# Export Emergence and Diffusion Patterns over the Product Space during Trade Liberalisation

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# Outline of Presentation

▸ Research Question

▸ What is the Product Space?

    ▸ How it is constructed?

    ▸ Why are we interested in it?

▸ Trade Liberalisation and Product Space Dynamics

▸ Evidence? Average Within-Country Responses.

▸ Conclusion

▸

# Trade Liberalisation

▶ Largely accepted as being of positive benefit to economies (informed by theory)

▶ Empirically hard to evaluate and test

"While there are serious methodological challenges and disagreements about the strength of the (empirical) evidence, the most plausible conclusion is that trade liberalisation generally induces a temporary (but possible long lived) increase in growth" (Winters, 2004)

# Literature

- Trade Liberalisation and Export Performance
  - Trade liberalisation is a significant determinant of export performance (but with a lot of heterogeneity)
  - Can improve exporter firm productivity and alters innovation (through competition, specialisation in export products, learning by doing … etc )
  - Santos-Paulino (2005), Winters L.A. (2004), Baldwin (2004) …

- Product Space and export structure (a network science approach) [Hausmann, Hidalgo et al, 2011]
  - A data driven approach to understanding the evolution in the productive structure of economies
  - Positions within the Product Space Network are highly correlated with levels of GDPPC
  - Hausmann & Klinger 2006, Hausmann et al. 2007, 2011, Hidalgo et al. 2007, 2009

# Research Question

▸ How does trade liberalisation change the structure of product emergence?

   ▸ A: Does the rate of product emergence ("de novo" products) increase following trade liberalisation?

   ▸ B: Is trade liberalisation associated with the emergence of products that are *similar* or *dissimilar* to existing exports?

▸ **Method:** exploit the structure of the Product Space developed by Hidalgo, Hausmann et al. (using network science techniques) … as a measure of distance between products (i.e. proximity).

▸

# Preview of Results …

- Trade liberalisation is associated with an ~18% *increase* in the rate of products that emerge with high proximity to current country exports

- Trade liberalisation is associated with a moderate 8% *increase* in the distance of diffusion to products that are more dissimilar to those in the pre-reform export basket

- Suggests that trade liberalisation contributes to both the accumulation and diversification of underlying country capabilities (via export channel).

# The Product Space:
# Revealed Product Similarity

▸ ## A network where

  ▸ ### Nodes: Products

  ▸ ### Edge Weight: Conditional Probability of Co-Export.
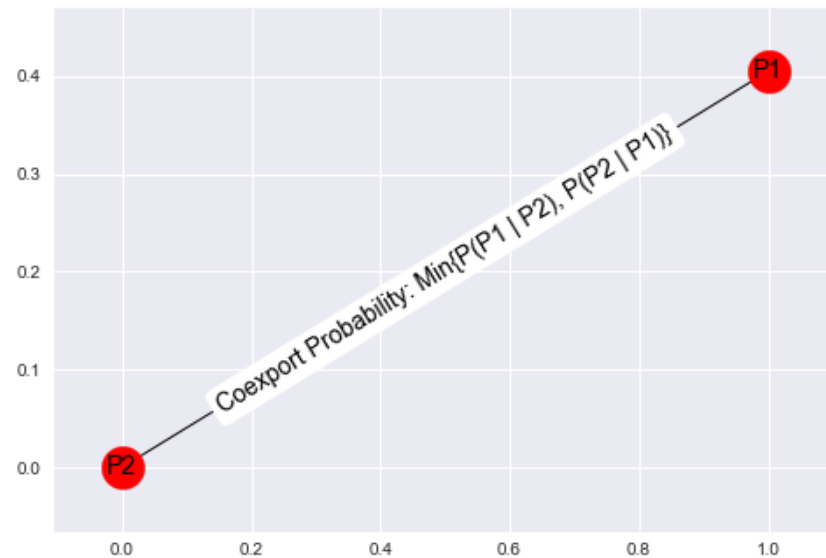


A Country Exports a product as identified by Revealed Comparative Advantage (RCA)

$$RCA_{cpt} = \frac{\dfrac{E_{cpt}}{E_{ct}}}{\dfrac{E_{pt}}{E_t}}$$

# Key Assumption

▸ If two products are highly co-exported, then they are revealed to share similar factors of production (unobserved set of capabilities that are required to produce them)

$$P(\text{Shirts} \mid \text{Pants}) > P(\text{Cars} \mid \text{Shirts})$$

# Proximity

$$M_{cp} = \begin{array}{l} 1 \text{ if } RCA_{cp} \geq 1 \\ 0 \text{ if } RCA_{cp} < 1 \end{array}$$

$$\phi_{ij} = \frac{\sum_c \{M_{cp_i} * M_{cp_j}\}}{max\{k_{p_i}, k_{p_j}\}}$$

Where,
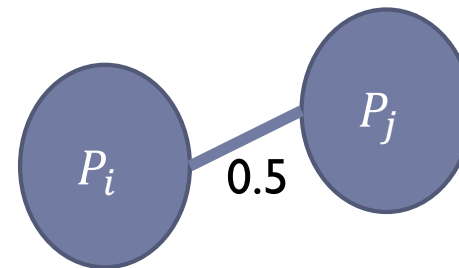- $k_p$ is ubiquity of product $p$

