



On the evolution of comparative advantage: path-dependent versus path-defying changes

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25/02/2019

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Research questions of this paper

1. Does the evolution of countries specialization follows a **path-dependent pattern** as suggested by the **Product Space** framework (see Hidalgo et al. 2007)?
2. Which countries are able to **diversify away from their static comparative advantage** in areas of the Product Space that are unrelated with the initial production basket (more **radical diversification**)? [\[relevant for industrial policy\]](#)
3. Do countries that 'defy' their static comparative advantage (i.e. have higher shares of **radical changes**) experience a **better economic performance**? [\[relevant for industrial policy\]](#)



Novelties of the paper

- We employ a novel **non-parametric methodology for analysing the evolution of the export basket over time** (Coniglio, Lagravinese & Vurchio 2018);
- **First study, to our knowledge which:**
 - **tests the PS hypothesis of path-dependence at country level;**
 - Shed light on the **determinants** of path-dependence in production (export).
 - Explore the nexus between **path-dependence and growth**



Presentation road map

- The **Product Space (PS)** framework and its implications for policy;
- Testing the PS hypothesis: **data, methodology and results**;
- **(determinants)** Path-dependence and country characteristics;
- **(growth)** Radical changes in the export basket and economic performance.



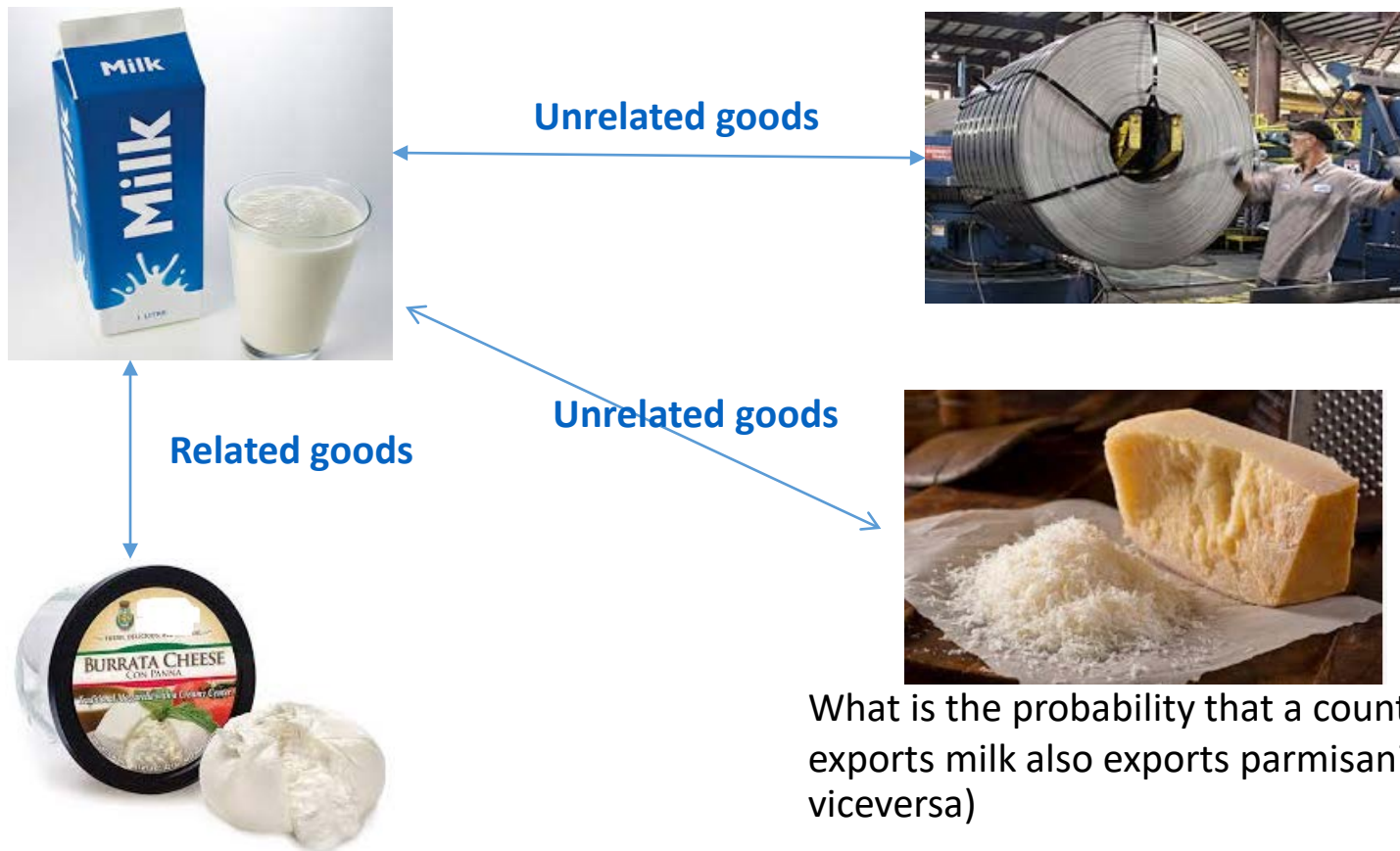


The Product Space Framework



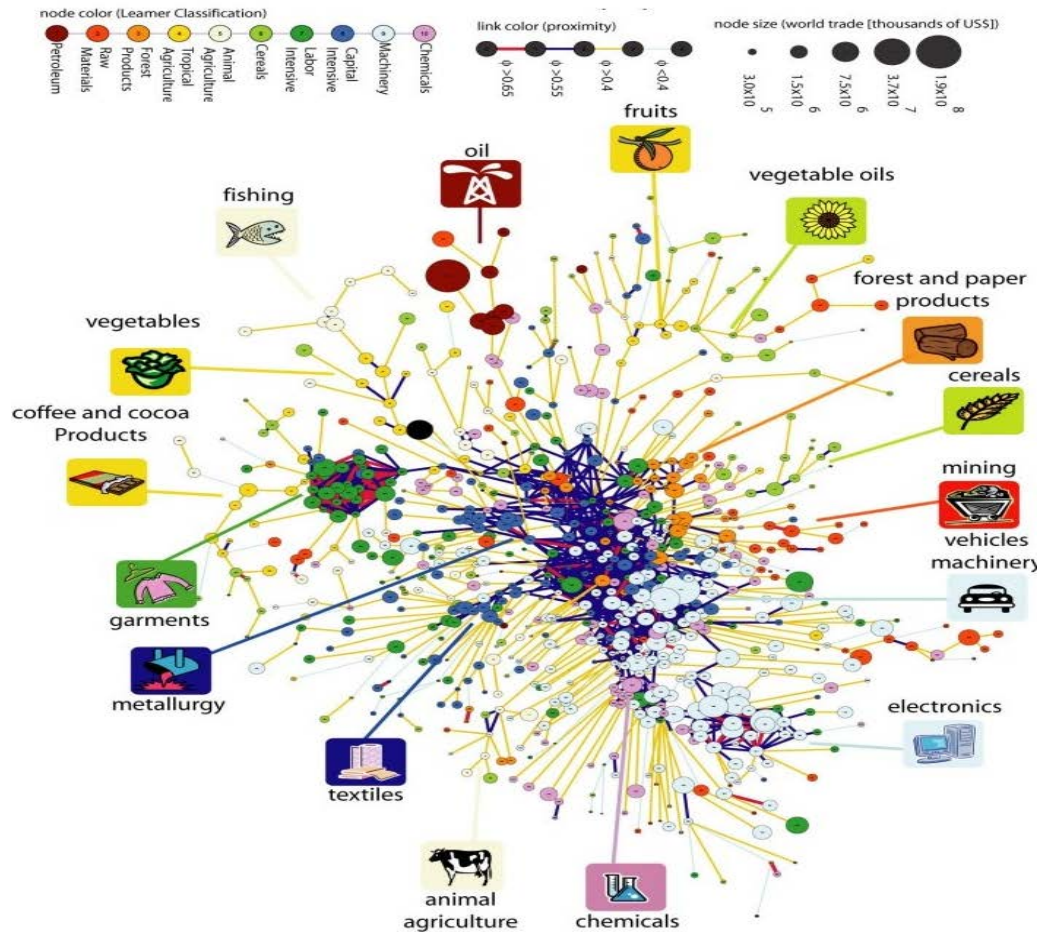
Relatedness between goods: the main idea

Take a country that exports milk: what is the probability that it also exports flat rolled steel? (and viceversa)



What is the probability that a country that exports milk also exports parmisan? (and viceversa)

The product space



Network representation of all goods exported in the world at a given time;

Nodes = products / **connections** = relatedness btw goods (measured as the minimum of the pairwise conditional probability of being co-exported);

Core/periphery structure → relatively more sophisticated products;



The product space

“It is **quite difficult for production to shift to far-away products in the space,** and therefore policies to promote large jumps are more challenging. **Yet,** precisely these long jumps are the ones generating new options for **subsequent structural transformation**” (Hidalgo et al (2007) *pag. 7*);





