



Série de Seminários do Programa Crescimento inclusivo em Moçambique

Crescimento inclusivo em tempos de múltiplas crises

ORIENTAÇÕES PARA SESSÃO

- A apresentação durará 30 minutos, seguida por uma sessão de perguntas e respostas de 30 minutos.
- Durante a apresentação, o seu microfone será colocado no modo mudo. No entanto, pode enviar perguntas aos apresentadores por meio do *chat*.
- Uma sessão de perguntas e respostas será realizada após a apresentação. Para fazer uma pergunta, clique em “Levantar a mão” e o moderador/a da sessão ativará o som.
- Recordamos que apresentação do seminário será gravada e adicionada a posterior no canal do CEEG/UEM no YouTube.



IGM Seminar series 2021 | 18 March 2021

Economic Complexity and Structural Transformation: The Case of Mozambique

by

Bjørn Bo Sørensen (presenter)

Christian Estmann (presenter)

Enilde Francisco Sarmento

John Rand

Mozambique's current industrial policy regime focuses on a broad range of sectors

Mozambique's current industrial policy regime

- **The National Development Strategy (2015-35)** gives priority to 1) agriculture; 2) fishery; 3) extractives; 4) tourism; and 5) manufacturing.
- **The Industrial Policy and Strategy (2016-25)** gives priority to 1) food and agro-industry; 2) clothing, textiles and footwear; 3) non-metallic minerals; 4) metallurgy and manufacture of metal products; 5) wood and furniture processing; 6) chemicals, rubber and plastics; and 7) paper and printing.
- Sectors are chosen based on broad set of policy objectives
 - e.g. the Industrial Policy and Strategy (2016-25) prioritizes sectors in accordance with their 1) contribution to the current production level; 2) origin of raw materials used in production; 3) job creation; 4) import substitution; 5) export potential; 6) potential to generate upstream and downstream linkages; and 7) ease of policy implementation.

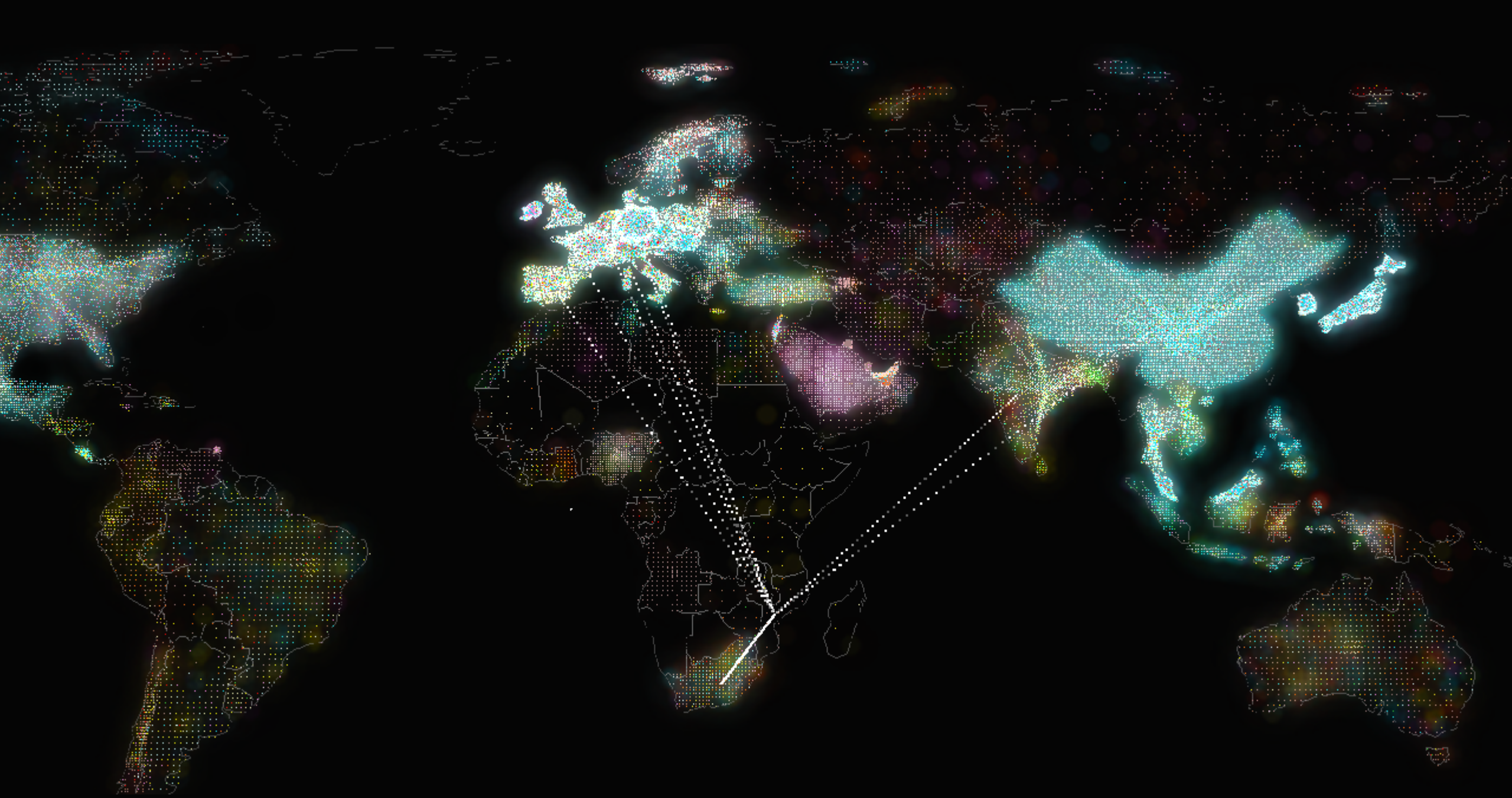
What we do

- We develop a supply-demand framework
 - **Supply-side:** The literature on **economic complexity** proposes a method to identify sectors that are important for structural transformation based on the productive capabilities residing in a country.
 - **Demand-side:** We extend the complexity-method with **gravity models** to estimate the country-specific export potential of different products across export destinations.
- We apply the supply-demand framework to Mozambique and identify an alternative set of “target sectors” and “target destinations”.

