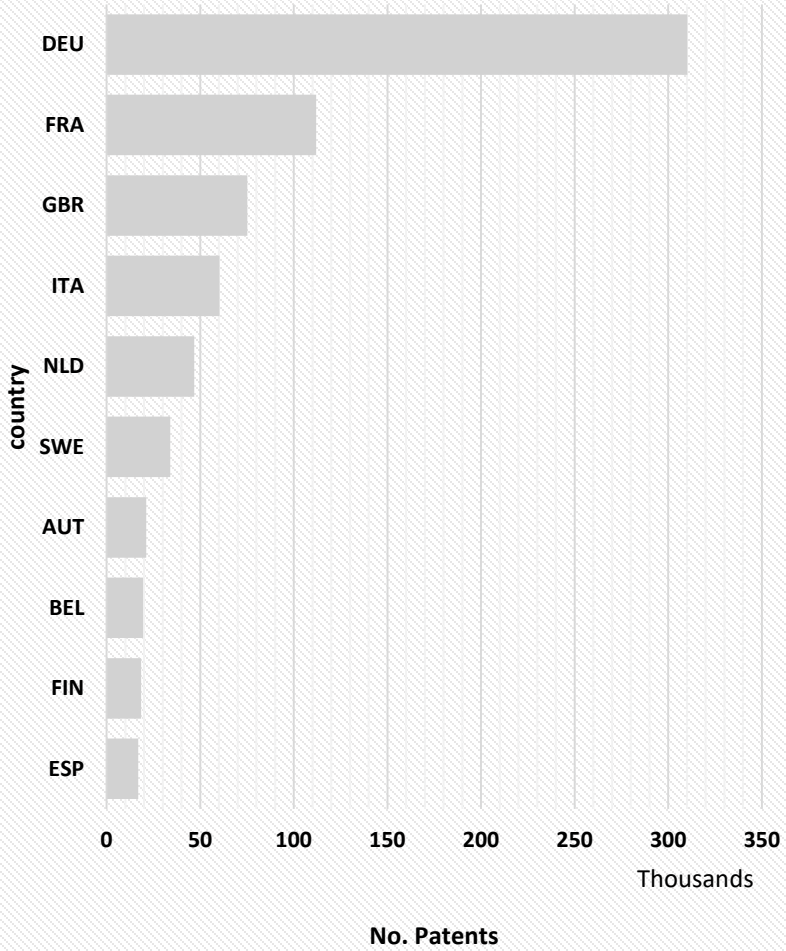
Intangibles' intensity growth per sector (post crisis period, 2011-2014)

