



TECHNOLOGY AND INNOVATION REPORT 2023

Opening green windows
*Technological opportunities
for a low-carbon world*

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**Pathways to more
complex and sustainable
production**

Content

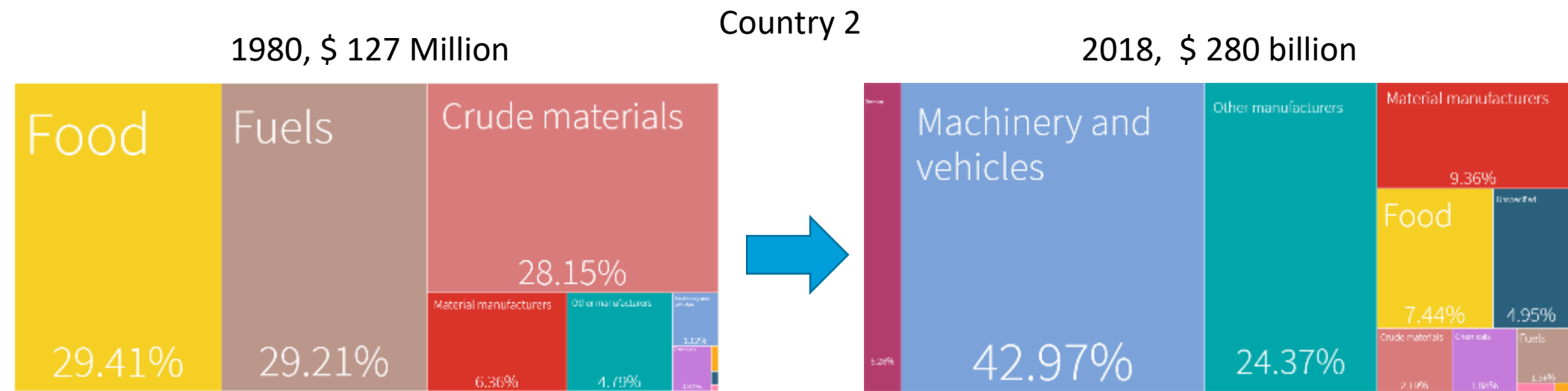
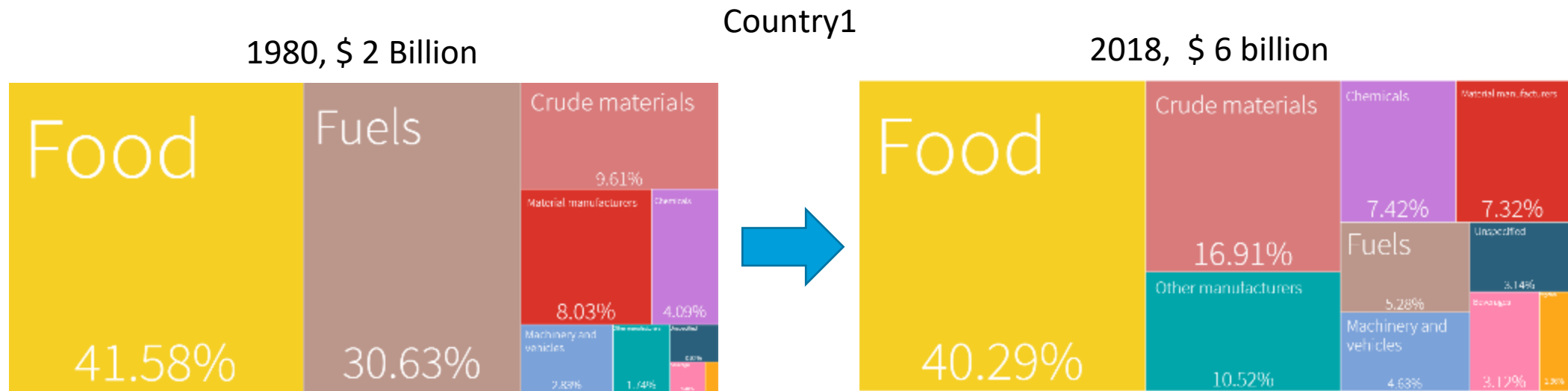
- The importance of economic diversification
- Economic development: diversification towards complex products
- Identifying complex and greener paths

The Importance of Economic Diversification

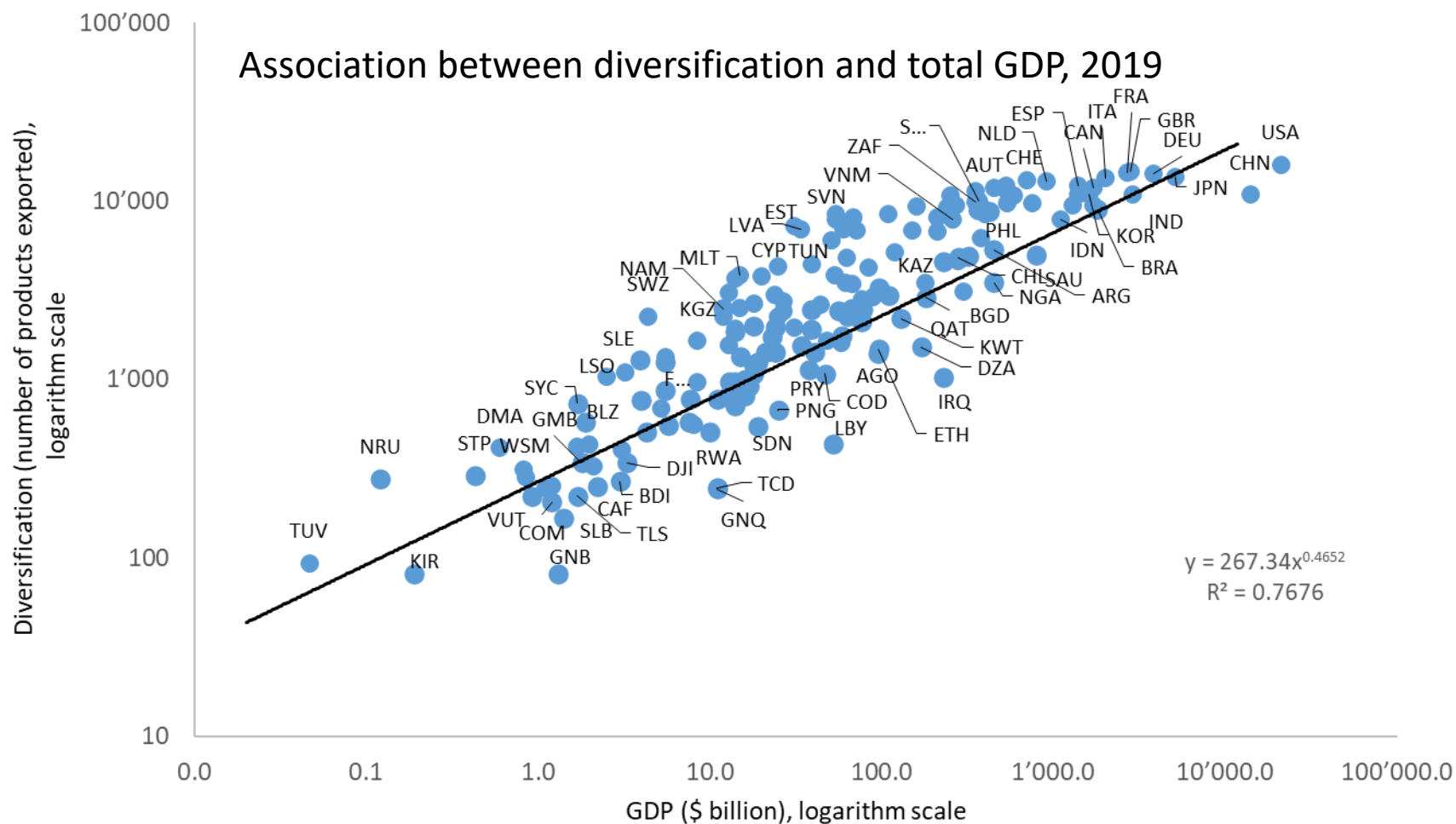
Advantages

- Reduce vulnerability to commodity price volatility
- Mitigate revenue dependency
- Encouraging the sustainable development of countries dependent on primary products
- Promoting employment opportunities and skills development
- Promoting innovation and technological advancement
- Strengthening economic resilience and long-term growth