Path-dependence: how far apples fall from the tree?

- **PS main prediction:** the evolution of production basket is a path-dependent process (small jumps over the PS)
- **Why is it important?** → positive and normative implications, in particular for the design of effective industrial policies (Lin vs Chang 2009);
- Notable **examples of long-distance ‘jumps’ over the PS:** aircraft industry in Brazil and the automotive industry in Korea;
- **Evidence of path-dependence:** Hausmann & Klinger (2010) on Ecuador; Hidalgo (2012) on Africa; Felipe et al. (2013a; 2013b) on China and India; Boschma et al (2013) on Spanish regions 1988-2008.
- These authors generally derive **strong industrial policy implications for developing countries (the ‘Harvard CID recipe’)**



An example of policy (mis-)use of PS framework

Trinidad and Tobago: Lessons from a Product Space Analysis*

Dany Bahar

Harvard Center for International Development

Vanessa Cheng Matsuno

Consultant

Building on this analysis, this report explores and presents recommendations for the diversification of TTO's export basket. For this purposes we rely on the methodologies developed by Hidalgo et al. (2007) and Hausmann et al. (2014) to identify sectors more likely to emerge given the country's current export structure. The analysis also takes into account possible spillovers to other industries that the appearance of a new sector might carry with. Based on this methodology we find that the highest potential for emergence of new sectors concentrate in the machinery, chemical and electronics sectors. Examples of products within this sector are transmission shafts, cranks, bearing housing, parts of power units, among others. In the chemical sector, instruments and appliances for chemical analysis, epoxide resins, glycosides and the refinement of existing lubricating petroleum oils and other heavy petroleum oils. In the electronics sector, refractory goods, telecommunications equipment and parts of optical elements are some of the potential exports.²





Testing the Product Space Hypothesis



The methodology

Data

4-digit HS classification CEPII BACI exports data (*network of relatedness* between any products exported in the world) / max 1241 goods

221 countries: compute Revealed Comparative Advantages (RCAs). *Identify the export baskets at time $t = (1995-2015)$ and its change over time;*

N° of periods: max 16

5 years intervals [$t_0=(1995:2010)$ and $t_1=(2000:2015)$];

Main hypothesis (H1):

are newly exported goods at time t_1 by a Country k statistically and non randomly related to the pre-existing export basket at time t_0 ?