Maximum Spanning Tree + $\phi_{ij} > 0.55$

Example $M_{cp}$ Matrix

$$M_{cp} = \begin{bmatrix} & P & P' & \\ \cdots & 0 & 0 & \cdots \\ \cdots & 1 & 0 & \cdots \\ \cdots & 1 & 1 & \cdots \\ \cdots & 0 & 1 & \cdots \end{bmatrix}$$

$$\phi_{ij} = \frac{1}{2}$$

$$\phi_{ij} = 0.5$$



$$\phi = \begin{array}{c|cc} & j & \cdots \\ \hline i & 0.5 & \cdots \\ \vdots & \vdots & \ddots \end{array}$$

# Examples of Proximity …

| Product 1 | Product 2 | Proximity |
|---|---|---|
| Men's and Boy's Trousers | Men's and Boy's Shirts | 0.81 |
| | Jersey's / Cardigans | 0.77 |
| | Linens / Textile Furnishings | 0.36 |
| | Motor Vehicles | 0.09 |
| | Commercial Aircraft | 0.06 |

| Product 1 | Product 2 | Proximity |
|---|---|---|
| Coffee (Green, Roasted) | Sugars, Raw | 0.50 |
| | Cut Flowers | 0.45 |
| | Jersey's / Cardigans | 0.33 |
| | Motor Vehicles | 0.03 |