Outline

- Economic complexity and the riddle of economic growth
- Contribution to literature
- Data
- Supply-side analysis
- Demand-side analysis
- Limitations
- Conclusion





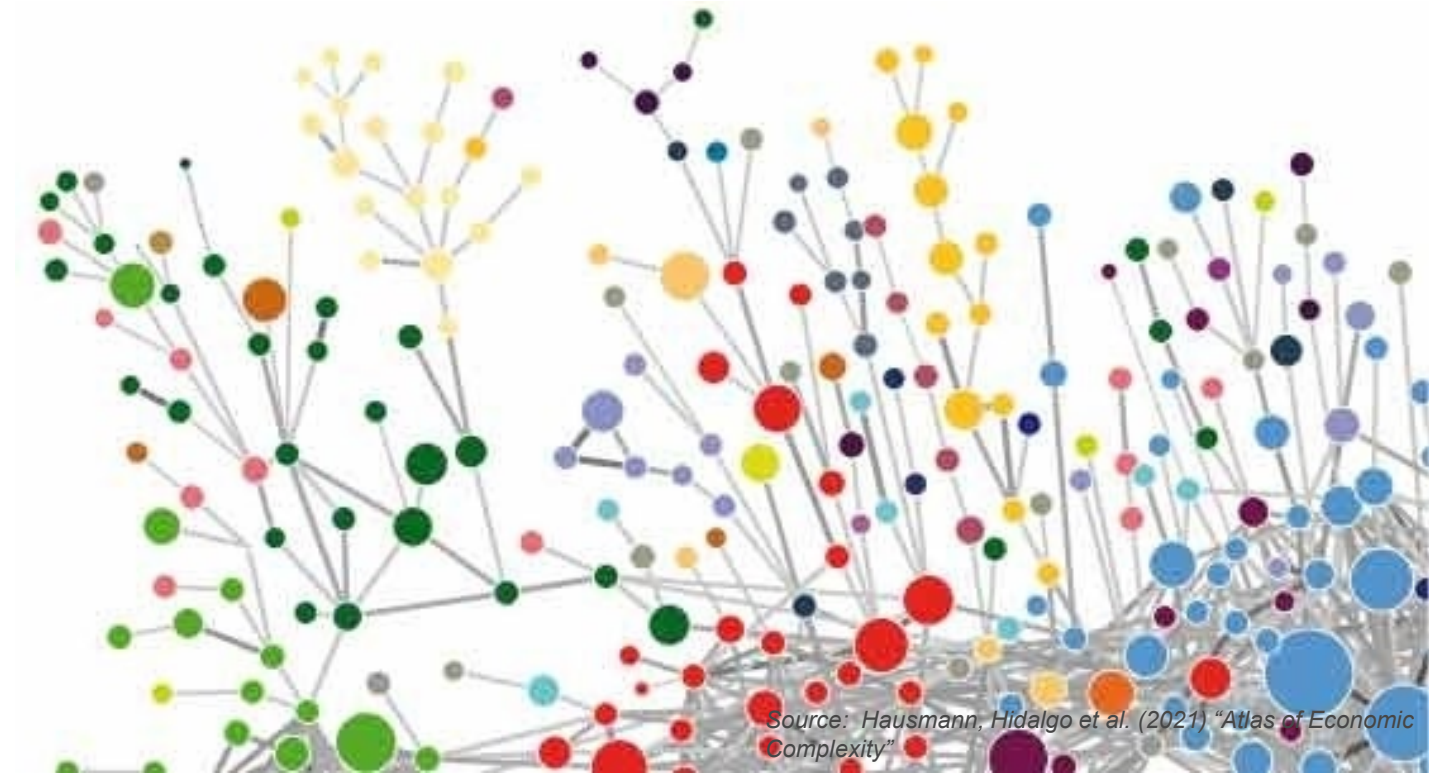
Source: *The Globe of Economic Complexity* / Center of International Development – Harvard University



Hausmann and Hidalgo – Atlas of
Economic Complexity
What you make matters



Associating complexity with
development



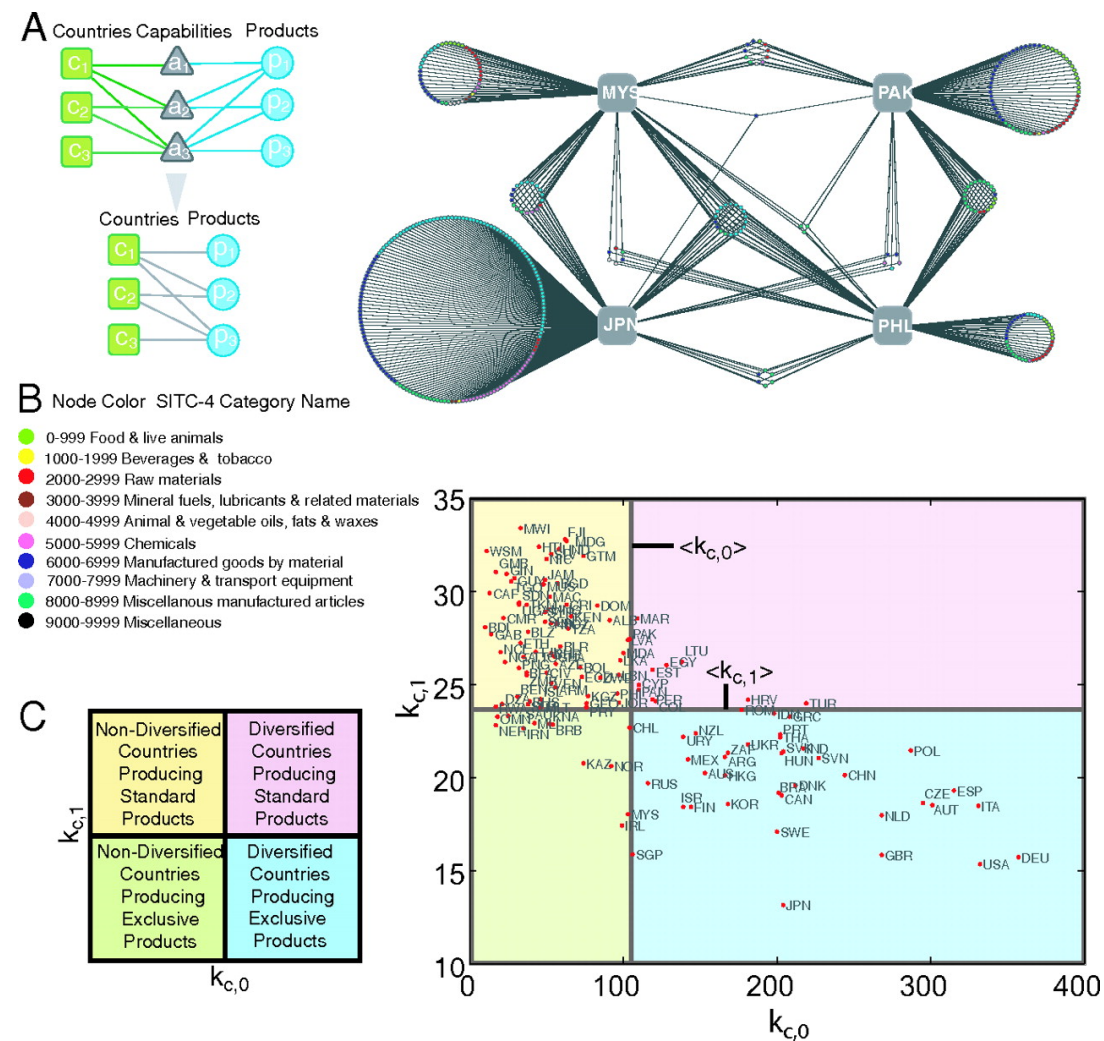
Source: Hausmann, Hidalgo et al. (2021) "Atlas of Economic Complexity"