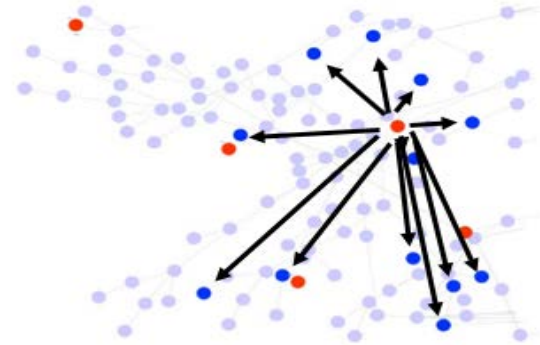
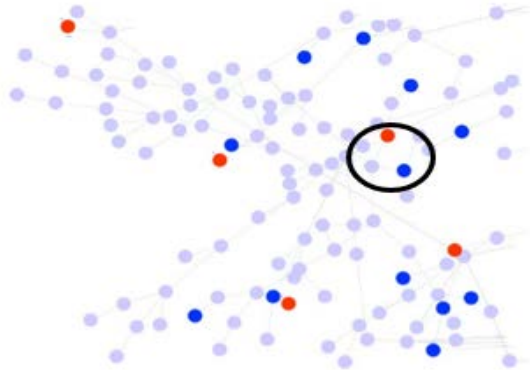
Testing (non-random) relatedness

- 1) Definition of **new entries**;
- 2) Definition of **relatedness** (or proximity) between new entry and pre-existing export basket;
- 3) Generation of the **counterfactual** (random distribution of relatedness);
- 4) **Test of null hypothesis of randomness (H_0)**.

1) New entries

- **Definition:** products that enter in the export basket of country k between time t_0 and t_1 ;
- **Identification (our preferred option):**
 - $RCA_{ik} < 0,5$ in t_0 and $RCA_{ik} > 1$ in t_1
- **Robustness:**
 - 2 alternative identifications [(a) $RCA_{ik} < 0,2$ in t_0 ; (b) $RCA_{ik} < 1$ in t_0]
- **New entries: (for our preferred option):**
 - 6591 new products (yearly average 1995-2015; 16 periods);

2) Relatedness



- Maximum proximity:
- Average proximity:

$$d_{ik,m}(\varphi_{ij}) = \max(\varphi_{ij})$$

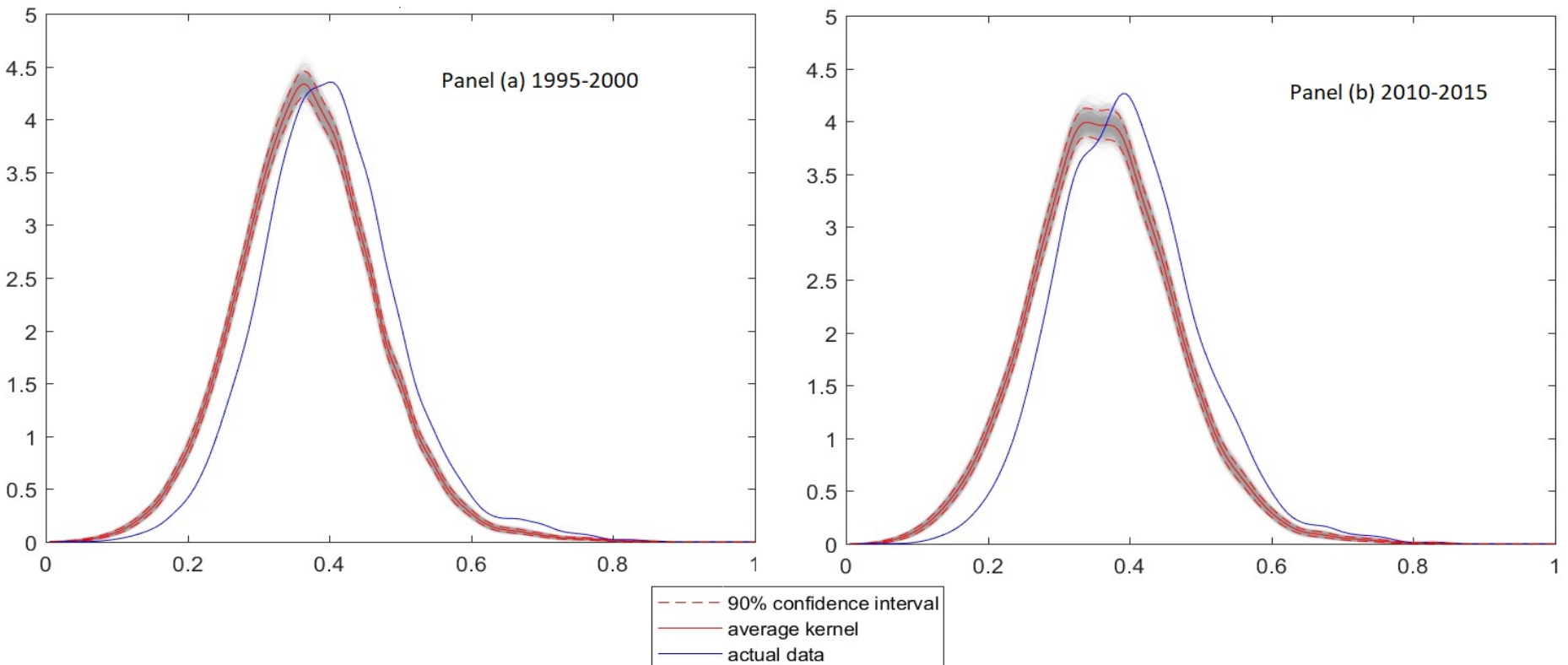
$$d_{ik,a}(\varphi_{ij}) = \frac{\sum_j \varphi_{ij}}{J_k}$$

3) Country (or year) counterfactual

- For each country k (or year t) with n_k (or m_t) new entries, **'actual' data** will tell us how related are these new products to existing ones (**true distances**);
- We develop a **counterfactual of distances from a random draw** of n_k (or m_t) products from potential ones (1000 random draws per country/year);