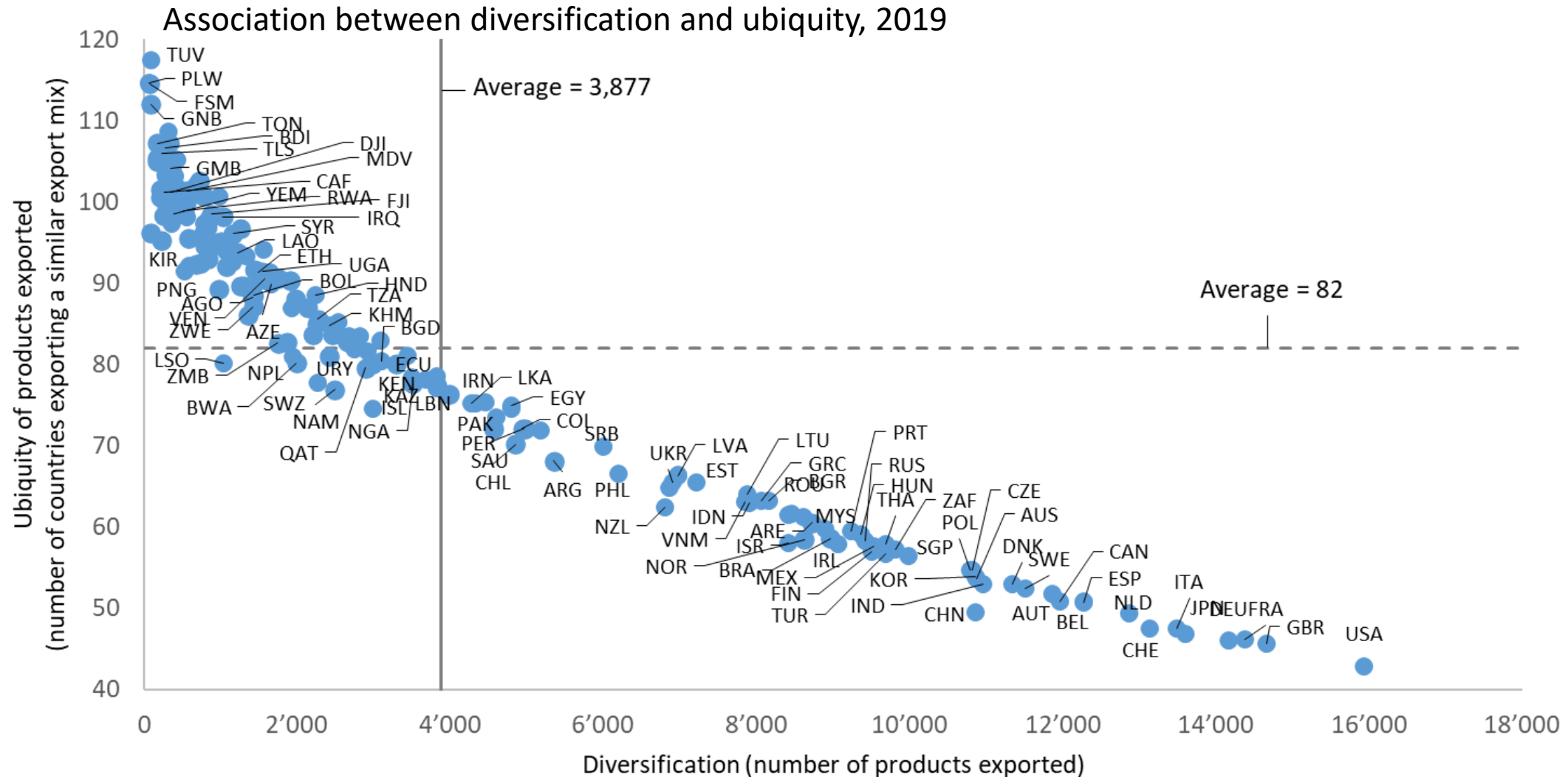
Diversification and international trade



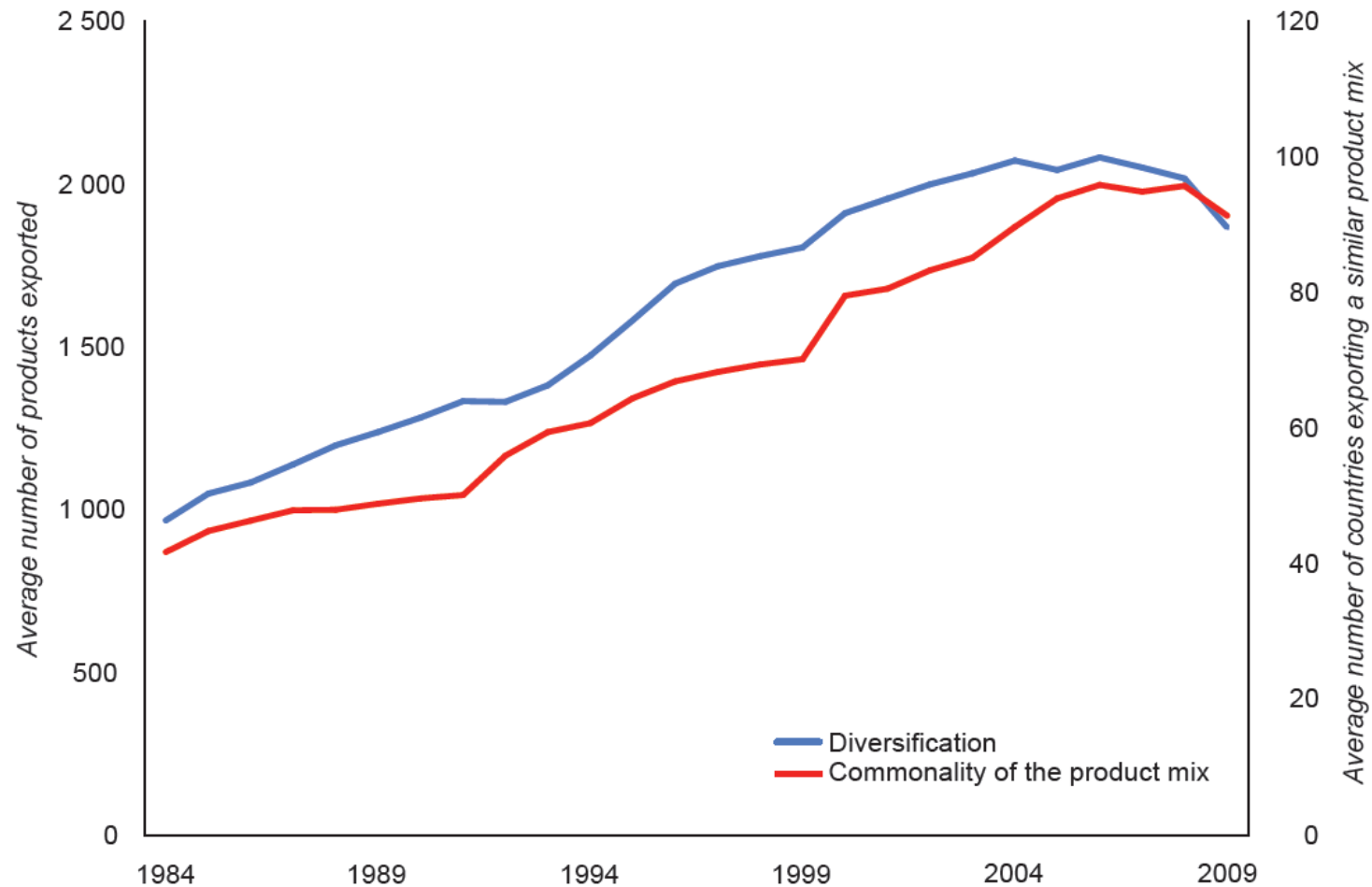
Higher total GDP is associated with diversification



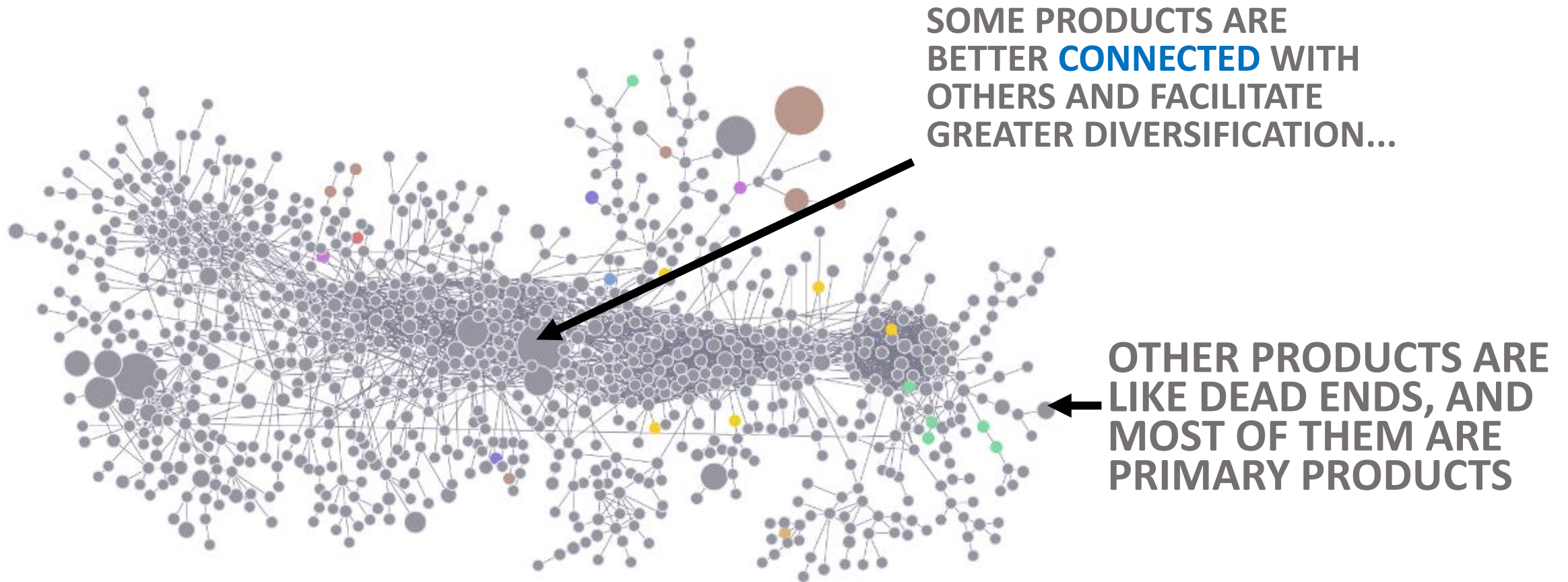
As economies diversify, they produce more unique products with reduced competition



Increasing diversification and competition: “..It takes all the running you can do, to keep in the same place”



diversification depends on the path...

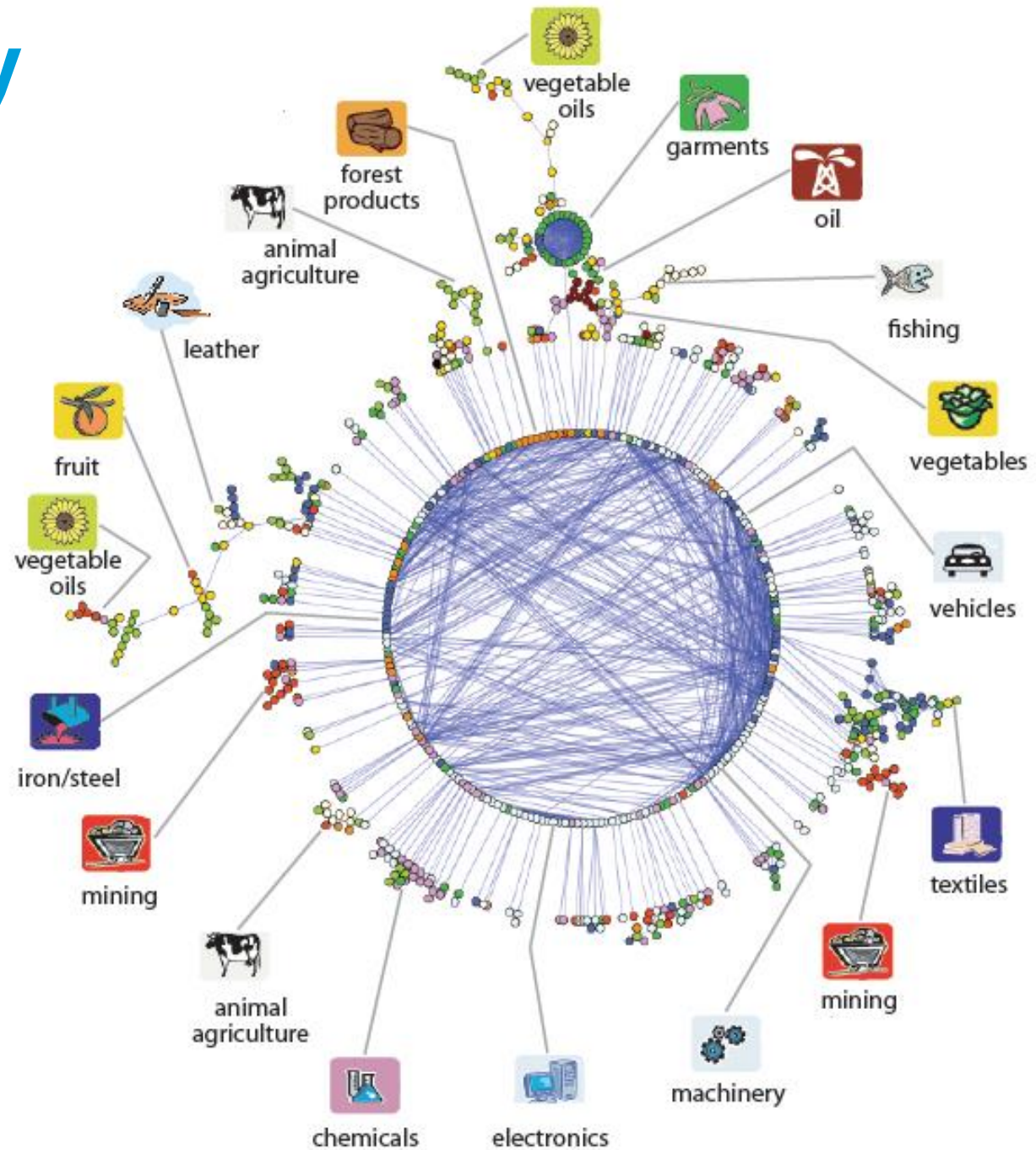


The product space that displays the products connected to each other based on the probability that they will be exported together

Path dependency

(Hidalgo, Klinger, Barabási, Hausmann 2007. The Product Space Conditions the Development of Nations.)