Only players (countries) with a larger diversity of letters (capabilities) will be able to make more and more unique (complex) words (products).



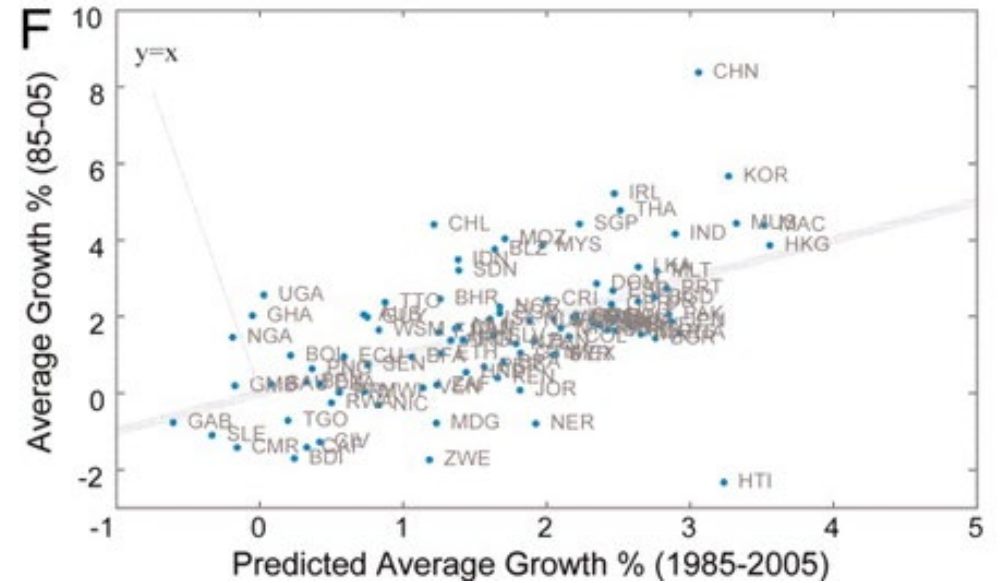
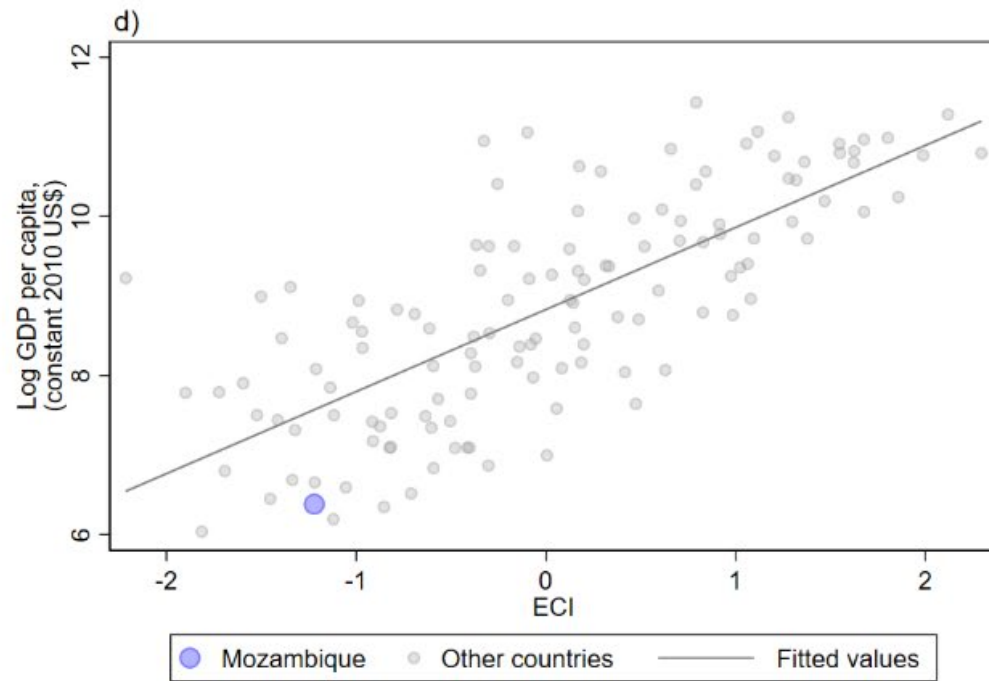
At the same time, words (products) that require more letters (capabilities) will be harder to make and therefore only made by players (countries) that have all the required pieces.