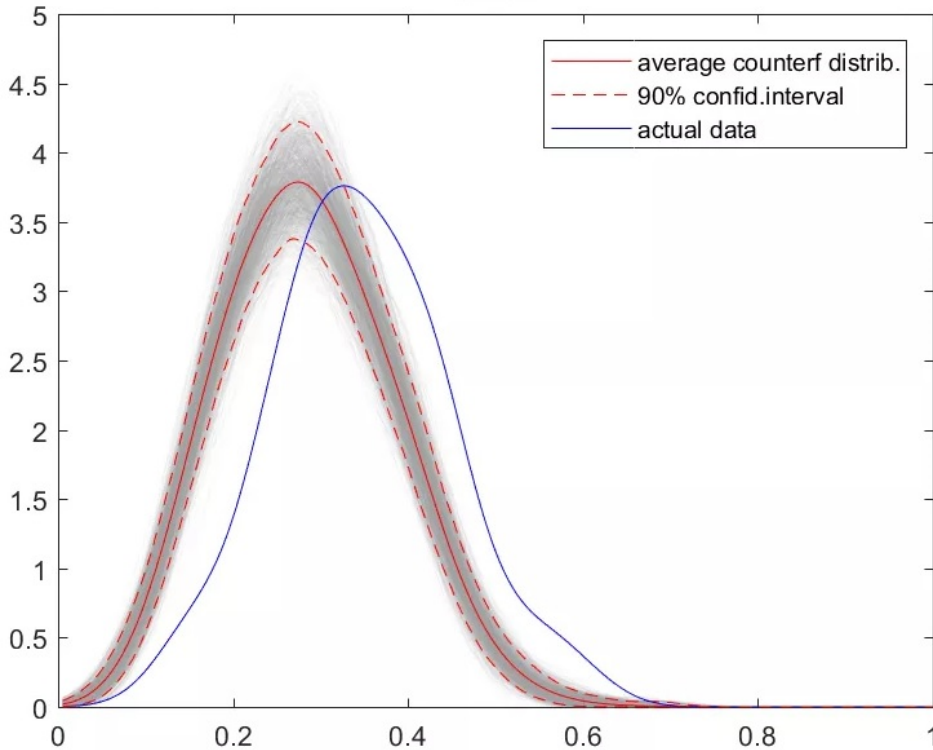
Kernel density estimates for all countries' new entries (first period 1995-2000; last period 2010-2015)

Distribution of proximities between new export products and pre-existing export baskets: actual data versus random counterfactual (5-years intervals 1995-2000 and 2010-2015)

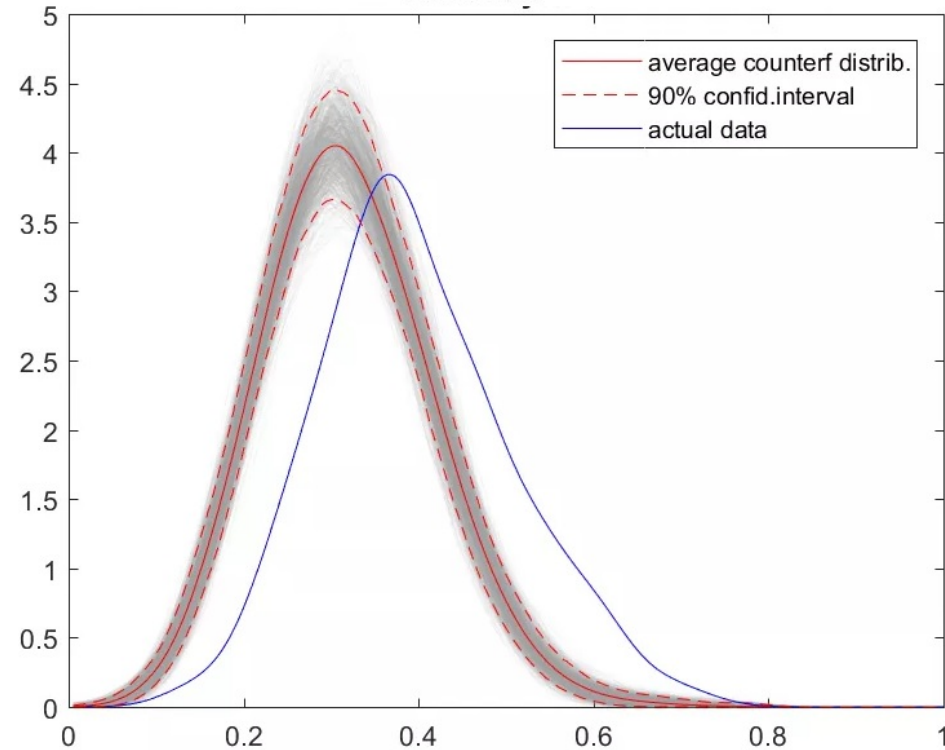


New export products: selected economies (all new entries, 1995-2015) (1)