Data from Year 2000

# Proximity Matrix
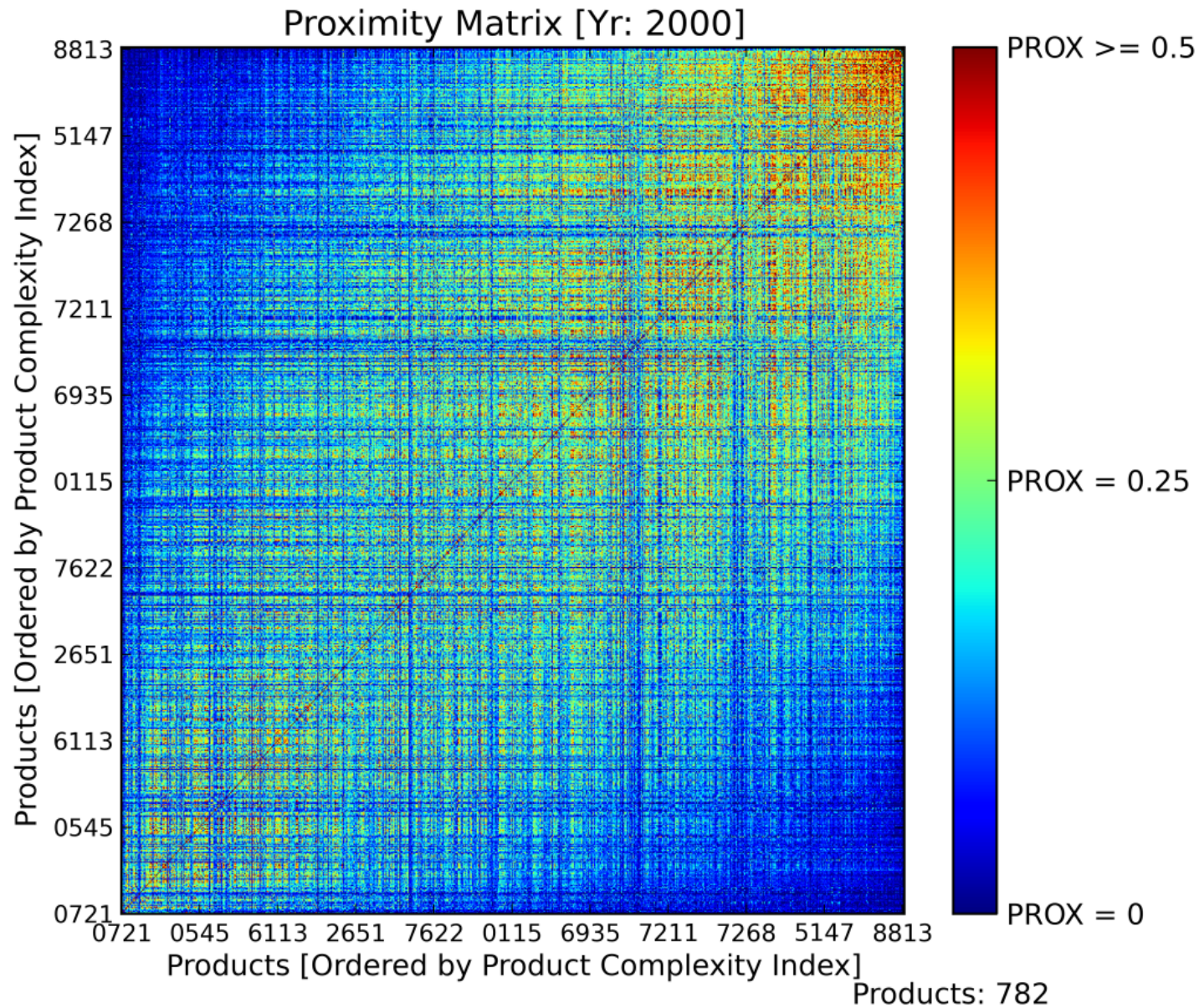


Proximity Matrix [Yr: 2000]
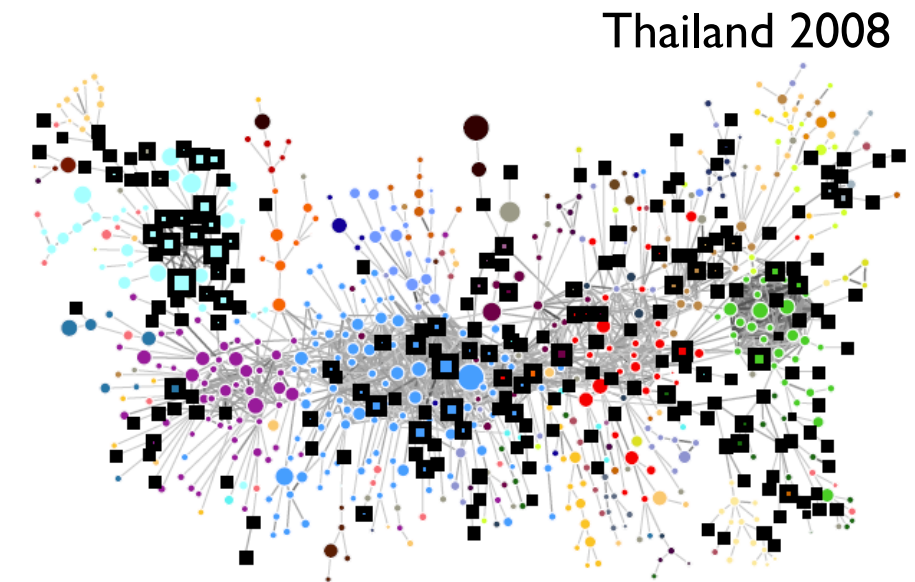
The product space.
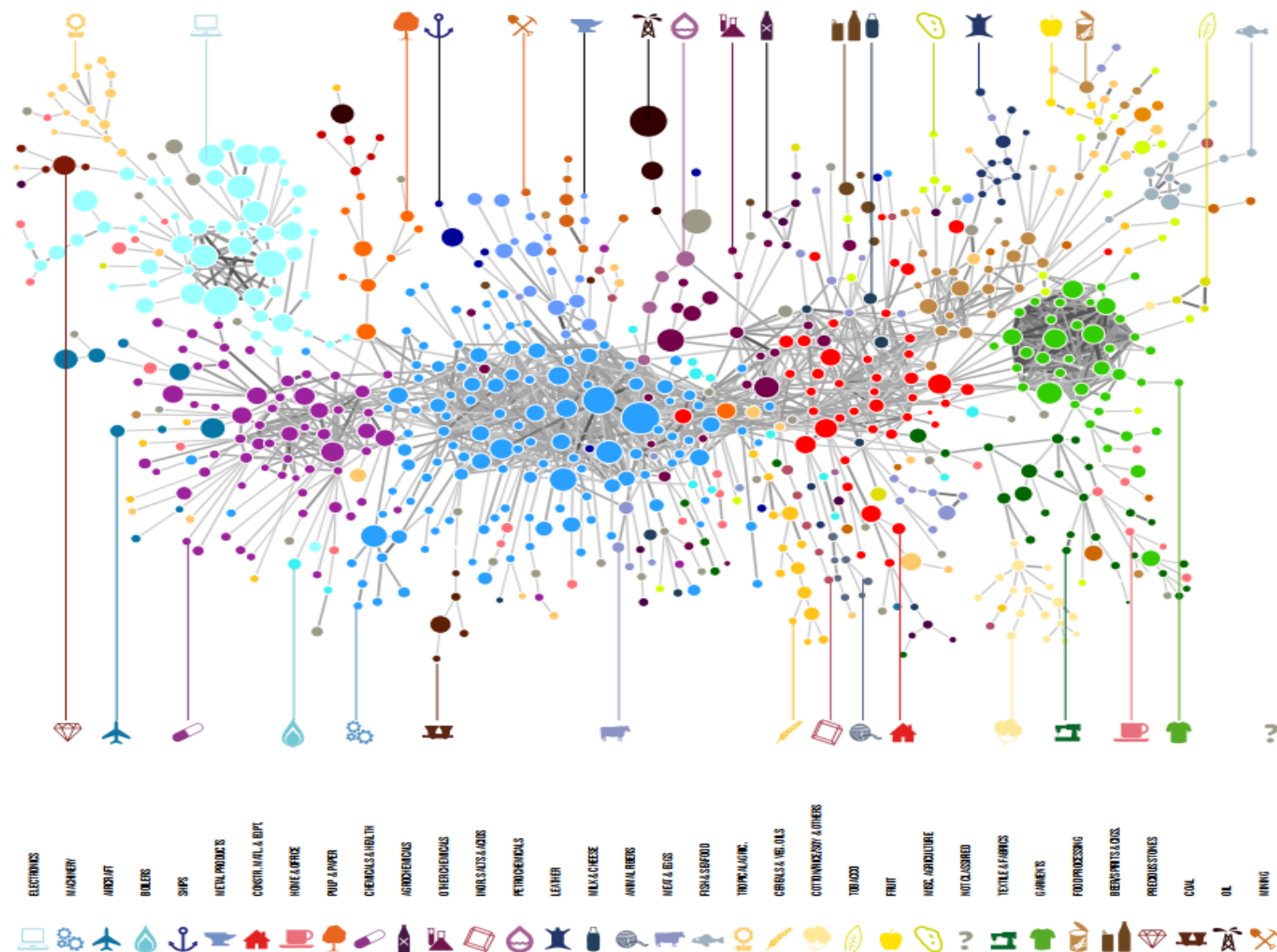
# Why are we interested in this Network?