Quantifying countries' economic complexity

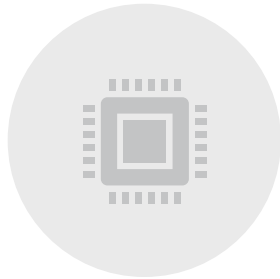


César A. Hidalgo, and Ricardo Hausmann PNAS 2009;106:26:10570-10575

Economic complexity and income



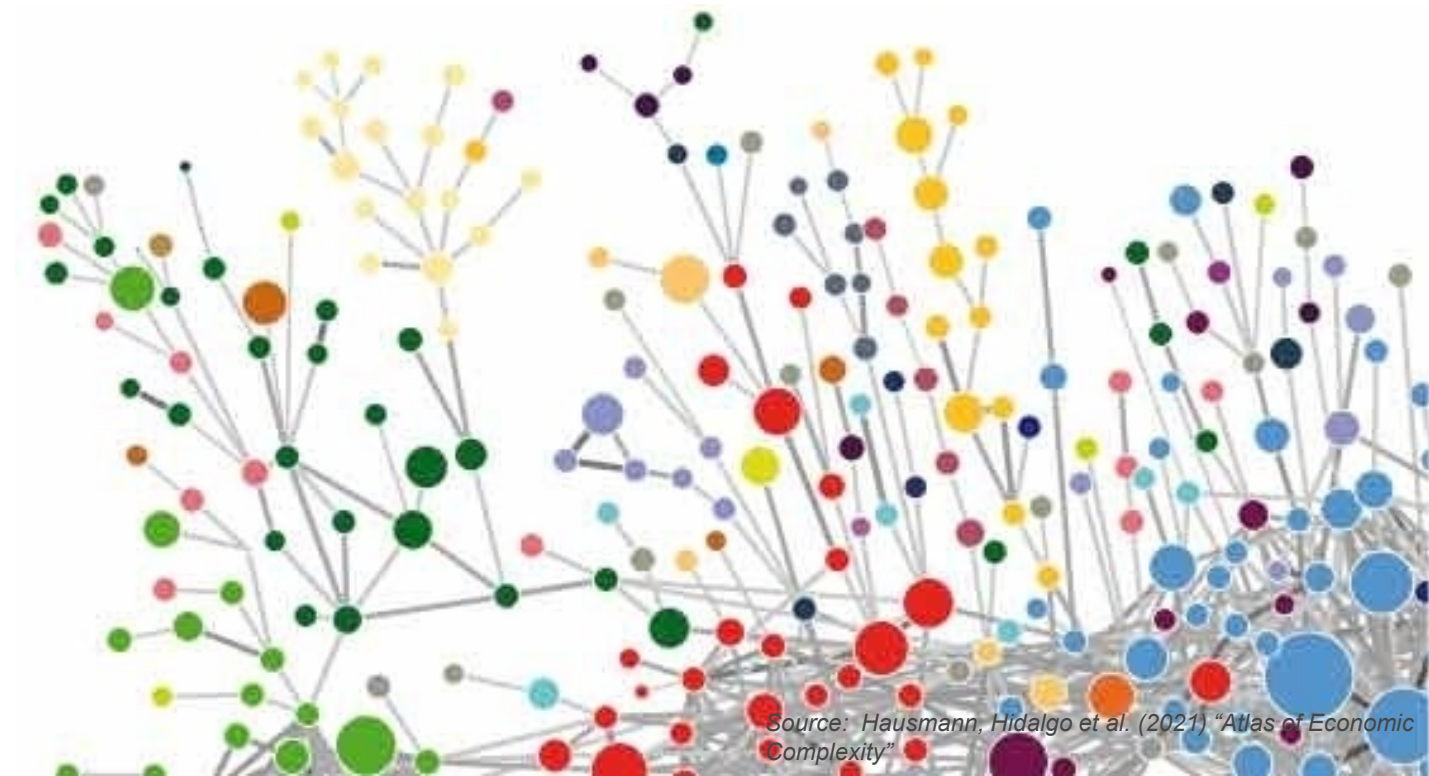
Source: César A. Hidalgo, and Ricardo Hausmann PNAS 2009;106:26:10570-10575