- What a country produces today affects what it will be able to produce tomorrow

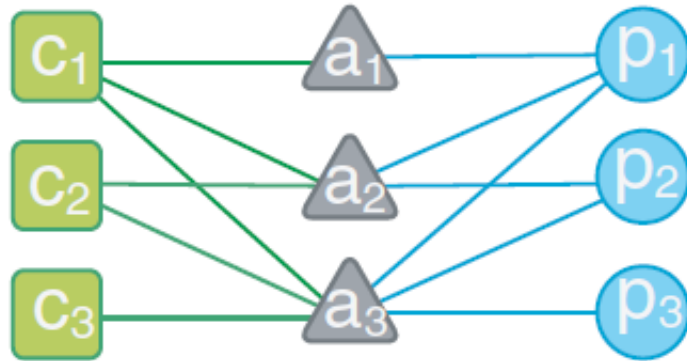


Economic development: diversification towards complex products

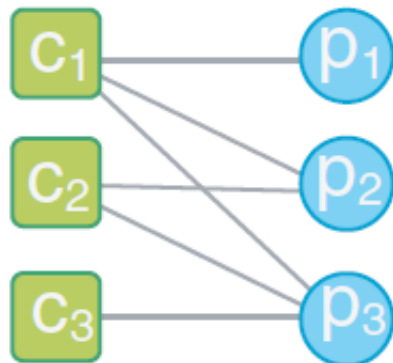
Technologies: Product complexity

(Hausmann and Hidalgo, 2010)

Countries Capabilities Products



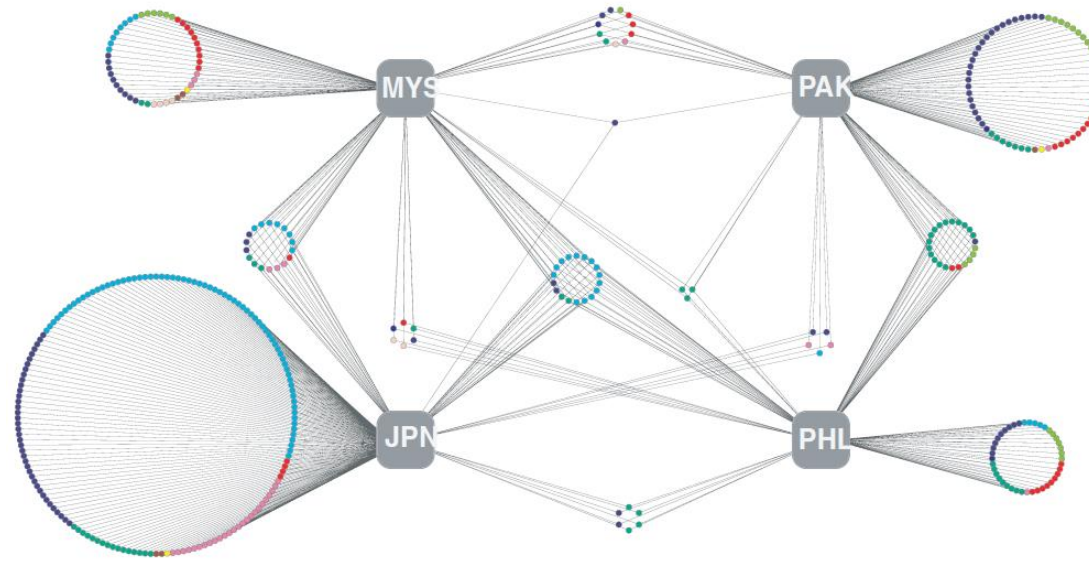
Countries Products



- Products require specific combinations of capabilities to be produced
- Countries have some capabilities but not others
- Countries will produce goods as long as they have all the required capabilities

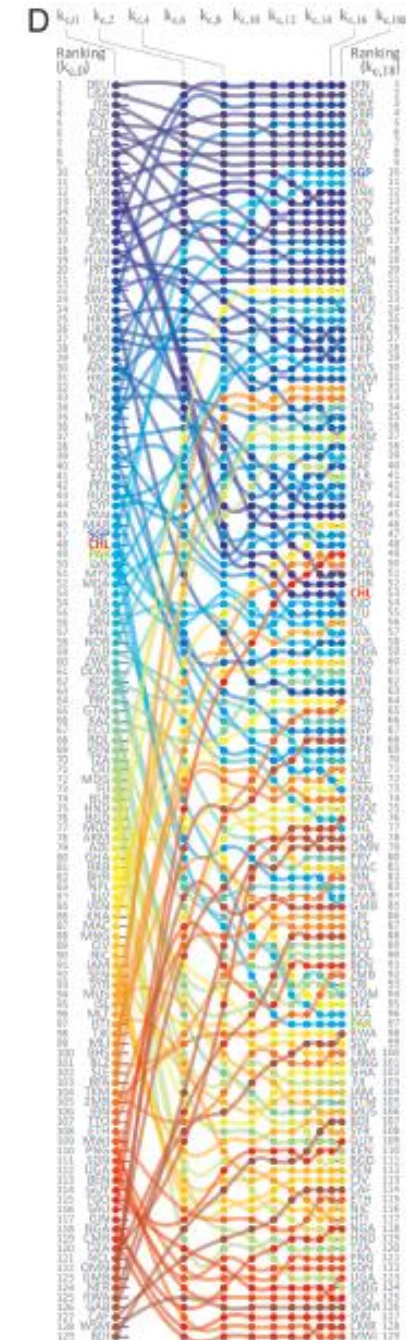
Method of reflections

Hidalgo and Hausmann (2009). *The building blocks of economic complexity.*

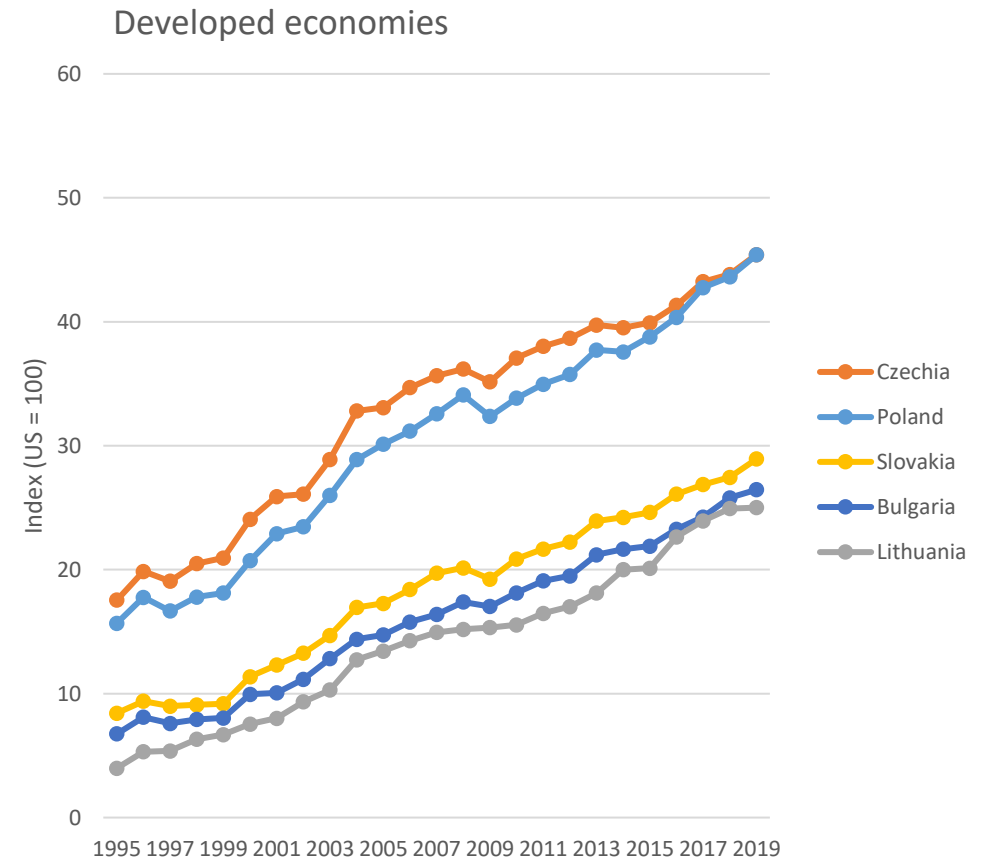
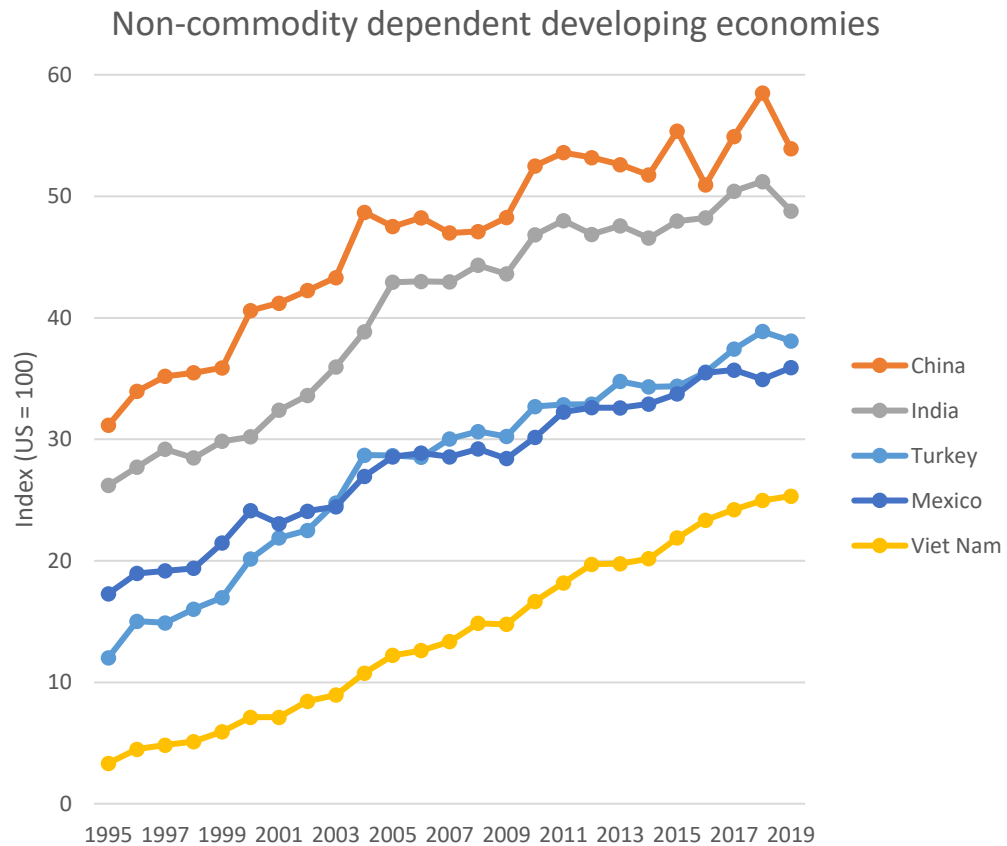