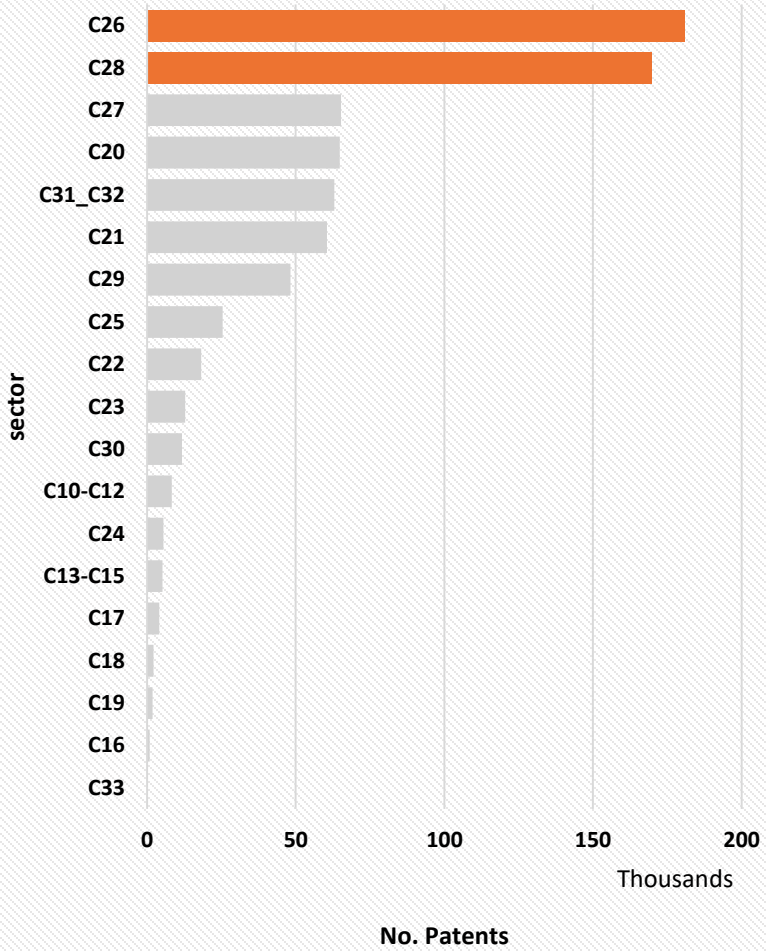


Remarks on intangibles intensity

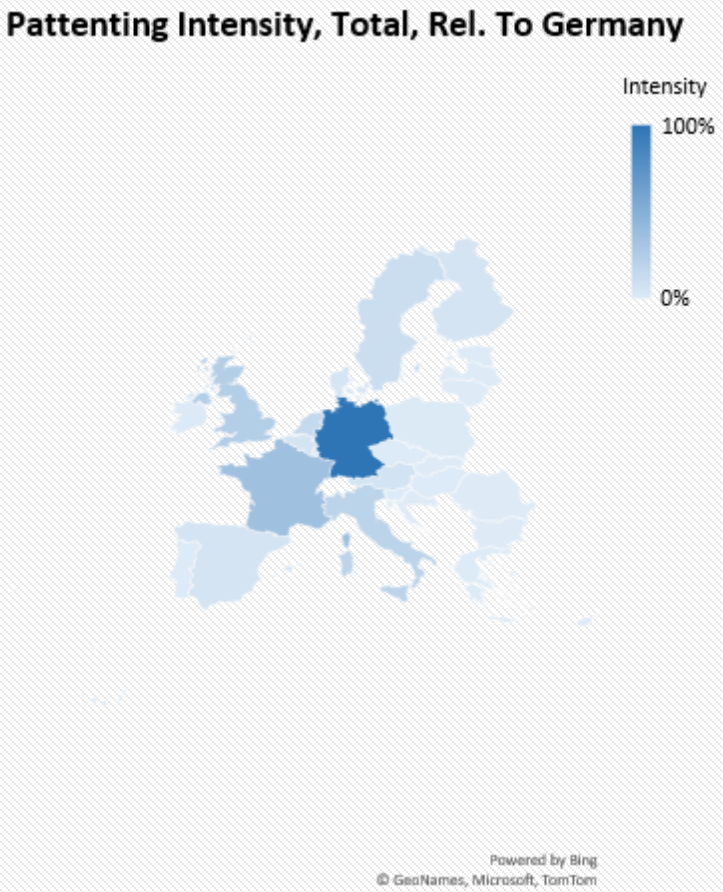
- Overall intangibles intensity is on a rise in the pre-crisis period
- Sharp drop in intangibles intensity growth during the crisis to rebound in the "*post crisis*" period
- Imported intangibles are constantly on a rising a trend → **inter-country intangibles trade**
- Different cases for each manufacturing industry → **intangibles intensity closely related with industry specific characteristics**

Cumulative pattenting activity per country and per sector





Technological asymmetry between different countries



- Intellectual property is concentrated in innovative manufacturing sectors from headquarter (a la Baldwin and Lopez Gonzalez, 2015) economies.
- Control of intangibles enables the production network coordination
- Knowledge and technology asymmetry between the manufacturing activities of *different countries*

➢ ***Need for separate case studies of the specialization patterns***

A taxonomy based on the knowledge content of production and innovation performance

Innovators

- France
- The Netherlands
- Sweden
- Germany
- Finland
- Denmark
- The United Kingdom
- Italy
- Austria
- Belgium

Assemblers

- Ireland
- Hungary
- Slovenia
- Spain
- Greece
- Portugal
- Estonia
- Poland
- Croatia
- Romania
- Latvia
- Czech Republic
- Slovakia
- Bulgaria
- Lithuania

- Taxonomy based on a simple (weighted) innovation score
- We weight aggregate patent intensity with 0.7 and total intangibles' intensity with 0.3 as ***Innovators*** should be classified mainly based on their actual innovation outcome (patent applications) compared to their knowledge inputs.

Correlations

Methodology

Correlations between the variables of interest in an approach organized as follows:

1. Pearson correlations of domestic, imported, and total intangibles' intensity for each EU-27 and UK manufacturing sector with:
   - ✓Patent applications to EPO per sector.
   - ✓Specialization at the sector level.
   - ✓Backward participation in GVCs at the sector level.
2. Pearson correlations of patent applications to EPO from each of the EU's and the UK's manufacturing sector with:
   - ✓Specialization at the sector level.
   - ✓Backward participation in GVCs at the sector level.