Yemen

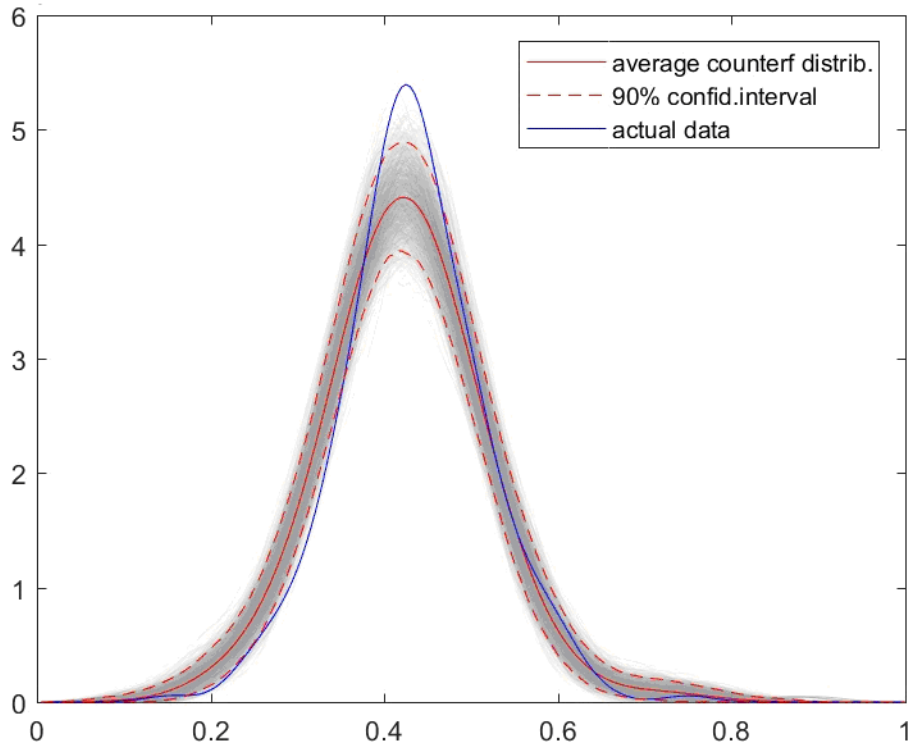


Cambodia

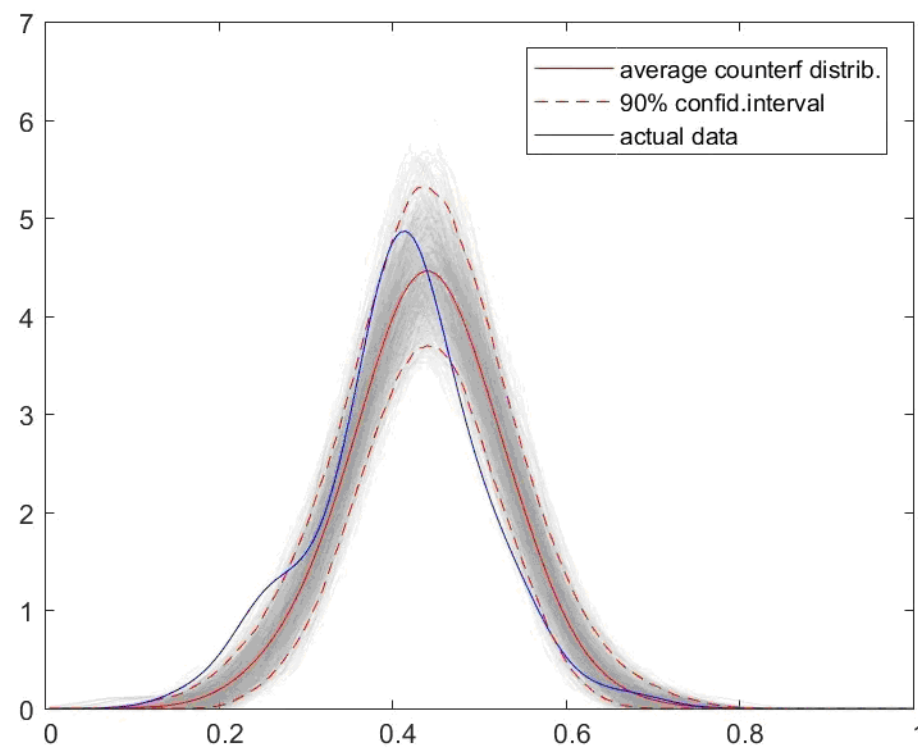


New export products: selected economies (all new entries, 1995-2015) (2)