Definition	Working Name	Description: Short summary Question Form
$k_{a,0}$	Diversification	Number of products exported by country a . How many products are exported by country a ?
$\kappa_{\alpha,0}$	Ubiquity	Number of countries exporting product α . How many countries export product α ?
$k_{a,1}$	$k_{c,1}$	Average ubiquity of the products exported by country a . How common are the products exported by country a ?
$\kappa_{\alpha,1}$	$k_{p,1}$	Average diversification of the countries exporting product α . How diversified are the countries that export product α ?
$k_{a,2}$	$k_{c,2}$	Average diversification of countries with an export basket similar to country a . How diversified are countries exporting goods similar to those of country a ?
$\kappa_{\alpha,2}$	$k_{p,2}$	Average ubiquity of the products exported by countries that export product α . How ubiquitous are the products exported by product's α exporters?

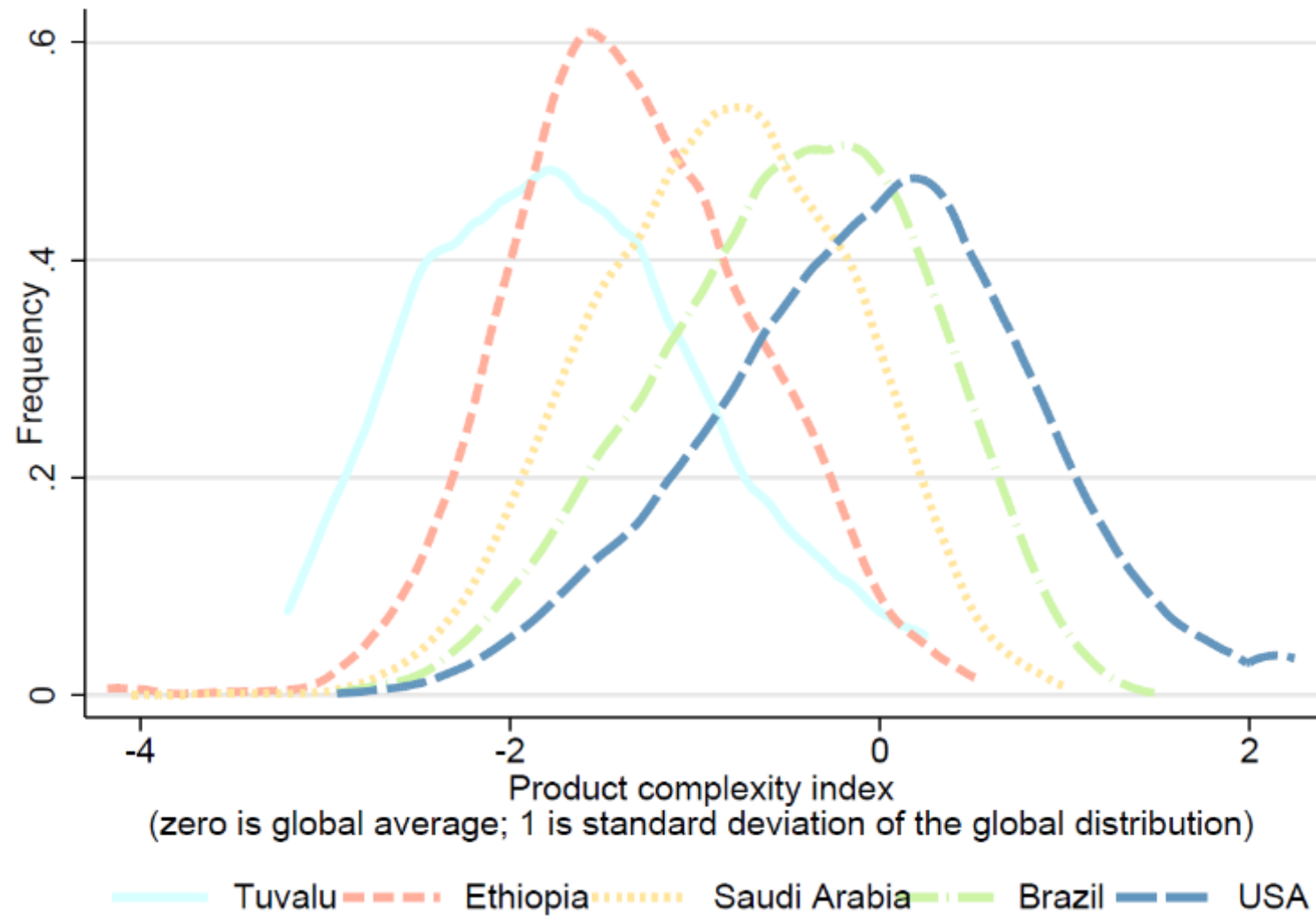
Source: Hidalgo and Hausmann (2009)



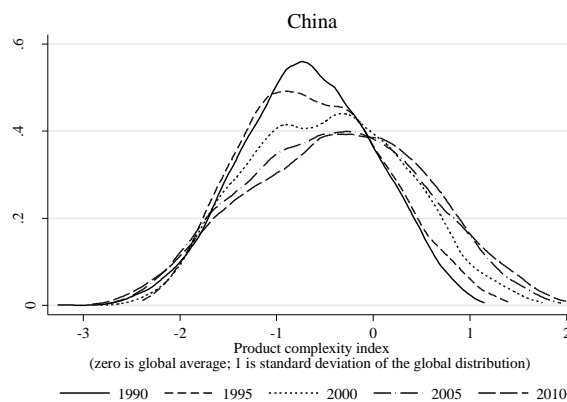
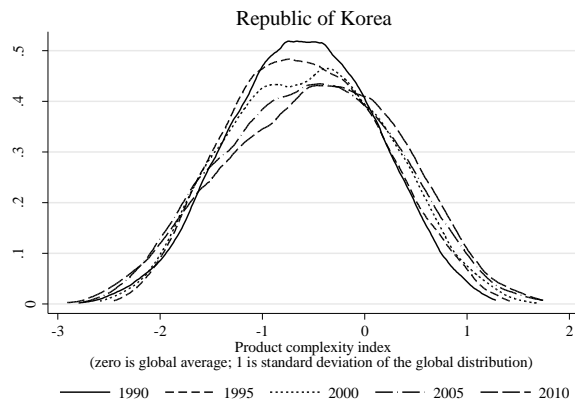
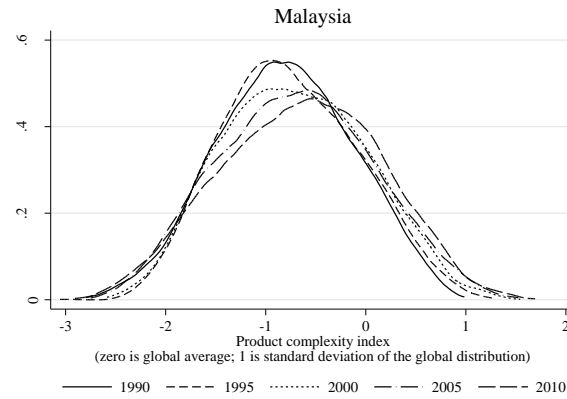
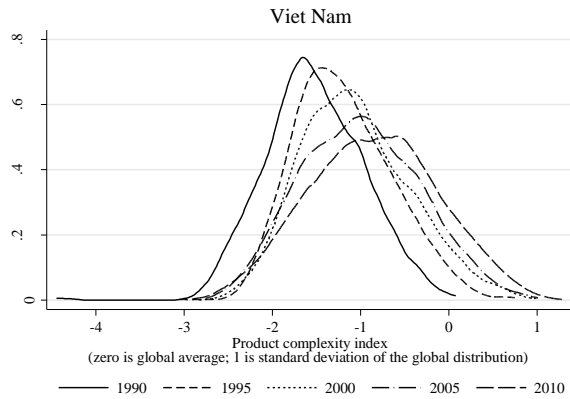
Productive/Technological Capacity



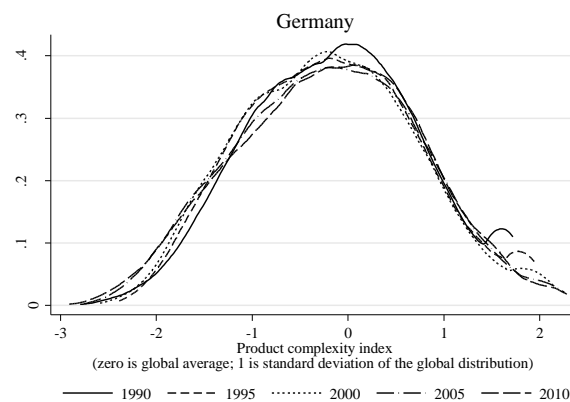
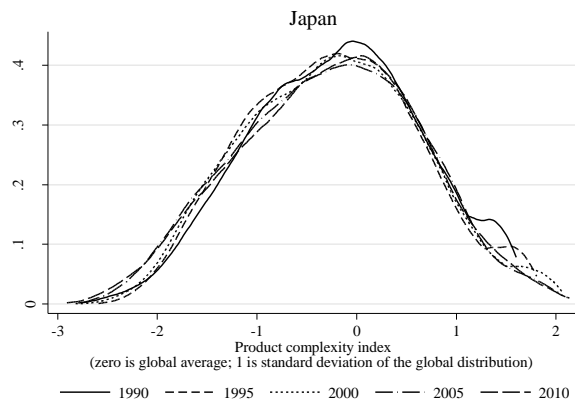
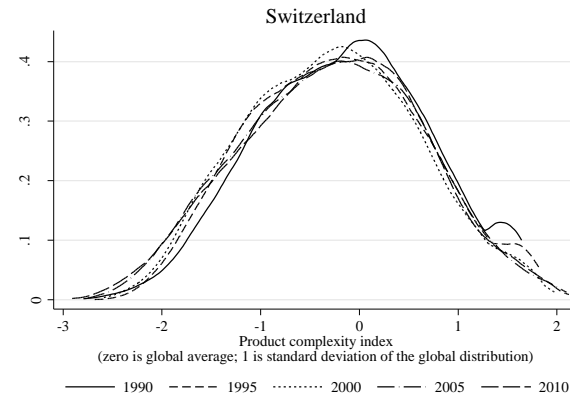
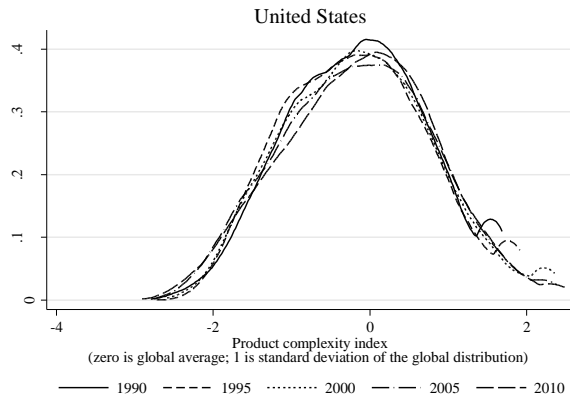
A country exports products within a wide range of complexity



Source: Freire(2017).Diversification and structural economic dynamics.