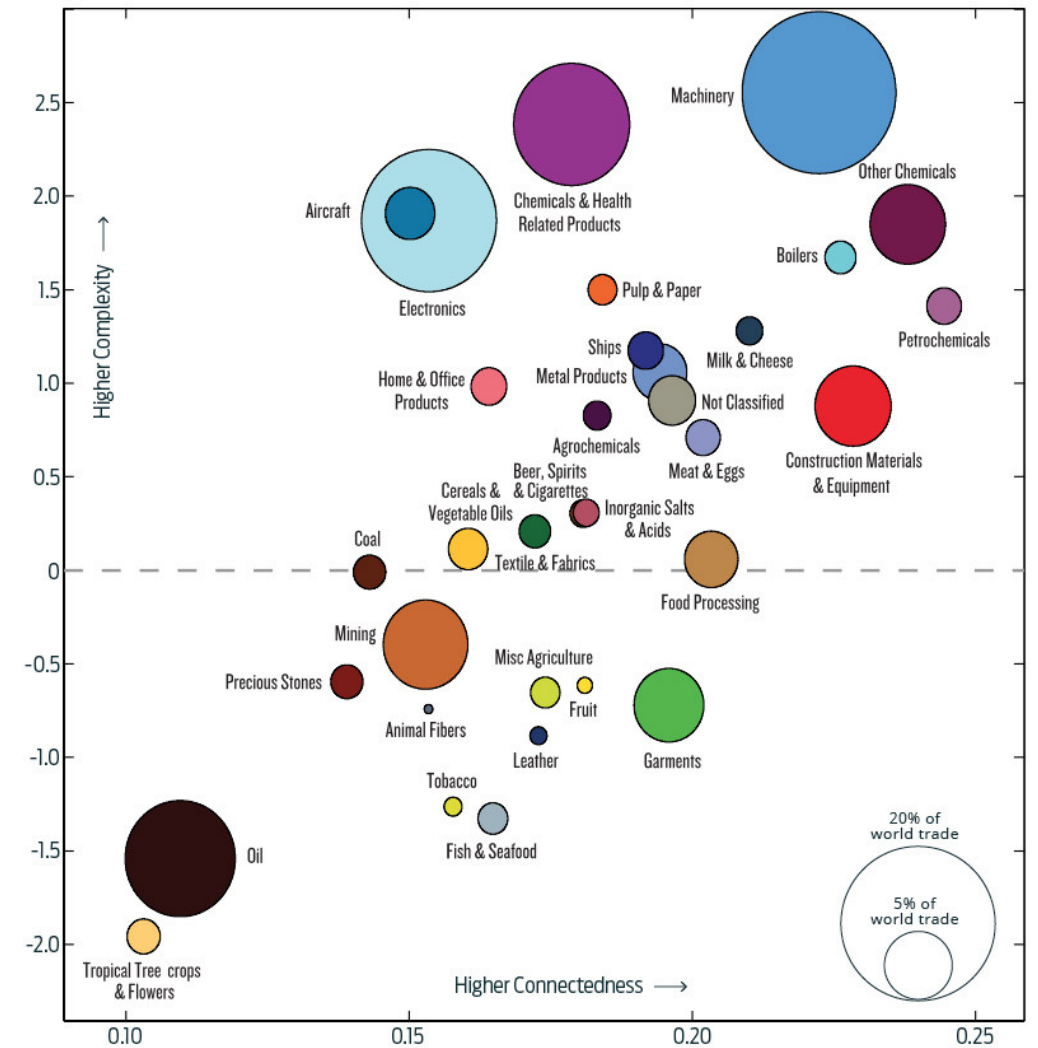
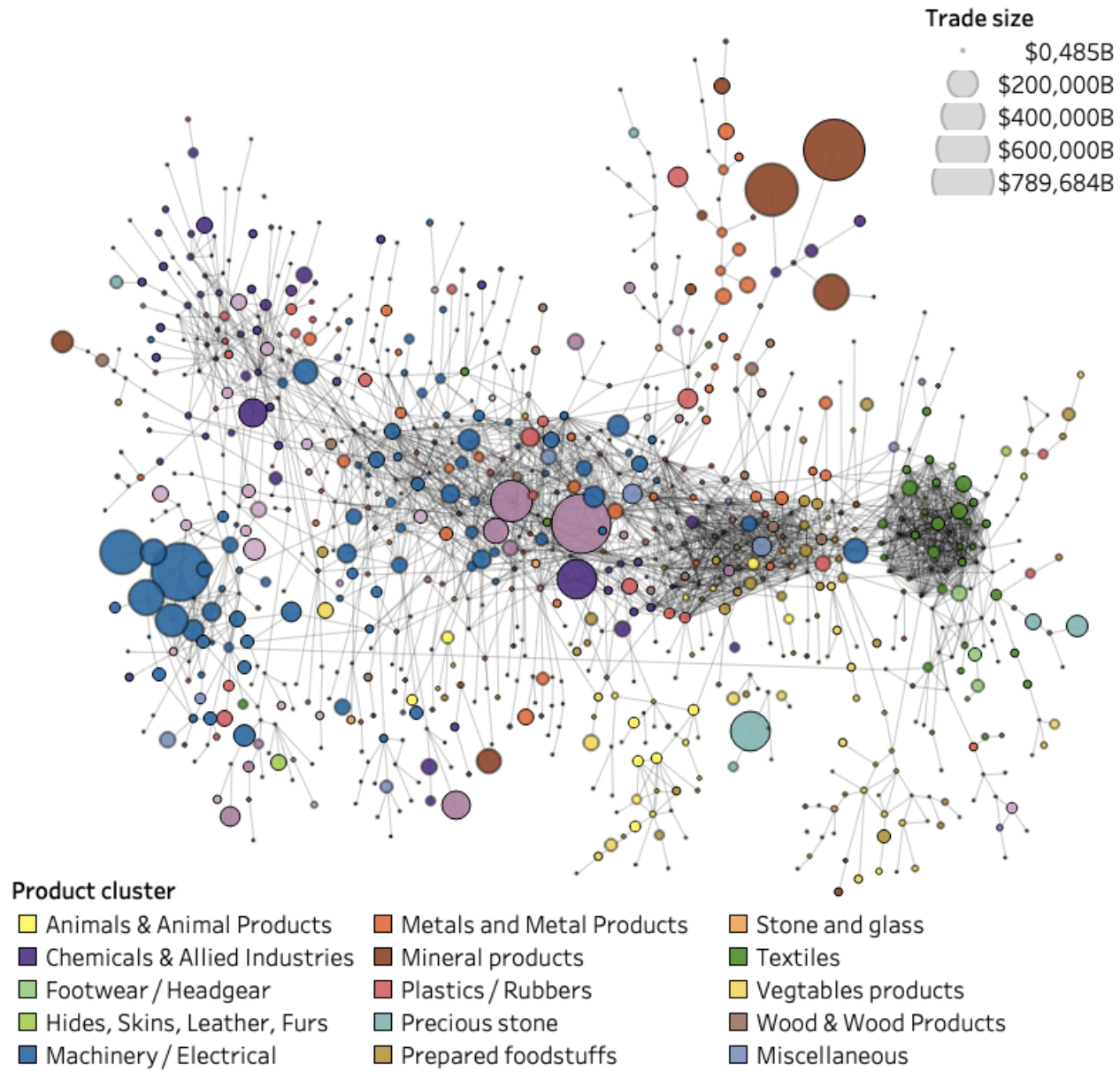
Data-driven approach,
conducting a network illustrating
products relatedness - the
Product Space



By mapping countries Revealed
Comparative Advantages (RCAs)
in the Product Space, we can
identify opportunities that lay
nearby