Rep. of Korea

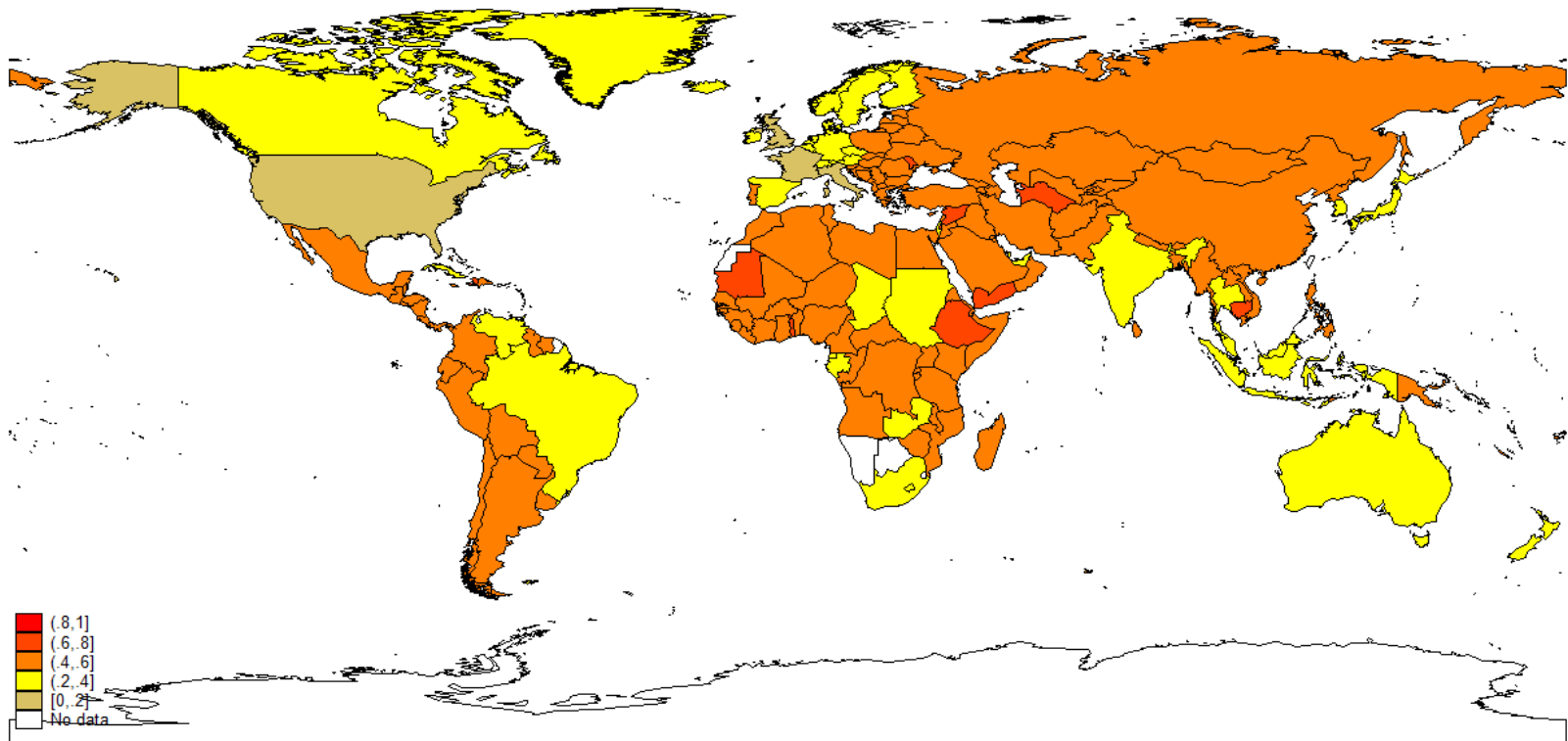


USA



When the apples fall near the tree? On the determinants of path-dependence

Share of path-dependent new export products (% of total new)





Testing the Drivers



High heterogeneity of path-dependence across countries (& to a lower extent across periods)

Dependent variable: **non random Entry** $_{k,t}$ = share* of new products that are non-randomly related with the country k export basket at t_0 ;

R_Question: **when is more likely to observe path dependence?** (i.e. the reverse question is: which country characteristics ‘defeat’ the initial comparative advantage)

Methodology: **panel tobit models** (definitions of relatedness as maximum proximity; for new entry definition, $RCA_{t0} < 0,5$ & $RCA_{t1} \geq 1$)

Panel tobit estimates:

$$PDshare_{i,t} = \alpha + \beta X_{i,t-5} + \phi_i + \gamma_t + \varepsilon_{it}$$

Main covariates: *focus on country characteristics*

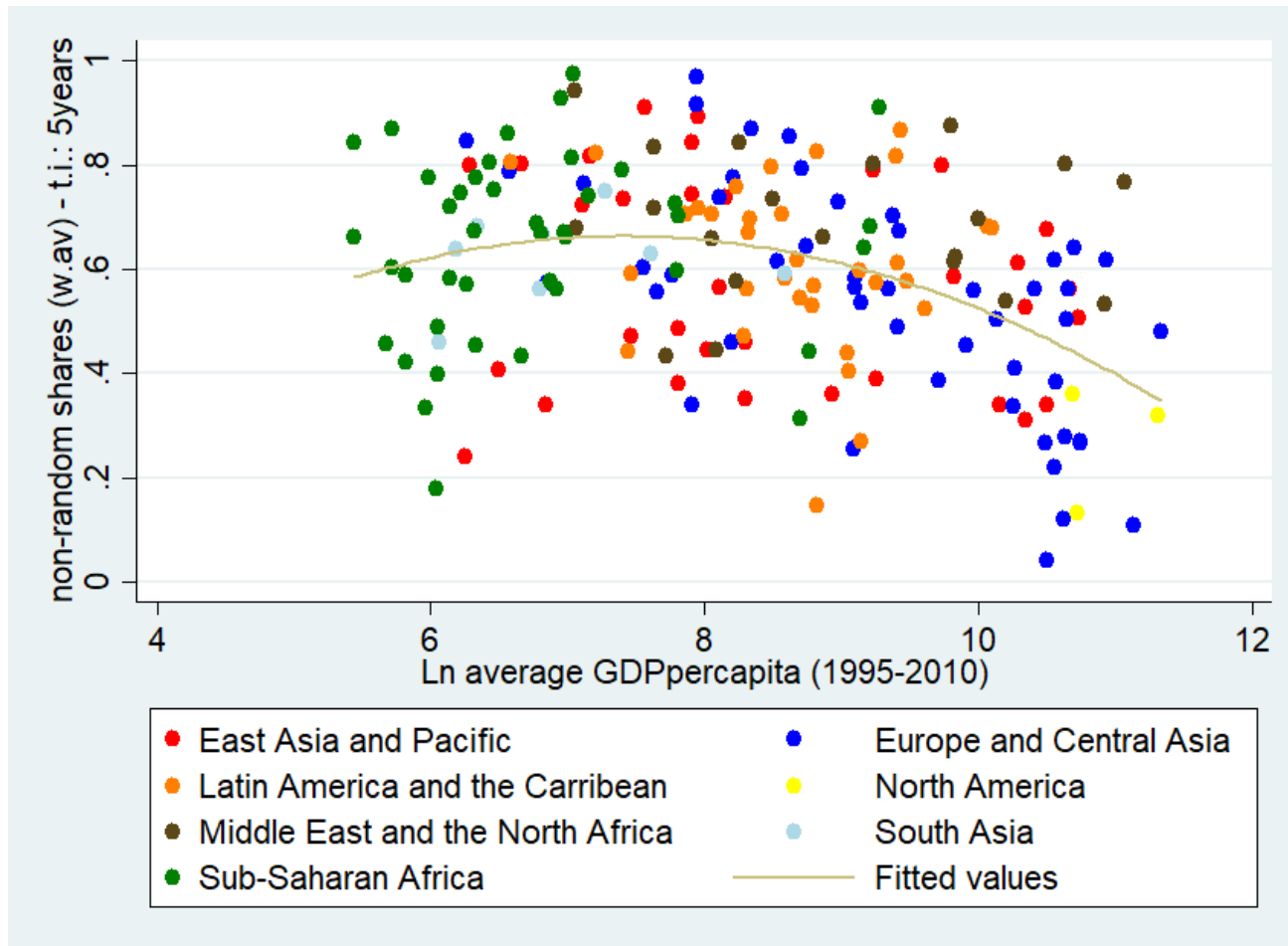
- **GDP per capita at t0** (in log)
- **Size: population** (in log)
- **Economic structure**: Natural resources as % of GDP
- **Trade diversification**: entropy index of export diversification
Frenken *et al*, 2007 – Borschma and Iammarino (2009);
- **human capital/innovation capacity**;
- **Openness to international trade**;
- **Institutional & policy variables** (Economic Freedom Indicators)
- **FDI** as agents of structural change;
- Control vars.: Regional and time fixed effects / n° & size of new entries.