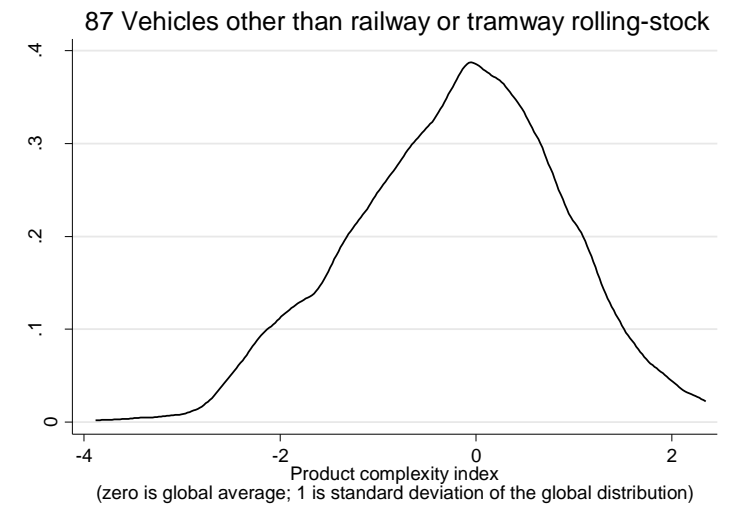
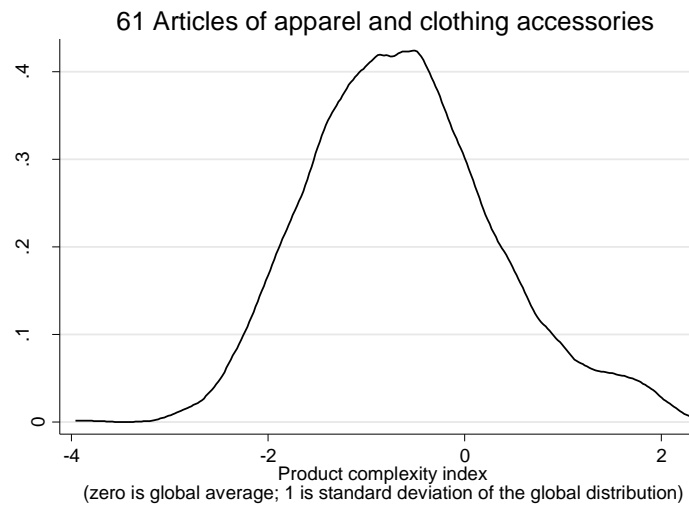
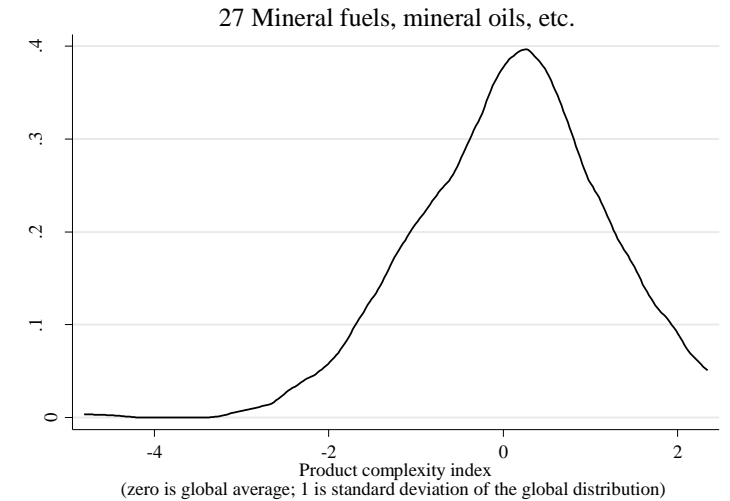
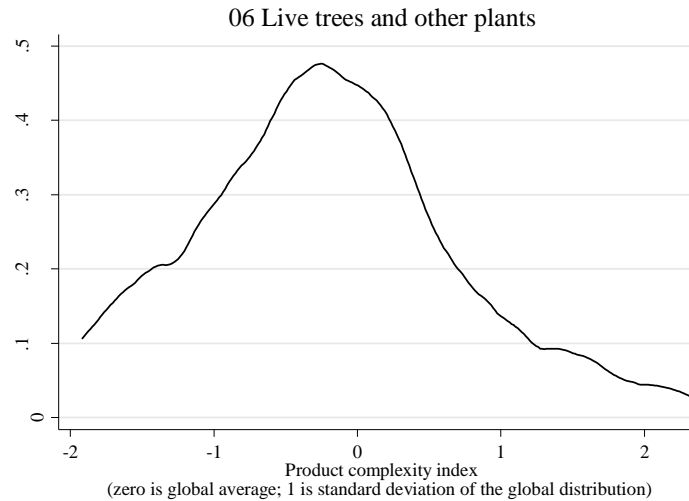


As economies develop and diversify, they tend to add more complex exports

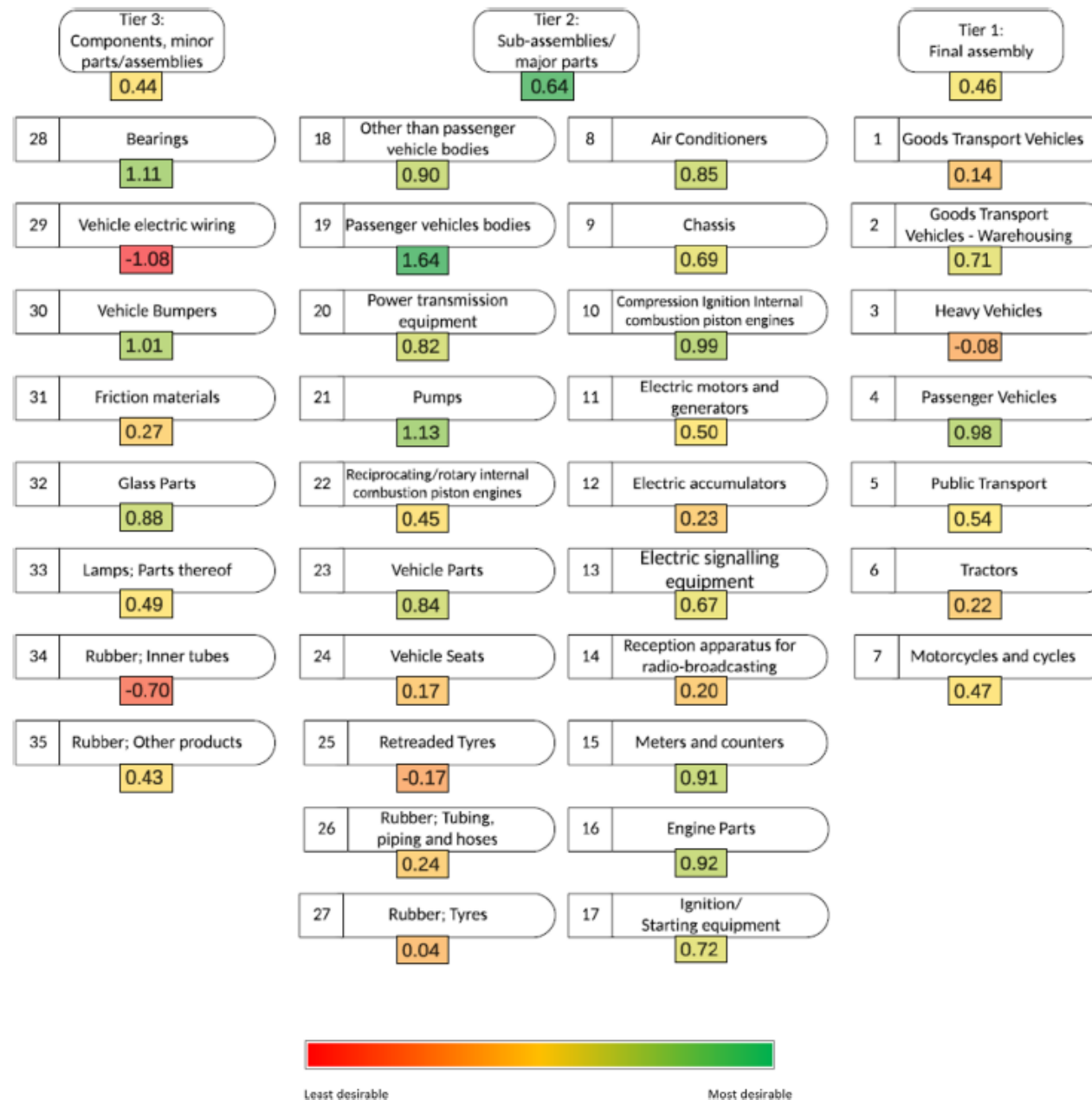


Countries at the technological frontier: a greater emphasis on the production and export of more complex products

What matters in terms of product complexity is not the broad classification of the industry, but the individual products within the industry



What matters in terms of product complexity is not the broad classification of the industry, but the individual products within the GVC



Identifying complex and greener paths

Relation between complexity and environmental outcomes

- Limited literature & mixed results
- Inverted U-Shaped Relationship with CO₂ Emissions
- Depend on the environmental measures used in the analysis
 - Complexity reduces greenhouse gas emission intensity (Romero and Gramkow, 2021)
 - Complexity results in better overall ecological performance as measured by the Environmental Performance Index (EPI) (Kosifakis et al., 2020)
 - But complexity reduces air quality (Boleti et al., 2021)
 - Complexity harms the ecological footprint (Neagu, 2020; Rafique et al., 2021; Ylanci and Pata, 2020; Neagu, 2021)
- Depend on the level of development of countries
 - Higher carbon emissions but limited environmental degradation in high-income economies (Neagu and Teodoru, 2019; Dogan et al., 2019)
 - Negative impact on environmental quality in emerging economies (Ahmad et al., 2021)
 - Positive impact on carbon emissions in low-emission economies (Majeed et al., 2021)

Identifying greener production

	TIR 2023	Mealy and Teytelboym, 2020	Romero and Gramkow, 2021
Countries	233 economies	122 economies	67 countries (147 countries to calculate RCA)
Products	> 43,000 products (HS 6-digit disaggregated by unit value)	543 “green” products + 57 renewable energy products	786 products (SITC rev2 4-digit)
Period	1995-2018	1995-2014	1976-2012
Method	Index of carbon emission: Method of reflections but no RCA, use all information for calculation, $Kc,0$ as the carbon emission per capita (or carbon emission per GDP)	Green complexity index: Sum of product complexity of green products (HH method)	Product emission intensity index: weighted average of GHG emissions intensity of products exported with RCA (weights are the product’s share in total country’s exports)