Thailand GDP per Capita


Thailand 1975


Thailand Top 4 Export Communities (Change in Value)


Thailand 2008
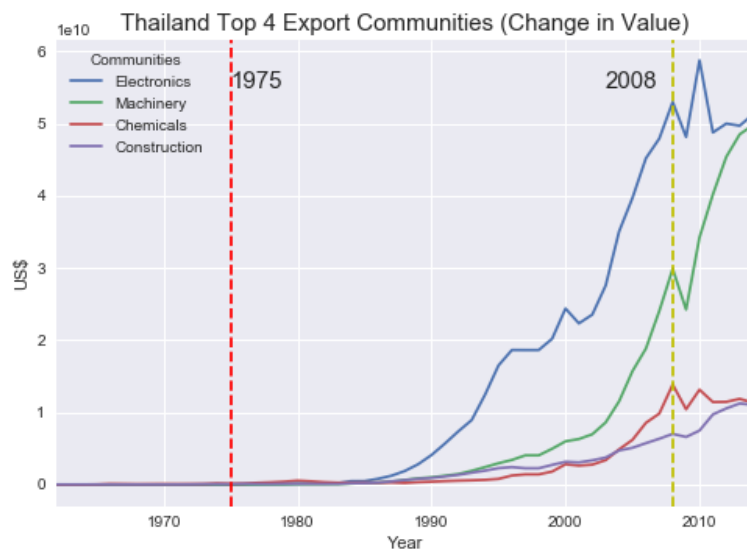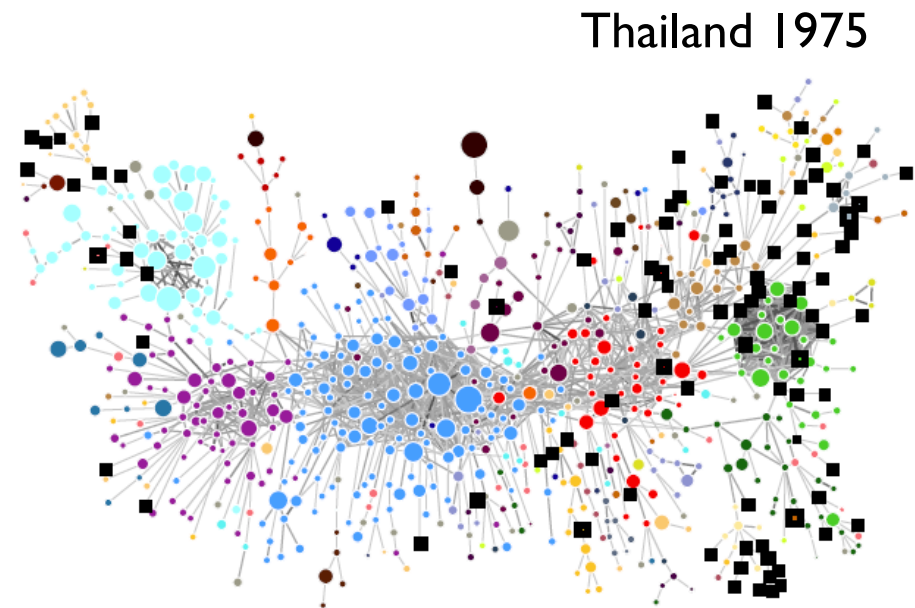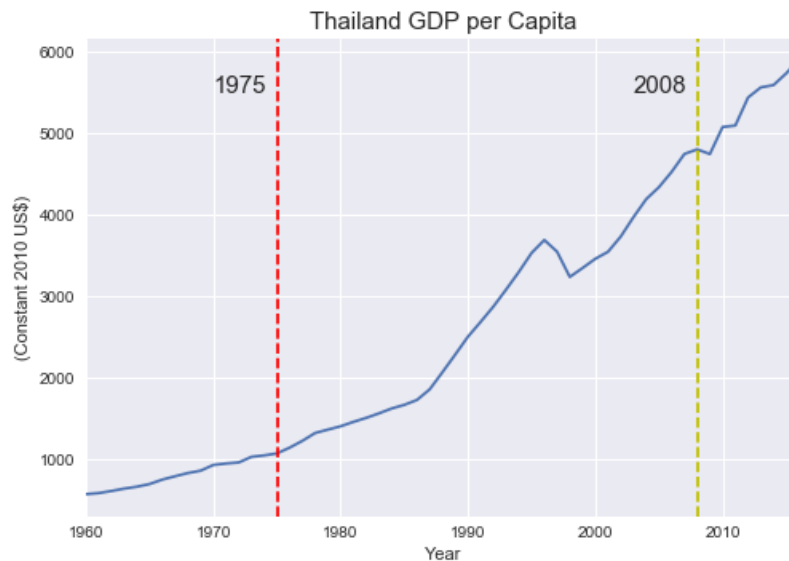
Network Diagrams from Hausmann et al (2011), Chart data WDI, and COMTRADE

# Analysis Strategy

▸ Use the structural information contained in $\phi_{ij}$ (Proximity) matrix to characterize how new products emerge in relation to trade liberalization episodes

  ▸ Step 1: Compute Proximity Matrices
  ▸ Step 2: Compute Probable and Improbable Export Emergence
    Step 3: Compute Diffusion Width and Variance of "de novo" products
  ▸ Step 4: Econometric Evaluation

# Compute Proximity Matrix

▸ Using SITC Rev 2 Level 4 Data

▸ Combined NBER (1962-2000) with CEPII (BACI) (1998-2012)*

▸ Years: 1962 to 2012 (51 Years)

| | A | B | C |
|---|---|---|---|
| Exporters | 179 | 179 | 179 |
| Products | 1066 | 783 | 283 |
| Trade Flows | 2,953,496 | 2,774,537 | 1,312,310 |

▸ Notes

    ▸ * overlapping years are averaged at the product level to smooth the transition.