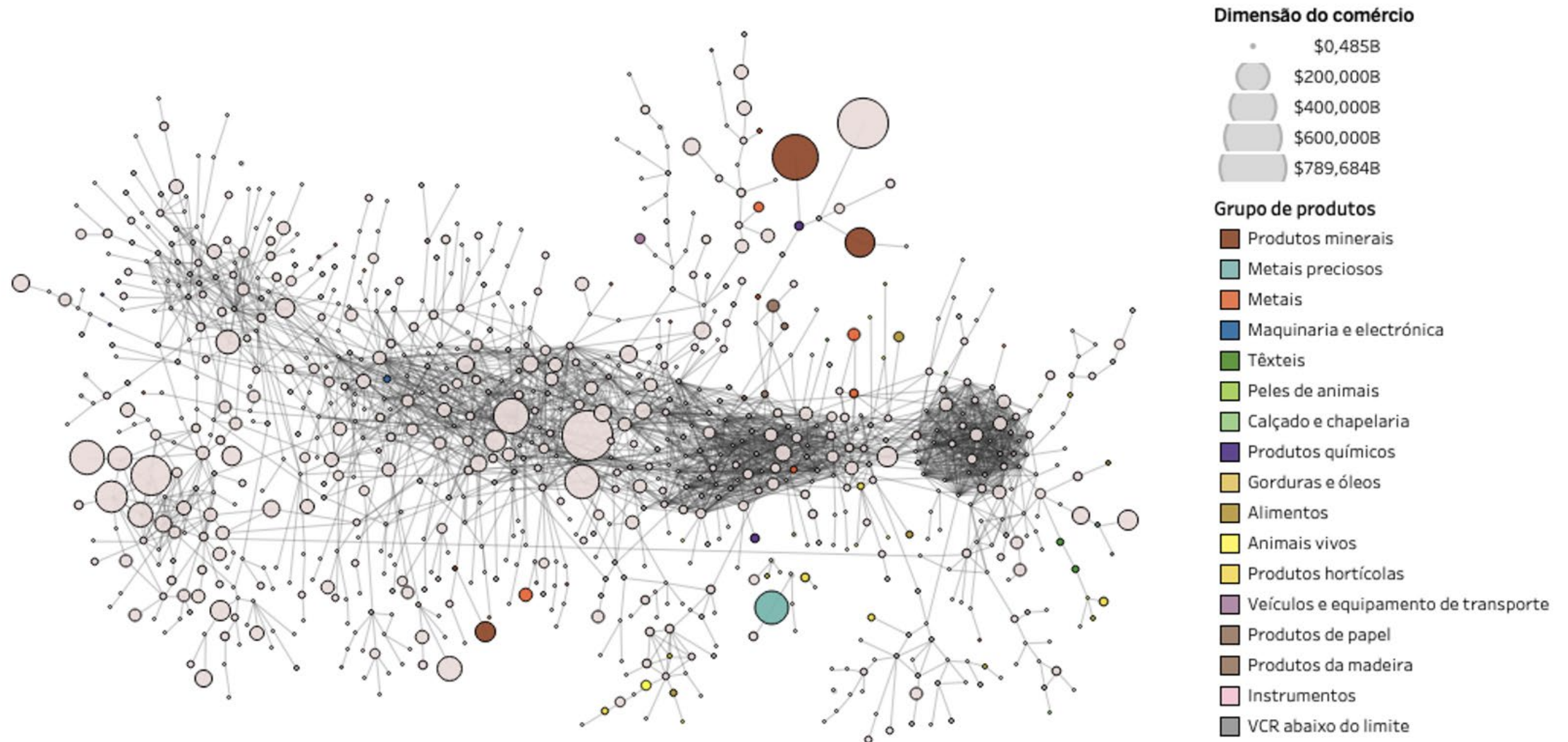


Source: Hausmann, Hidalgo et al. (2021) "Atlas of Economic Complexity"



Source: Diversifying Growth in Light of Economic Complexity, by Muhammed Yildirim

Mapping Mozambique in the Product Space and identifying derivate industries to promote in order to move up the complexity scale



We contribute to two strands of literature

Studies applying the economic complexity methodology to guide industrial policy

- **Examples include:** work on South Africa (Hausmann and Klinger 2006), Rwanda (Hausmann and Chauvin 2015), Jordan (Hausmann et al. 2019), Panama (Hausmann, Morales, and Santos 2016; Hausmann, Santos, and Obach 2017), Myanmar (Ayres and Freire 2014), Uganda (Hausmann et al. 2014), the Netherlands (Hausmann and Hidalgo 2013), and Southern Africa (Hidalgo 2011).
- **Contribution:** Demand-side analysis using gravity model estimation.

Studies on sectoral importance for structural transformation in Mozambique

- **Examples include:** CGE models analyzing the effects of investments and productivity improvements in agriculture and agro-processing (Jensen and Tarp 2004) and biofuels (Arndt et al. 2010; Hartley et al. 2019).
- **Contribution:** We add a new methodology to evaluate the attractiveness of sectors in Mozambique.

Data

Our analysis relies primarily on **international trade data** collected by UN COMTRADE, cleaned by the Growth Lab at Harvard University.

Supply-side

- Trade data at exporter-product level.
 - Export value of 1221 products (HS 4-digit) for 131 countries from 1998-2018.
- Used to calculate the structural transformation-potential of different products.

Demand-side

- Trade data at exporter-importer-product level.
 - Trade value of 84 target products for 195 countries from 2011-2018.
 - Supplemented with GDP data (World Bank), regional trade agreements (WTO), and various distance indicators such as common language, colonial ties, contiguity, and physical distance, (CEPII).
- Used to run gravity regressions to estimate the export potential of identified target products across destinations.

Supply-side methodology

Aim

Identify new products and sectors that will contribute to economic complexity and that Mozambique can develop relatively easily.

Basic approach

We use methods from network science to calculate the structural transformation-potential of products.