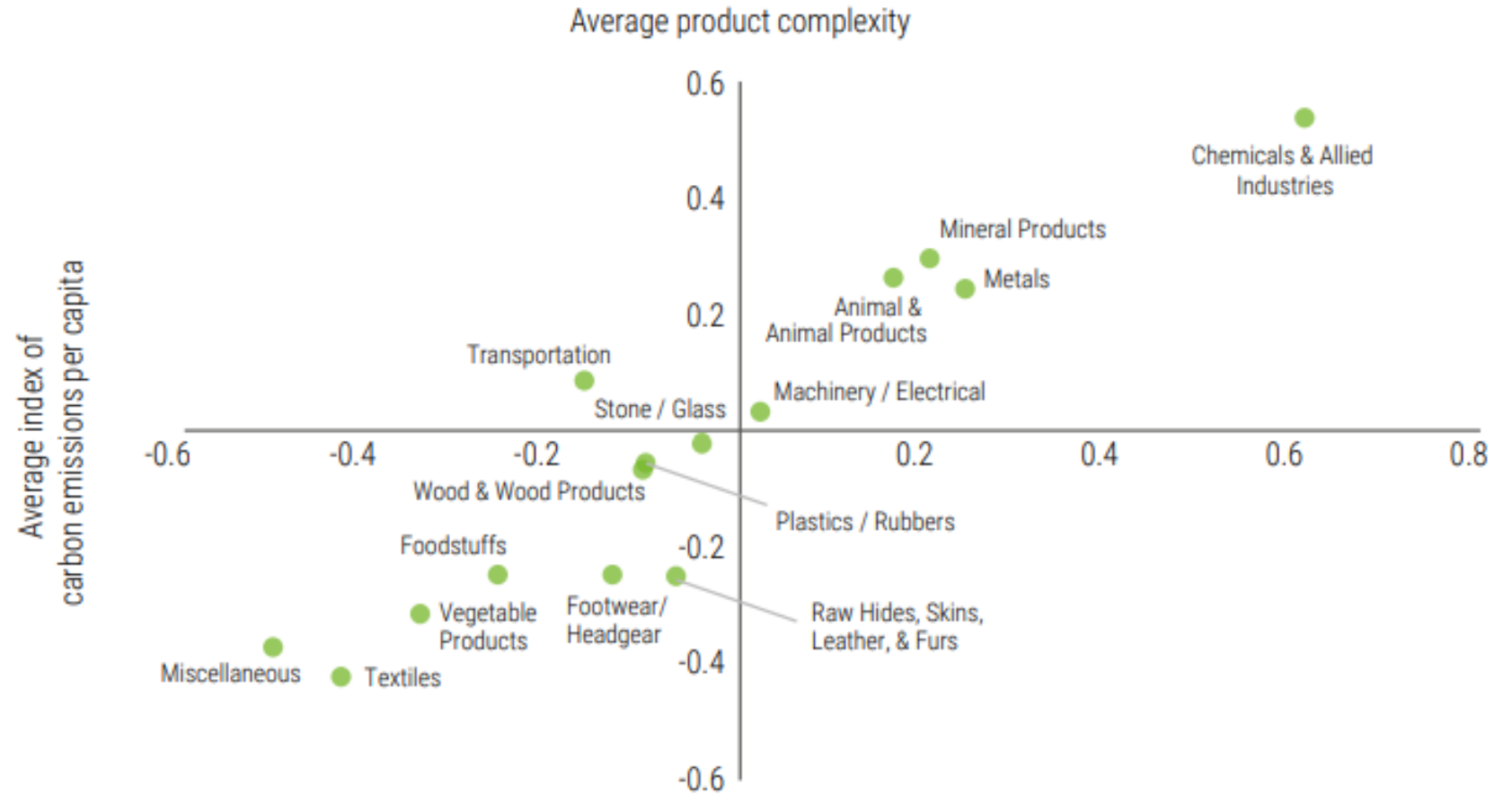
It is not intuitive to identify the products that are at the same time more complex and greener

Description	complexity	co2gdp	co2pc
(520291) Garnetted stock of cotton, \$145-211	2.41	-1.50	-0.04
(540331) Yarn of viscose rayon, single untwisted nes not retai, \$321-1234	2.41	-1.50	-0.04
(842330) Constant weight scales, including hopper scales, \$417709+	2.41	-1.50	-0.04
(810810) Titanium, unwrought, waste or scrap, powders, \$4678+	2.41	-1.50	-0.04
(720943) Cold rolled iron or non-alloy steel, flat, width >600mm, t 0.5-1mm, nes, \$13-14	2.41	-1.50	-0.04
(845819) Horizontal lathes nes for metal, \$317867+	2.41	-1.50	-0.04
(180320) Cocoa paste wholly or partly defatted, \$105-331	2.41	-1.50	-0.04
(520535) Cotton yarn >85% multiple uncombed <125 dtex, not ret, \$45-61	2.41	-1.50	-0.04
(845310) Machinery to prepare, tan, work hides, skins, leather, \$114096-158773	2.41	-1.50	-0.04
(270400) Coke, semi-coke of coal, lignite, peat & retort carbo, \$15-31	2.41	-1.50	-0.04
(160416) Anchovies, prepared or preserved, not minced, \$206+	2.41	-1.50	-0.04
(580429) Mechanical lace, other material (piece, strip, motif), \$891-948	2.41	-1.50	-0.04
(700232) Tubes of low expansion glass (Pyrex etc), \$862-906	2.25	-2.01	-0.14
(961320) Pocket lighters, gas-fuelled, refillable, \$414-463	2.25	-2.01	-0.14
(631010) Used or new rags textile material, sorted, \$260+	2.14	-1.46	-0.00
(580639) Woven fabric materials nes, < 30 cm wide, \$446-555	2.13	-1.53	-0.03
(852210) Pick-up cartridges, \$5100-8966	2.09	-1.85	-0.06
(551221) Woven fabric >85% acrylic staple fibres, unbl/bleache, \$390-472	2.09	-1.85	-0.06
(950611) Snow-skis and parts, \$1505-1920	2.09	-1.84	-0.18
(911280) Clock, etc cases, except metal, \$3244-3894	2.09	-1.84	-0.18

OPENING GREEN WINDOWS

Technological opportunities for a low-carbon world

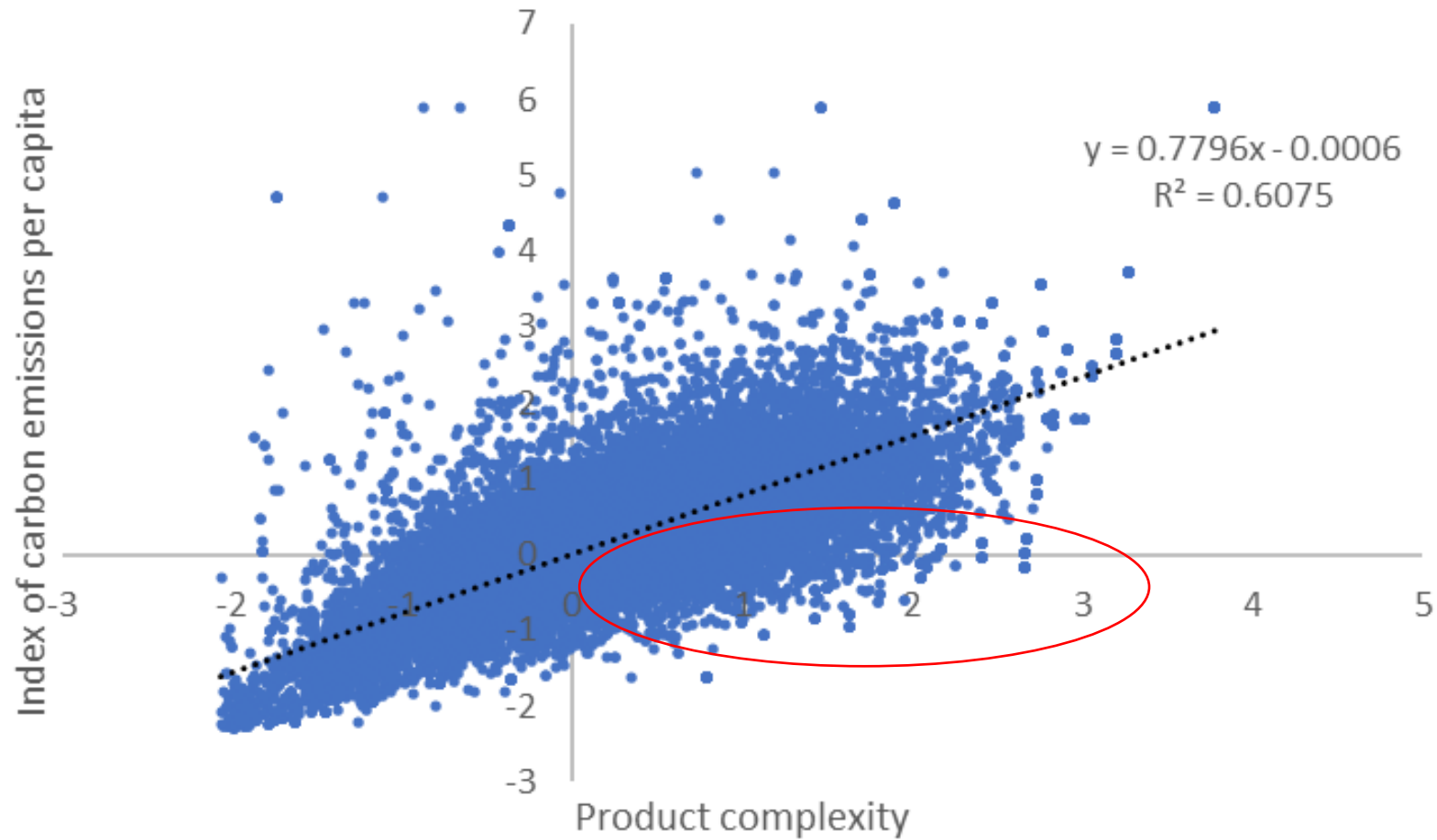
On average, more complex sectors are associated with higher emissions per GDP and per capita