    ▸ A: NBER (removed 'A' and 'X')

    ▸ B: NBER (removed non-official SITC Codes)

    ▸ C: NBER (recodes products to be intertemporally consistent through *selective* aggregation of products to maximise product variation)

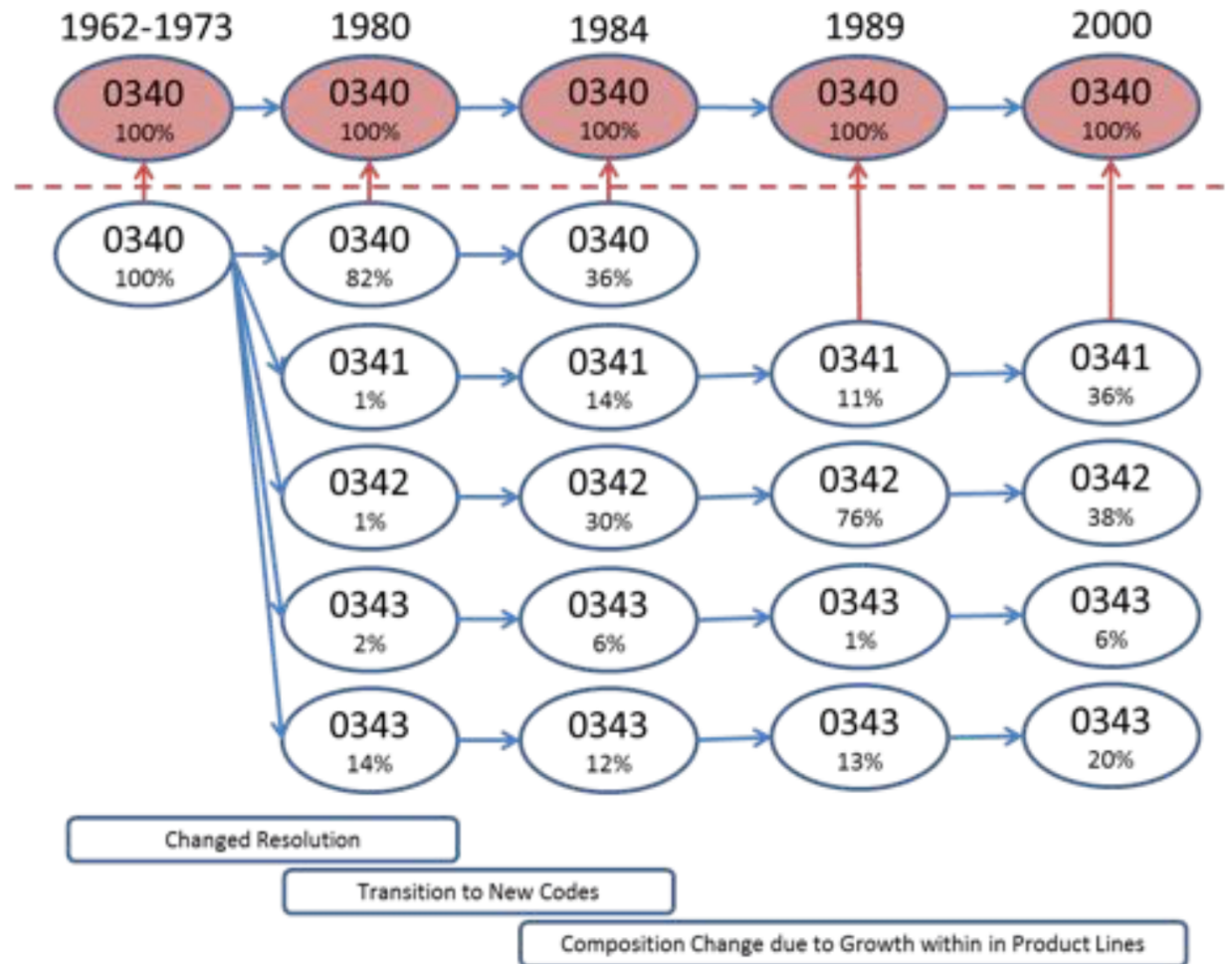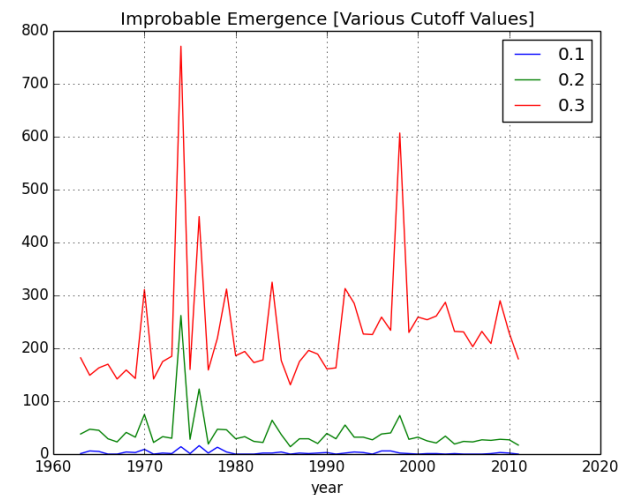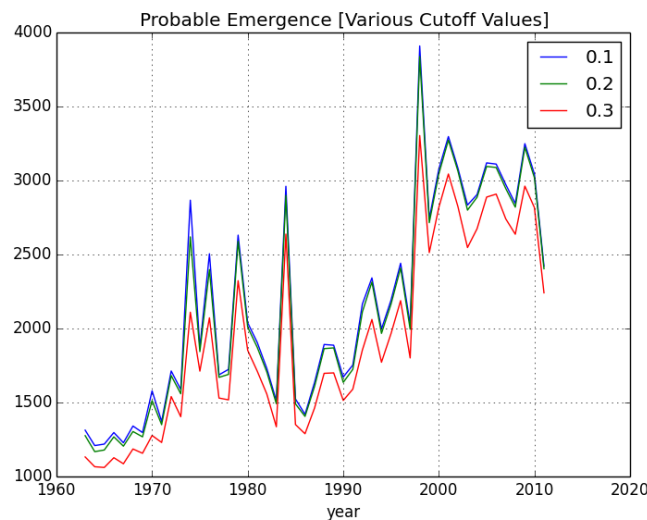▸