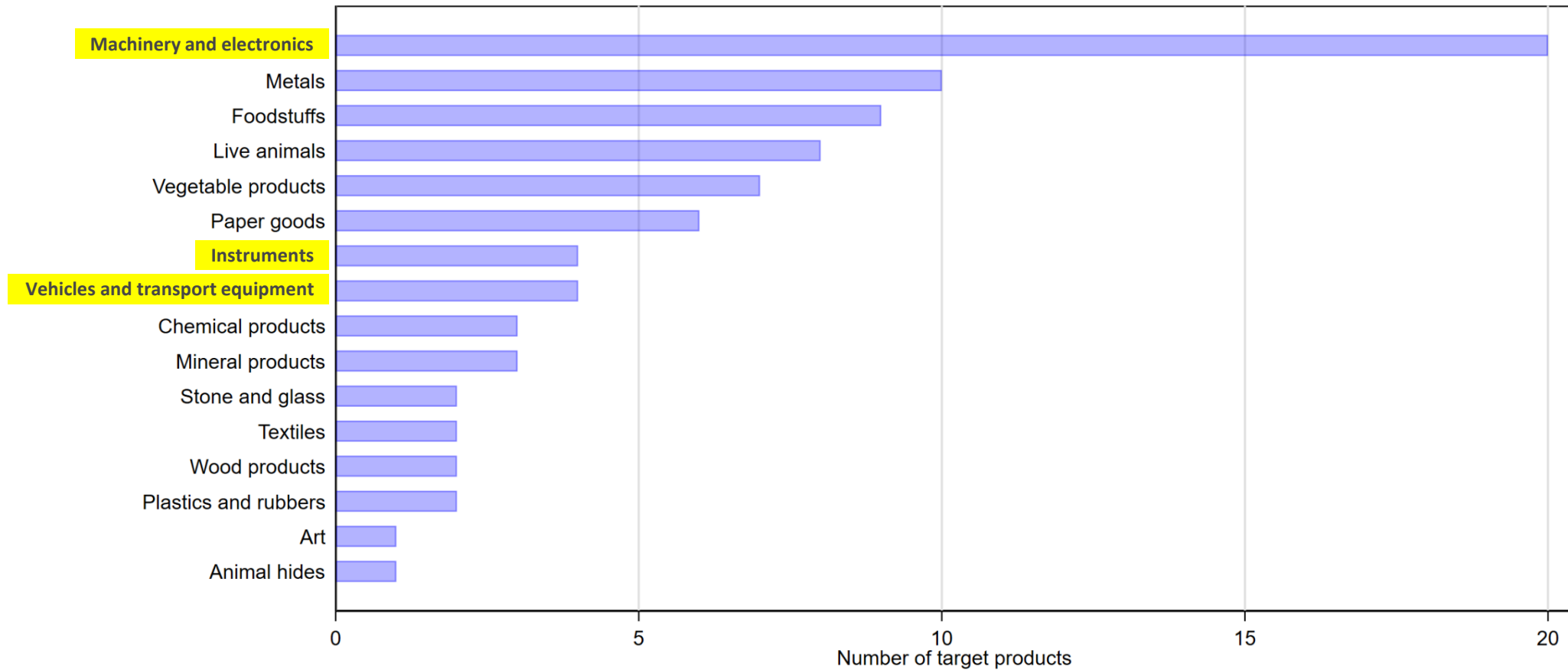
Three criteria for selection of products

1. **Complexity:** products increasing the complexity of Mozambique's economy.
2. **Ease of development:** products relying on the productive capabilities Mozambique's already has.
3. **Stepping-stone potential:** products making it easier to diversify into other complex products.

Weighting scheme

To evaluate the structural transformation potential of each product, we combine all three measures into one variable by assigning a weight to each measure and summing the weighted measures.

Distribution of 84 identified target products across sectors



Demand-side methodology

Aim

Rank the 84 target products according to their export potential for Mozambique.

Gravity model

- Product-level gravity estimations, where we run a regression for each target product to allow for product-specific coefficients.
- Poisson Pseudo-Maximum-Likelihood (PPML) estimator.

$$T_{int}^{\{p\}} = \exp \left(\alpha^{\{p\}} + \boldsymbol{\beta}^{\{p\}'} \ln \boldsymbol{\phi}_{in} + \gamma_{it}^{\{p\}} + \theta_{nt}^{\{p\}} \right) \times \varepsilon_{int}^{\{p\}}$$

Indexing

- p : product; i : exporter; n : importer; t : year

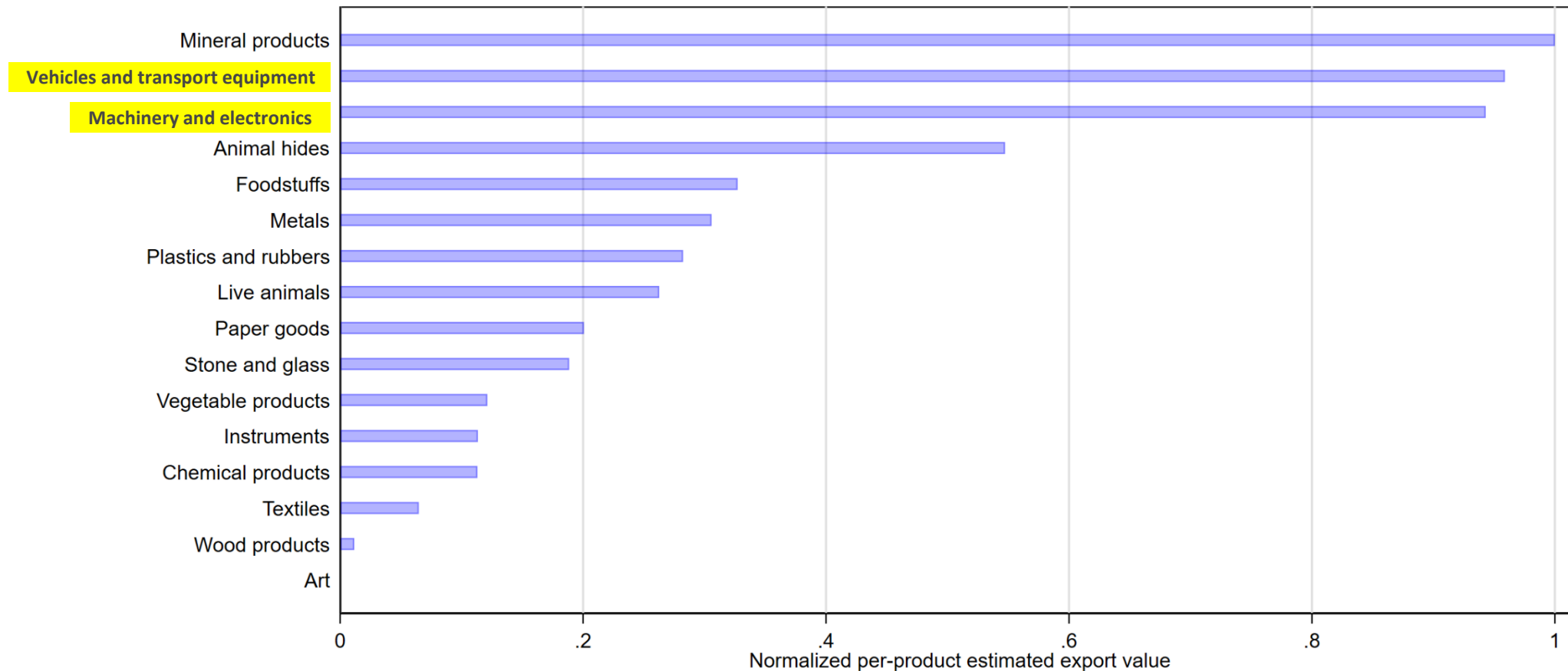
Variables

- $T_{int}^{\{p\}}$: trade volume between exporter i and importer n in product p and year t
- $\boldsymbol{\phi}_{in}$: vector of dyadic distance measures: physical distance (log); contiguity (dummy); common language (dummy); colonial tie (dummy), regional trade agreement (dummy).
- $\gamma_{it}^{\{p\}}$, $\theta_{nt}^{\{p\}}$: importer-year and exporter-year fixed effects.