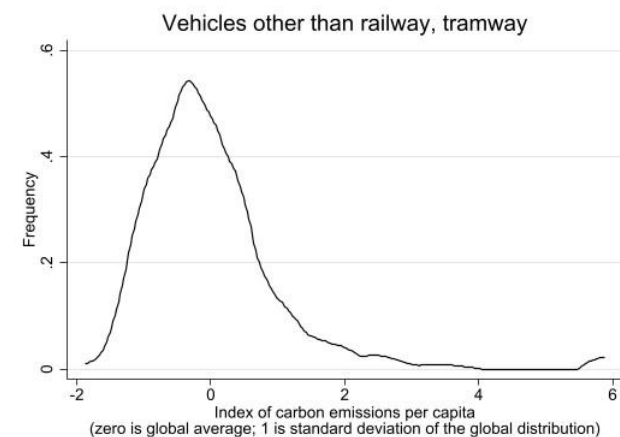
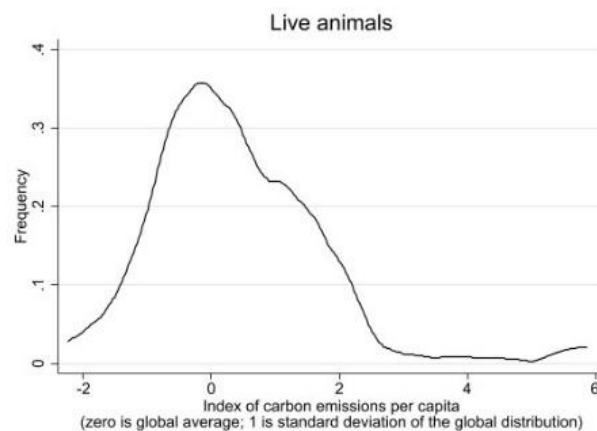
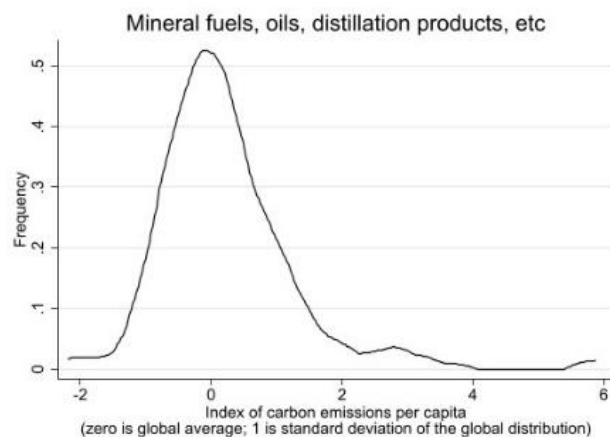
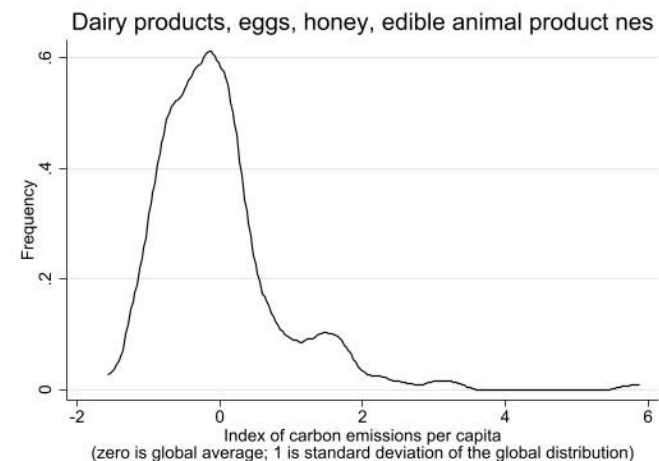
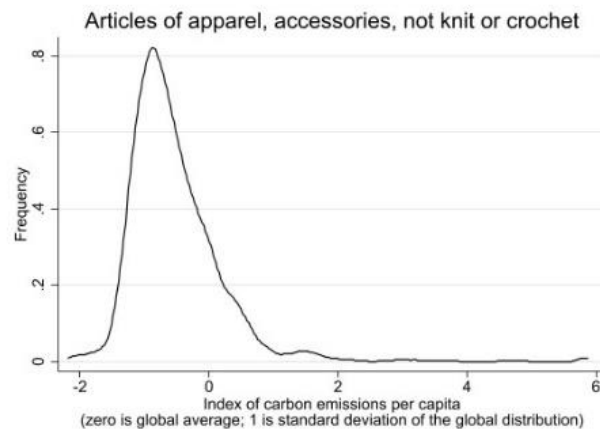
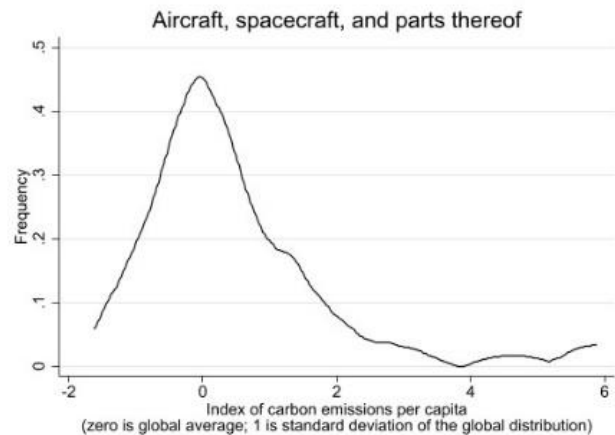
Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

Note: On both axes, zero represents the global average, and 1 is the standard deviation of the distribution.

But some complex products are associated with lower per capita and GDP carbon emissions



There is no particular 'broad' industry category is associated exclusively with higher or lower levels of carbon footprint

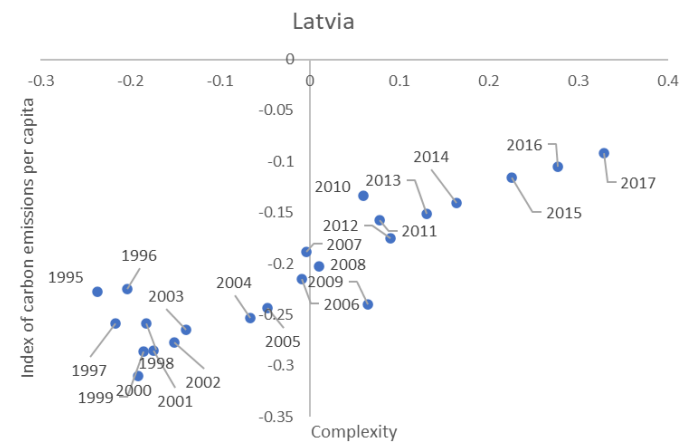
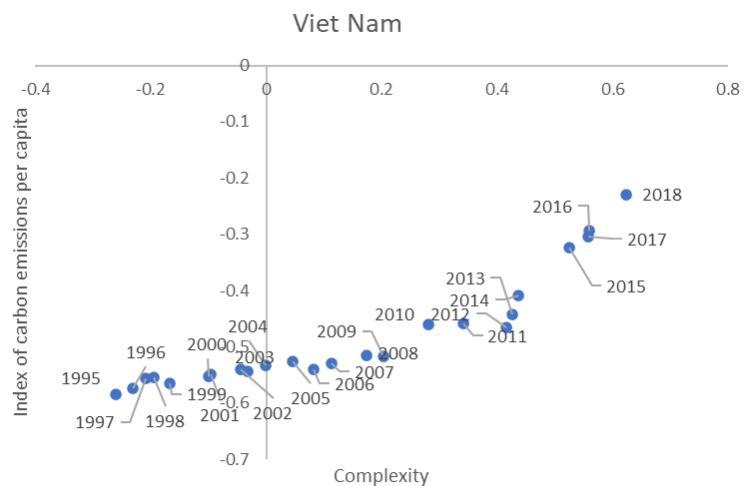


Limited evidence of past greener and more complex paths

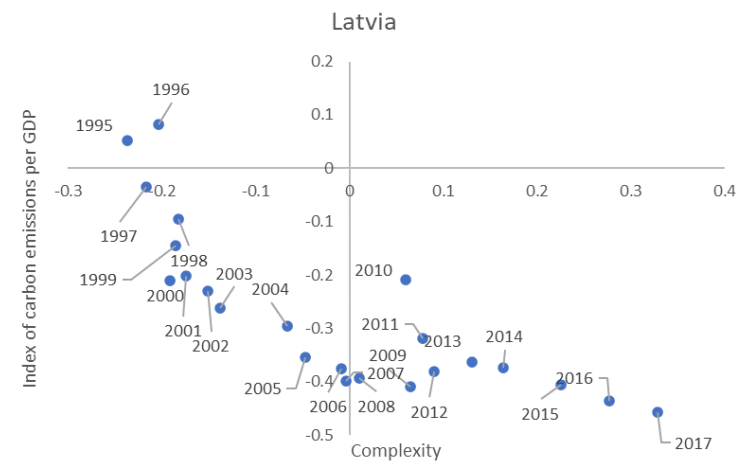
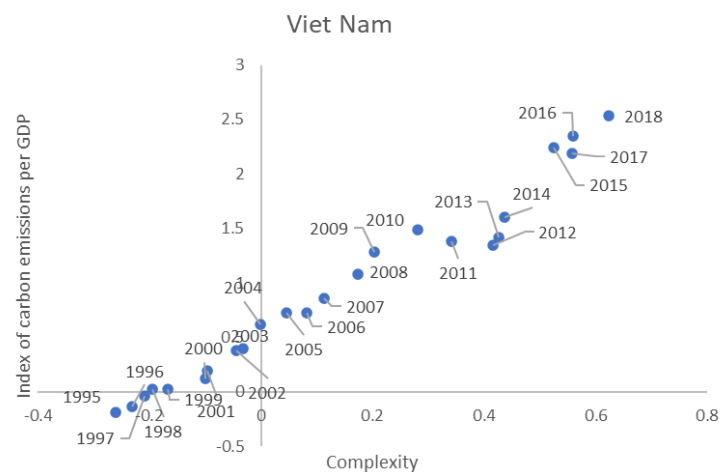


Latvia and Viet Nam

Carbon emissions per capita



Carbon emissions per GDP



Different approaches

Latvia

- Window of opportunity: Fast globalization and integration of GVCs & broader integration of Central and Eastern Europe (CEE) into the European Union
- Response: Prioritized the expansion of specific sectors (identify the binding constraints, supported by economic complexity and growth diagnostics frameworks)
- Key policy instrument: regional clusters & financial support of selected projects in priority areas