Estimation results

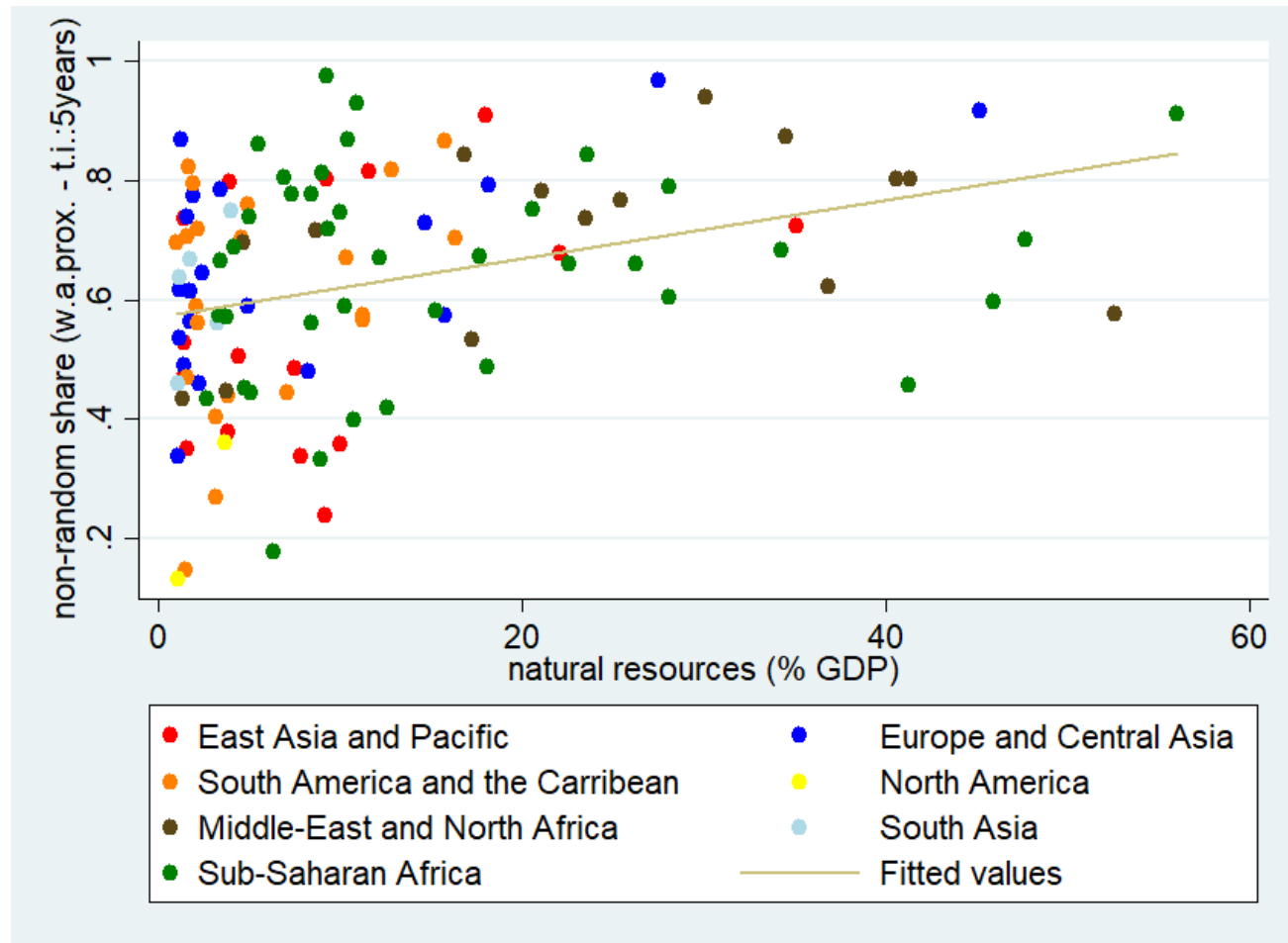
Dependent variable: % share of path-dependent new entries over total new entries (5 years time periods)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
➔ GDP per capita (log)	-4.020*** (0.727)	-3.109*** (0.751)	-2.348*** (0.806)	-2.789*** (0.834)	-2.724*** (0.838)	-5.305*** (1.405)	-5.384*** (1.891)
Population (log)	-1.126** (0.474)	-0.364 (0.502)	0.227 (0.553)	-0.376 (0.608)	-0.381 (0.612)	-2.282* (1.192)	-1.255 (1.654)
Trade openness (log)	0.231 (1.292)	0.0203 (1.288)	0.442 (1.289)	-1.371 (1.432)	-0.820 (1.446)	-0.605 (1.612)	3.011 (3.014)
➔ Trade variety (log)		-7.615*** (1.730)					
Related varieties (log)			-0.290 (1.290)	0.849 (1.326)	0.508 (1.337)	2.153 (1.622)	1.589 (2.367)
➔ Unrelated varieties (log)			-4.992*** (1.679)	-4.185** (1.794)	-3.892** (1.803)	-5.551** (2.219)	-8.420** (3.566)
➔ Natural resources (% of GDP)				0.177* (0.0910)	0.162* (0.0917)	0.272** (0.106)	0.00470 (0.161)
FDI inflows (net, % of GDP)					-0.0777** (0.0383)	-0.0550 (0.0417)	-0.0267 (0.0551)
Scientific & tech. publications (log)						1.891** (0.921)	1.925 (1.262)
➔ Educational expenditure (% of GDP)							-0.353 (0.223)
	 other controls (see paper)					
<i>Observations</i>	2,715	2,715	2,715	2,696	2,657	1,827	1,137
<i>Macro-area and year dummies</i>	YES	YES	YES	YES	YES	YES	YES
<i>Number of countries</i>	177	177	177	177	177	173	154