# Intertemporal Consistency Issue



**Figure A.6**: Japanese Fish Exports Recoding Trade Data for Intertemporal Consistency

# Q1: Does Product Emergence ("de novo" products) increase under trade liberalisation regimes?

▸ **Measure of Probable and Improbable Emergence**

Compute Vector of New Products → For each new product check all product connections ($\phi_{pp\`}$) to last years export basket for country c

If **any** connection is greater than cut-off ($\phi$) → Add to Vector of Probable Emergence

If **ALL** connections are less than cut-off ($\phi$) → Add to Vector of Improbable Emergence



Probable Emergence [Various Cutoff Values]



Improbable Emergence [Various Cutoff Values]
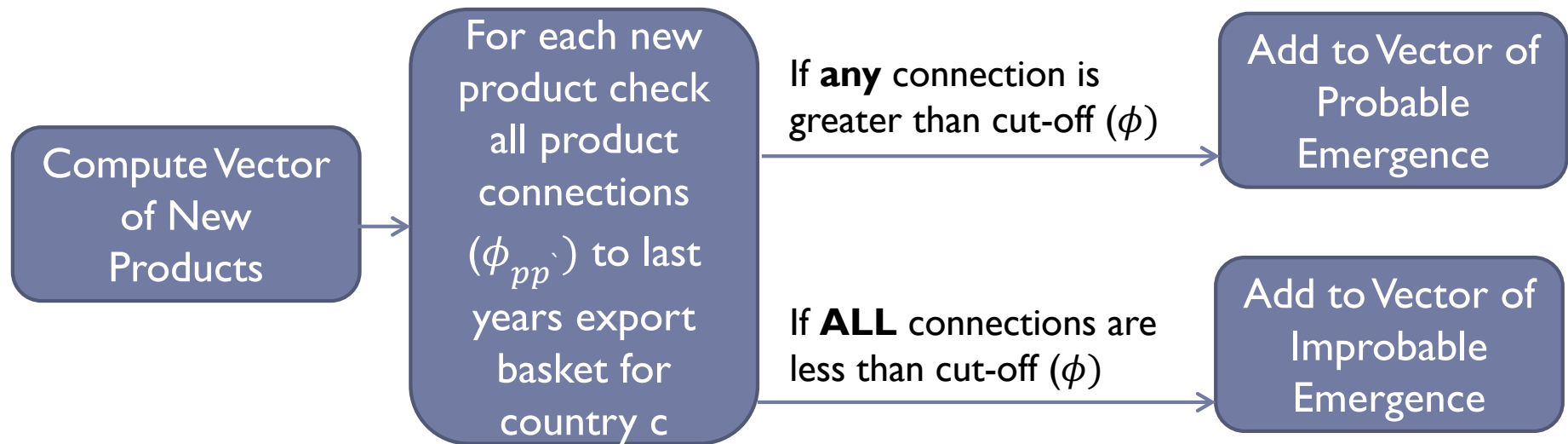
# Country Level Dataset

By summing the vector of Probable Products for each country, we acquire a country level dataset of total product emergence.

| Dataset | All Countries | | | Developing Countries | | |
|---|---|---|---|---|---|---|
| | A | B | C | A | B | C |
| # Products | 1066 | 783 | 283 | 1066 | 783 | 283 |
| # Countries | 129 | | | 107 | | |
| Years | 1963 to 2012 | | | 1963 to 2012 | | |
| Observations | 5469 | | | 4441 | | |

# Trade Liberalisation Data

| Number of Countries under a Liberal Trade Regime | | |
|---|---|---|
| | All Countries | Developing Countries |
| Year 1963 | 21 | 6 |
| Year 2012 | 96 | 75 |
| Period 1963 to 1969 | 28 | 12 |
| Period 1970 to 1979 | 33 | 15 |
| Period 1980 to 1989 | 54 | 34 |
| Period 1990 to 1999 | 97 | 76 |
| Period 2000 to 2012 | 97 | 76 |
| Countries w/ multiple episodes | KEN (2), LKA (2), VEN (2) | |
| Average Episode Length | 22.8 years (std. dev = 17) | 18.4 years (std. dev = 14.2) |

▸ Trade Liberalisation indicator is from Wacziarg and Welch 2008 (original series cover (1950 to 2000); extended to 2012 assuming status quo)