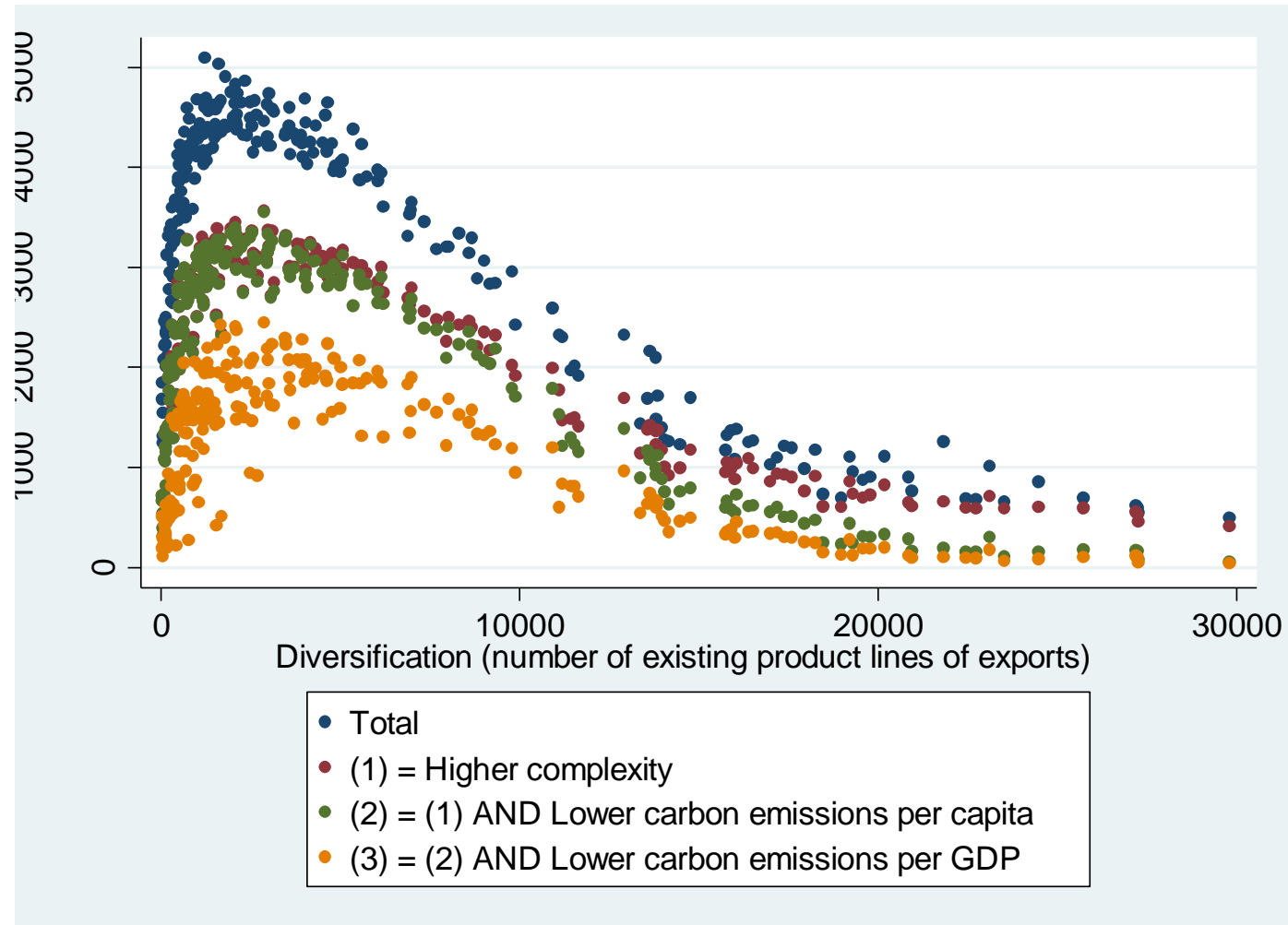
Viet Nam

- Windows of opportunity: Fast globalization and integration of GVCs & participation in international agreements, whether bilateral, plurilateral or membership of ASEAN, and WTO membership.
- Response: Special economic zones (SEZs) to attract FDI
- Key policy instrument: Special Economic Zones; 376 functioning zones in Viet Nam by the end of 2017

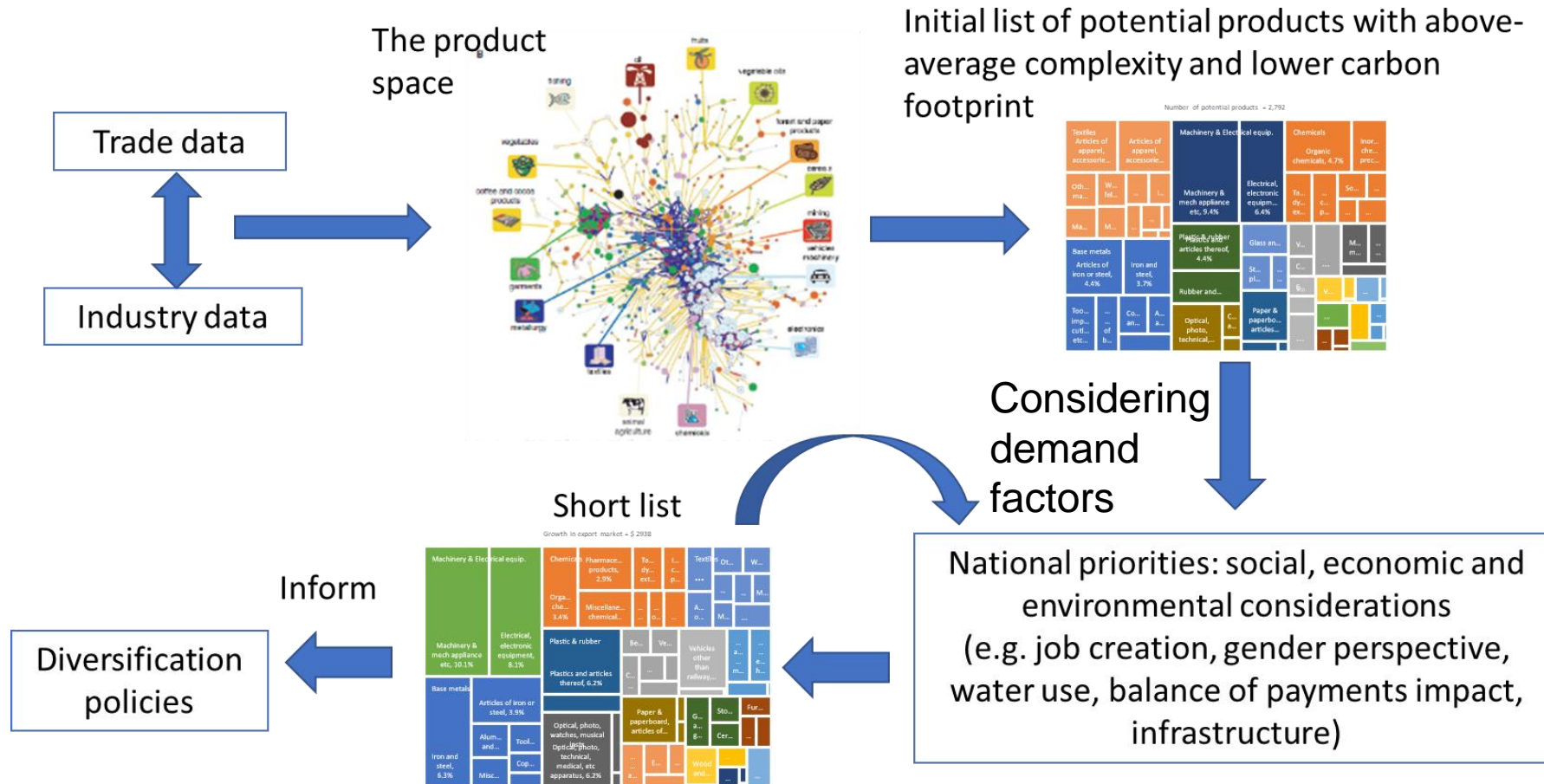
What affects the relationship between complexity and green indicators?

Variable	Impact on index of carbon footprint	Impact on complexity
Economic complexity	Reduce future index of carbon emission, with temporary increase; the moderating effect is stronger in developing countries	
FDI	Increase, particularly in developing countries	Increase
Trade openness	Reduce	Increase
Researchers in R&D (% of total)	Reduce	Increase
Research and development expenditures (% of GDP)	Increase, but the increasing impact decreases when a country enhances trade openness	Increase
Environmental policy stringency	Literature suggests an inverted U-shaped relationship	Increase
Energy intensity level of primary energy	Increase	Reduce
Electricity production from oil, gas and coal	Increase	Reduce

As countries diversify, the likelihood of further diversifying towards more complex and greener products change in a non-linear way



Developing countries need to build their capacities to identify potential new sectors for more complex and more sustainable diversification



Example: Angola

Exports to the World - Sector (HS code, 4 digits) Description	\$ Million
9013 - Liquid crystal devices not constituting articles provided for more specifically in other headings; lasers, not laser diodes; other optical appliances and instruments n.e.s. in this chapter	14,136
7208 - Iron or non-alloy steel; flat-rolled products of a width of 600mm or more, hot-rolled, not clad, plated or coated	6,937
3907 - Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and other polyesters, in primary forms	5,490
2707 - Oils and other products of the distillation of high temperature coal tar; similar products in which the weight of the aromatic constituents exceeds that of the non-aromatic constituents	5,264
9018 - Instruments and appliances used in medical, surgical, dental or veterinary sciences, including scintigraphic apparatus, other electro-medical apparatus and sight testing instruments	4,382
2933 - Heterocyclic compounds with nitrogen hetero-atom(s) only; nucleic acids and their salts	4,050
7210 - Iron or non-alloy steel; flat-rolled products, width 600mm or more, clad, plated or coated	3,691
1205 - Rape or colza seeds; whether or not broken	3,562
7225 - Alloy steel flat-rolled products, of a width 600mm or more	3,308
1001 - Wheat and meslin	3,066

Example: Angola

Exports to African countries - Sector (HS code, 4 digits) Description	\$ Million
7208 - Iron or non-alloy steel; flat-rolled products of a width of 600mm or more, hot-rolled, not clad, plated or coated	756
7402 - Copper; unrefined, copper anodes for electrolytic refining	745
3907 - Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and other polyesters, in primary forms	479
7210 - Iron or non-alloy steel; flat-rolled products, width 600mm or more, clad, plated or coated	389
3901 - Polymers of ethylene, in primary forms	373
1507 - Soya-bean oil and its fractions; whether or not refined, but not chemically modified	246
3904 - Polymers of vinyl chloride or of other halogenated olefins, in primary forms	227
7308 - Structures of iron or steel and parts thereof; plates, rods, angles, shapes, sections, tubes and the like, prepared for use in structures	210
8437 - Machines for cleaning, sorting, grading seed, grain, dried leguminous vegetables; machinery used in the milling industry for the working of cereals or dried leguminous vegetables, not farm type machinery	198
4804 - Uncoated kraft paper and paperboard, in rolls or sheets, other than that of heading no. 4802 or 4803	175

Example: Angola

Import substitution - Sector (HS code, 4 digits) Description	\$ Millio n
1507 - Soya-bean oil and its fractions; whether or not refined, but not chemically modified	120
7210 - Iron or non-alloy steel; flat-rolled products, width 600mm or more, clad, plated or coated	78
8437 - Machines for cleaning, sorting, grading seed, grain, dried leguminous vegetables; machinery used in the milling industry for the working of cereals or dried leguminous vegetables, not farm type machinery	33
8429 - Bulldozers, graders, levellers, scrapers, angledozers, mechanical shovels, excavators, shovel loaders, tamping machines and road rollers, self-propelled	26
3901 - Polymers of ethylene, in primary forms	26
8477 - Machinery; for working rubber or plastics or for the manufacture of products from these materials, n.e.s. in this chapter	20
1001 - Wheat and meslin	20
0203 - Meat of swine; fresh, chilled or frozen	20
4802 - Uncoated paper and paperboard, used for writing, printing etc, punch card stock and punch tape paper, in rolls or sheets, excluding paper of heading no. 4801 or 4803; hand-made paper or paperboard	18
8428 - Lifting, handling, loading or unloading machinery (eg lifts, escalators, conveyors, teleferics)	18



Thank you!



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