Main results regarding intangibles' intensity

- **Total intangibles** have a **positive** correlation with **sector specialization**
- **Domestic** (and not imported) **intangibles** are **positively** correlated with **patent applications**
- **Imported intangibles** are **positively** correlated with **backward participation in GVCs**
  - But domestic intangibles have a negative correlation

Heterogeneity across sectors (and without taking into account the country factor)

Main results regarding patent applications

- **Patents** are **positively** correlated with sector **specialization**
- Ambiguous results in terms of robustness for backward participation in GVCs and patents
  - Heterogeneity across sectors
  - Weak significance in most cases

Simple panel regressions

Model specification and variables

- Simple panel regressions to test the joint effect of intangible inputs, GVC participation and innovation on sector specialization.
- Estimation method: Fixed effects estimators with Driscoll-Kray (1998) robust std. errors.
- Variables taken in natural logarithms.
- Three different samples: Total, ***Innovators*** and ***Assemblers***
- Model specification:

$$Sp_{i,c,t} = \alpha_0 + \boldsymbol{X_{i,c,t}}\beta_1 + \lambda_i + \lambda_c + \lambda_t + \varepsilon_{i,c,t}$$

with

$$\boldsymbol{X_{i,c,t}} = (t_{i,c,t}^{INTAN}, d_{i,c,t}^{INTAN}, i_{i,c,t}^{INTAN}, B_{i,c,t-1}^{GVC}, p_{i,c,t}, k_{i,c,t}, s_{i,c,t}, M_{c,t})$$

Variable description

Variable	Description
$t_{i,c,t}^{INTAN}$	Total intangibles intensity (i.e., share of inputs to total int. consumption)
$d_{i,c,t}^{INTAN}$	Domestic intangibles intensity (i.e., share of domestic inputs to total int. consumption)
$i_{i,c,t}^{INTAN}$	Imported intangibles intensity (i.e., share of imported inputs to total int. consumption)
$B_{i,c,t-1}^{GVC}$	Backward participation in GVCs lagged by one period
$p_{i,c,t}$	Patent intensity (as the share of patent applications to total output)
$k_{i,c,t}$	Capital stock intensity (as the share of capital stock to total output)
$s_{i,c,t}$,	Sector size (as the share of its sectors VA compared to the VA of its aggregate domestic manufacturing sector)
$M_{c,t}$	GDP per capita growth at the country level
$\lambda_i, \lambda_c, \lambda_t$	Industry, country and time fixed effects

Main empirical results

- Total intangibles' intensity has a positive and statistically significant contribution to sector specialization, especially for the ***Innovators*** sample → a priori knowledge intensive manufacturing industries benefit more from knowledge inputs in terms of specialization.
- Imported intangibles provides the positive and statistically significant contribution to sector specialization.
- Domestic intangibles appear to be rather insignificant.
- The contribution of intangibles to the specialization of the ***Assemblers*** sample is negative → traditional, large-scale production industries rely on different factors of production for specialization gains.
- Patent intensity has a positive and statistically significant effect on all three samples → innovation is important for specialization gains regardless of a priori orientation.
- Backward participation in GVCs has a negative effect on sector specialization on the full sample and the ***Innovators*** sample → disproportionate shares of foreign VA do not benefit each sector's specialization.
- Poor fitting of the model specification on the **Assemblers** sample → unobserved determinants of specialization.

Conclusions and policy discussion

Concluding remarks

- This study provides a significant contribution to the emerging field of the exploration of the dissemination of knowledge in GVCs.
- The novel I-O framework for the quantification of intangibles embeds them within the GVC context.
- **Intangibles' trade is on the rise** and provides evidence of a significant **increase in the knowledge content of production** for the EU's and the UK's manufacturing industries.
- Formation of **resilient cross-country knowledge linkages** that appear to be unaffected by the economic crisis.
- The **novel origin dichotomy** provides significant insights towards the better understanding of the linkage between intangibles, innovation and sector specialization in GVCs.
  - **Imported intangibles** have a positive link with **sector specialization**.
  - **Domestic intangibles** are related with **innovation**.
- There is a significant heterogeneity among different sectors and different countries that calls for country/sector specific case studies.

Policy implications

- The formulated domestic and international knowledge linkages outline the formation of local and international knowledge transfer networks.
- The dissemination of knowledge relies in strong user (manufacturing industries)-producer (KIBS industries) interactions.

Critical elements of national and international innovation systems *(Lundvall, 2010; Binz and Truffer, 2017).*

➢Our results consolidate the basis for a discussion revolving around industrial and innovation policy at the national and regional (EU) level.

➢Main focus: the co-development of manufacturing and services

Thank you for your attention.

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