▸

# Putting the data together …
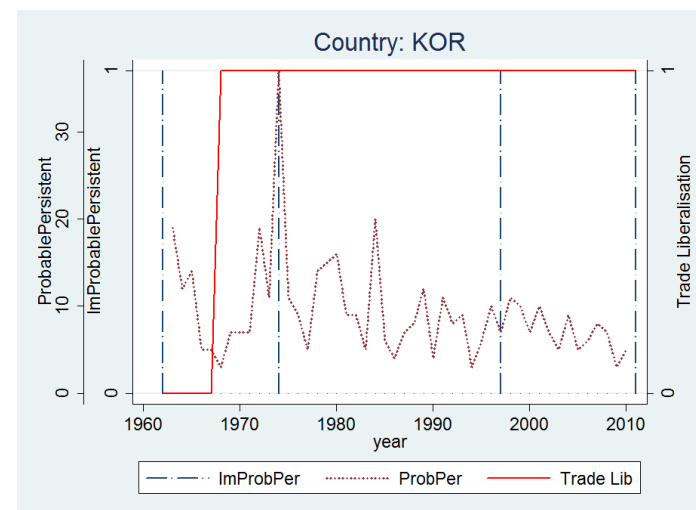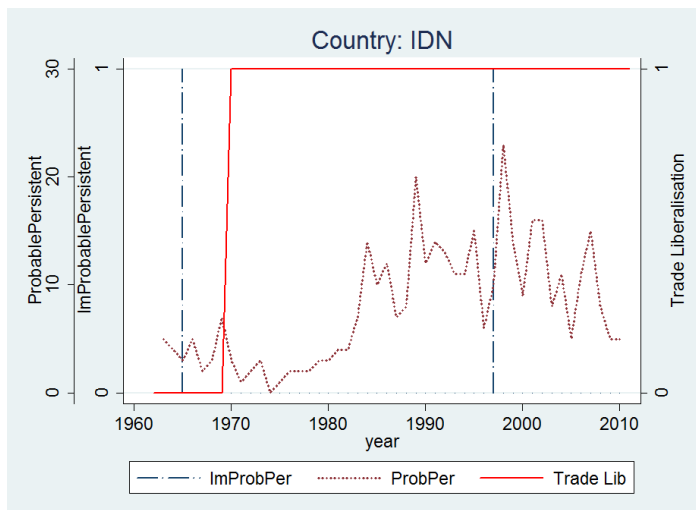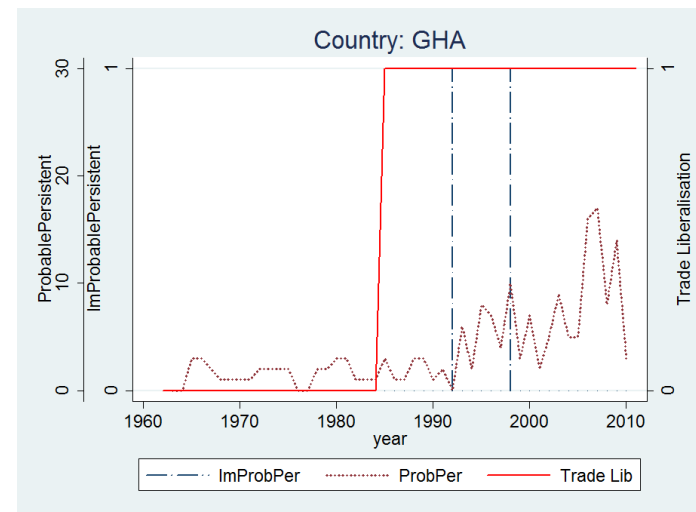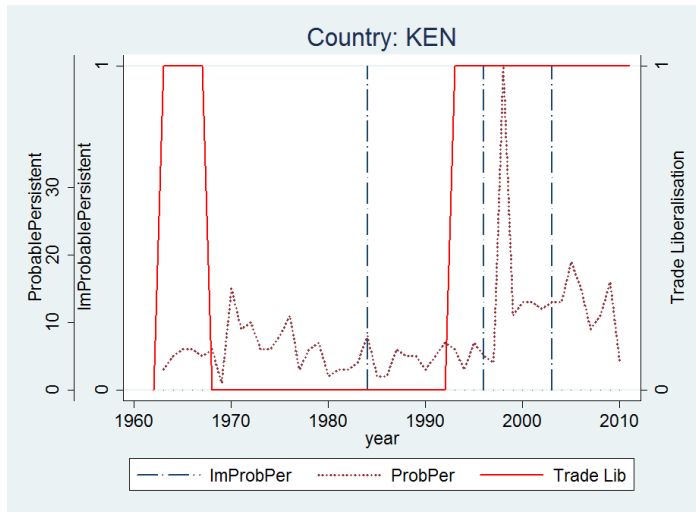
# Q1: Does Product Emergence ("de novo" products) increase under trade liberalisation regimes?

$$ProbableEmergence_{ct} = \beta_1 TradeLib_{ct} + GDDPC_t + Y_t + C_c + \epsilon$$

| ALL | Probable | | | Probable and Persistent | | |
|---|---|---|---|---|---|---|
| | A | B | C | A | B | C |
| Trade Liberalisation (0 = Not Lib) | 2.76*** (1.01) | 2.64*** (0.92) | 0.84** (0.39) | 1.84*** (0.5) | 1.89*** (0.45) | 0.58*** (0.21) |
| Observations | 5469 | | | 5342 | | |
| Country Clusters | 129 | | | 129 | | |
| R-Squared | | | | | | |
| Within | 0.19 | 0.21 | 0.12 | 0.19 | 0.19 | 0.10 |
| Between | 0.09 | 0.02 | 0.02 | 0.13 | 0.03 | 0.00 |
| Overall | 0.01 | 0.07 | 0.07 | 0.03 | 0.08 | 0.05 |
| Other Controls | GDDPC (Constant US$2005) | | | | | |
| Fixed Effects | Year and Country | | | | | |

# What does this mean?

| All Countries | A | B | C |
|---|---|---|---|
| Mean | 7.42 | 6.77 | 2.92 |

This suggests that an 1.8 additional products emerge *on average* which equates to ~25% increase in number of _probable_ and _persistent_ emergent products *on average*.