GDP per capita and share of path dependent products



Natural resources and share of path dependent products



The business and institutional environment matter

Institutional Environment

<i>I_Var = Institutional Variable reported in Column</i>	(1) <i>Economic Freedom Index</i>	(2) <i>Size of Government</i>	(3) <i>Legal system and property rights</i>	(4) <i>Sound money</i>	(5) <i>Freedom to trade internationally</i>	(6) <i>Regulation</i>	(7) <i>Tax on International Trade (% revenues)</i>
Institutional Variable (baseline = High Income Country)	-5.611** (2.795)	-1.008 (1.229)	-0.451 (1.536)	-3.15** (1.435)	-2.151 (1.949)	-1.648 (1.739)	-0.258* (0.146)
Low Income Country * I_Var	5.453 (3.745)	0.451 (1.880)	2.129 (2.359)	1.754 (1.832)	2.122 (2.767)	5.655** (2.614)	-0.0984 (0.294)
Lower-Middle Income Country* I_Var	3.186 (3.526)	-1.653 (2.044)	-0.364 (2.268)	2.817 (1.808)	1.944 (2.499)	0.663 (2.734)	0.247 (0.223)
Upper Middle Income Country* I_Var	5.732 (3.639)	-0.392 (1.822)	3.650 (2.404)	3.402** (1.707)	3.464 (2.699)	0.427 (2.442)	0.132 (0.184)
<i>Obs.</i>	<i>1,504</i>	<i>1,503</i>	<i>1,514</i>	<i>1,504</i>	<i>1,499</i>	<i>1,504</i>	<i>1,553</i>
<i>N. of countries</i>	<i>143</i>	<i>143</i>	<i>143</i>	<i>143</i>	<i>143</i>	<i>143</i>	<i>143</i>

Note: Estimations using Panel Tobit method; Includes all covariates and controls included in Table 1 (model 6); Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1



Does it matter for growth?



Growth regressions (panel estimates)

Dependent variable: *yearly average growth of GDP per capita (%)*
177 countries / non overlapping 5-years periods (1995-2015)

Main covariates:

- Non-path dependent new entries (radical changes) at t0 (in log)
- Initial level of development (GDP pc at t0, log)
- Export sophisticatedness (ExpY at t0; log)
- Economic freedom (Fraser Institute Index at t0);
- Human capital/innovation capacity (scientific&tech publications at t0);
- Control vars.: country fixed effects

Alternative estimators (as in the seminal paper by Hausmann & al 2007) : *Pooled OLS, LSDV, FE, IV, GMM*

Comparative advantage conforming vs comparative advantage defying diversification

In practical terms my difference with Justin lies primarily in the extent to which we think the defiance of comparative advantage is advisable. While Justin believes that the skipping of the rungs in climbing the ladder should very small (comparative advantage conforming in his words), I believe that it can be and sometimes it has to be “large”, (comparative advantage defying in his words). There is of course a chance that such an attempt may not succeed, but this is the nature of any venture, into new activities, whether purely private or assisted by the State.

Should industrial policy in developing countries conform to comparative advantage or defy it? A debate between Justin Lin and Ha – Joon Chang

Development Policy Review, 27, 483 – 502, Development Policy Review

Where you jump matters!

Table 5- Do path-defying changes (non path-dependent entries) lead to higher growth?

Dependent variable: GDP per capita growth, yearly average (5-year panel; % change)

	Pooled OLS (1)	LSDV (2)	FE (3)	FE (4)	IV (5)	System GMM (6)
Path-defying new entries (log)	0.271*** (0.105)	0.279** (0.126)	0.337*** (0.128)	0.354*** (0.115)	0.947* (0.489)	0.301** (0.120)
Initial GDP per capita (log)	-0.344*** (0.078)	-4.04*** (0.672)	-5.88*** (0.976)	-9.85*** (1.475)	-10.9*** (1.334)	-3.77*** (0.796)
Initial Export sophisticatedness, ExpY (log)			0.515 (0.575)	-0.338 (0.632)	-0.545 (0.556)	0.756 (0.305)
Initial Economic Freedom Index			1.003*** (0.234)	-0.275 (0.417)	-0.148 (0.356)	-0.500 (0.468)
Initial Scientific & tech. publications (log)				0.887*** (0.287)	0.0667 (0.337)	0.591 (0.434)
Constant	2.51*** (1.166)	28.66*** (4.712)	39.59*** (9.062)	84.20*** (11.40)	84.29*** (9.279)	26.554*** (7.931)
Observations	692	692	504	384	384	383
R2	0.031	0.554	0.188	0.356	0.745	
Number of countries	177	177	143	141	141	141

Note: Least Square Dummy Variable (LSDV) models in column (1)(2) include country fixed effects; Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 *Panel IV regression*: path-defying new entries (log) are instrumented with the 5 year lag of the variable and the log of population. *GMM is the Arellano-Bond / Blundell-Bond system estimator and includes the lagged dependent variable and year dummies as suggested by Roodman (2009) / (n° of instruments = 13).*

Arellano-Bond test for AR(1) in first differences: z = -0.386 Pr> z = 0.969

Sargan test of over id. restrictions: chi2(4) = 82.606 Prob> chi2 = 0.000

+10% of radical new entries leads to a 0,78-0.82% increase in yearly growth of GDP per capita in the next 5 years

Conclusion

First rigorous analysis of the PS framework:

- We confirm the **general pattern of path-dependency** (non-random concentration at short 'distances' from export basket) ...but... **almost 50% of new entries are not 'path-dependent'**
- High heterogeneity in the degree of path-dependent versus **radical changes**;
- **Radical changes matter for boosting growth**;
- **Important message**: we need to exercise **caution** in using this framework for 'informing' industrial policy;

Research agenda:

- Determinants of relatedness;
- Exploring the sectoral dimension.



Thank you!