In a sample of <u>developing countries</u> only the equivalent increase is ~18% increase in the number of _probable_ emergent products on average

# Looking at Distant Emergence

$$ImProbableEmergence_{ct}\{0,1\} = \beta_1 TradeLib_{ct} + GDDPC_t + Y_t + C_c + \epsilon$$

However, trade liberalisation regime has **no** systematic relationship to this characterisation of <u>Improbable</u> product emergence events

▶                                                                    Logistic Fixed Effects Regression

# Summary so far …

▸ Trade liberalisation is associated with an **increase** in the rate of probable product emergence (products that are relatively close to existing products in country export baskets) but **not** related to large jumps in the product space network.

▸ Result in line with Hidalgo (2007) which shows that products tend to emerge close to existing products

▸ Countries diffuse faster through the product space into *nearby* products suggesting trade liberalisation is supportive of faster accumulation of underlying capabilities on the margin.

▸

# Q2: Is trade liberalisation associated with more distant product emergence?

Measures of Diffusion Distance ....

Variance of Proximity

$$\phi_{var} = \frac{1}{n}\sum_{i=1}^{n}(\rho_i - \mu)^2$$
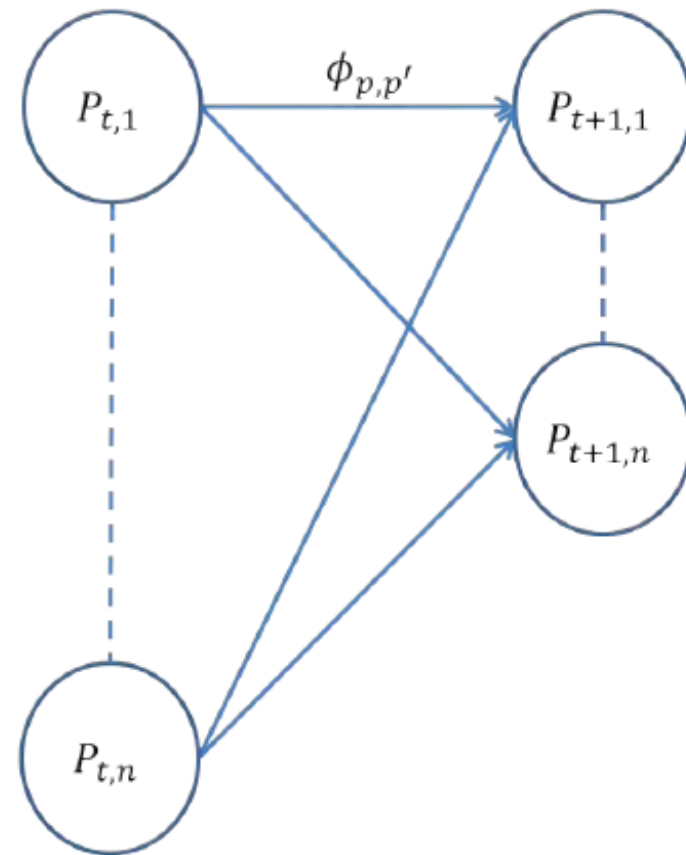
Width of Proximity

$$\phi_{width} = \max(\rho_{i\,..\,N}) - \min(\rho_{i\,..N})$$

<u>Pro:</u>
Measure is insensitive to the density of the distribution of proximity



Current Export Basket     New Products

# Q2: Are trade liberalisation regimes associated with more distant product emergence?

$$WidthProximity_{ct} = \beta_1 TradeLib_{ct} + GDPPC_t + Y_t + C_c + \epsilon$$

| ALL | Width of Diffusion | | |
|---|---|---|---|
| | A | B | C |
| Trade Liberalisation (0 = Not Lib) | 0.037** (0.018) | 0.041** (0.017) | 0.033** (0.014) |
| Observations | 5069 | | |
| Country Clusters | 129 | | |
| R-Squared | | | |
| Within | 0.13 | 0.15 | 0.10 |
| Between | 0.06 | 0.07 | 0.10 |
| Overall | 0.01 | 0.01 | 0.01 |
| Other Controls | GDDPC (Constant US$2005) | | |
| Fixed Effects | Year and Country | | |

Panel Fixed Effects Regression

# What does this mean?

▶ Trade liberalisation is correlated with an **increase** in the width of diffusion in the product space.

▶ Given the effective region of the histogram constitutes values between 0 and 0.5, trade liberalisation is associated with a *moderate* increase of 0.04, or a widening of approximately 8%.

▶ Products emerging further away from existing products suggests a higher degree of underlying diversification in the set of country capabilities.

▶

# Robustness

- Regressions conducted on **all** countries and a restricted dataset for just **developing** countries (as defined in 1962)

- Regressions conducted on dataset restricted to 1962 and 2000 (NBER only data) and 1984 to 2000 to use a dataset with fully consistent SITC rev 2 product codes with similar results

# Conclusions

▸ Trade liberalisation is associated with an **<u>increase</u>** in new probable product emergence of between 18 and 25%

  ▸ Reinforcing a country's comparative advantage

  ▸ This paper also confirms the finding in Hidalgo (2007) that products tend to emerge "close" (probable product emergence) to current exports.

▸ Trade liberalisation regimes are associated with a moderate **<u>increase</u>** in the ***diversity*** of new products.

  ▸ Diffusion to products further away suggests an *increase* in the underlying diversity of a country's set of unobserved capabilities

▸

# Future Work

▸ Learn more about network diffusion models

▸ Does trade liberalisation encourage diffusion towards the centre (industrialized core) of the network?

▸ Import Structural Change
  ▸ Are there systematic structural differences on the import side under trade liberalisation regimes?

▸ A directed Network Representation of the Proximity Matrix to account for asymmetry of conditional probabilities.

▸