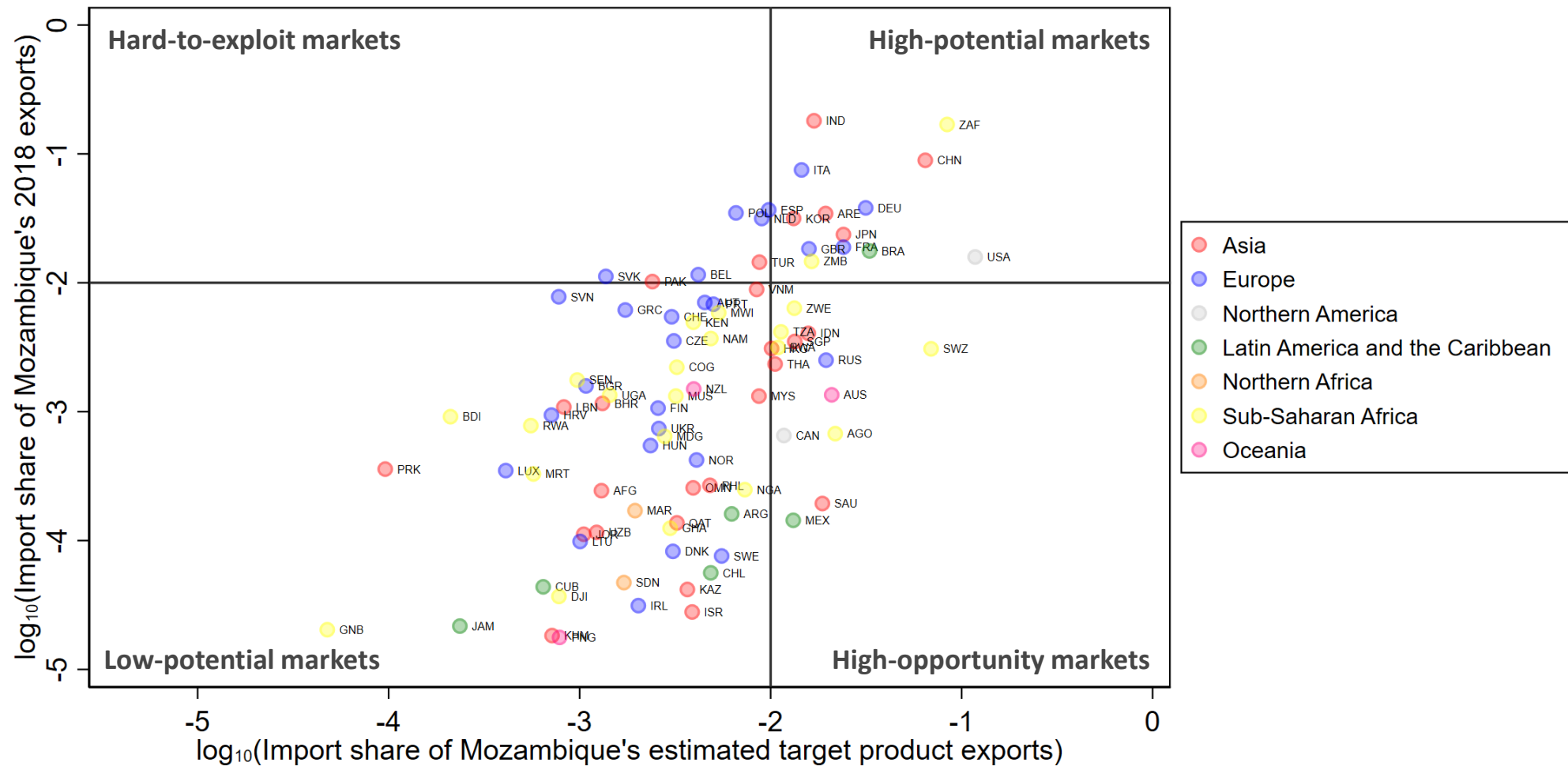
Product and destination export potential

With the gravity model we can predict the potential export revenue of each target product for Mozambique across different destinations.

Average, predicted export value of the 84 target products across sectors (normalized values)



Countries' current share in Mozambique's exports (2018) versus Countries' predicted share of Mozambique's target products



Limitations

Data limitations:

- **Only tradable sectors:** We only measure the productive capabilities in tradable sectors. There is a large part of Mozambique's economy that is “invisible” in our analysis.
- **No service data:** We can only account for *tradable products* because no detailed data on *tradable services* exist.
- **Re-exports:** We cannot distinguish between domestic production and re-exports. We may incorrectly attribute re-exports to productive capabilities in Mozambique.

Political priorities and realities:

- **Selection criteria:** Our criteria for selecting target products are narrower than the selection criteria listed in the Industrial Policy and Strategy (e.g. employment generation). Policy makers should take all relevant objectives into account when prioritizing industries.

Conclusion

What we do

We combine a supply-side and demand-side analysis to identify new product sectors that **(i)** are important for structural transformation and **(ii)** export revenue in Mozambique. **(iii)** We also identify export markets important to drive demand for these products.

What we find

- Target products:
 - The **broad sectoral focus** of Mozambique's current policy is largely in line with an ambition to boost structural transformation.
 - The current focus on **agriculture, agro-industry, and metals** is especially important for structural transformation and export revenue.
 - There are unaddressed opportunities in **machinery & electronics** and **vehicles & transport equipment**.
- Target destinations:
 - Mozambique's **current trade partners** are also important export destinations for Mozambique's target products.
 - Some of Mozambique's **neighboring countries** have a high-potential in driving demand in target sectors.

A photograph of a port area. In the foreground, there are several stacks of shipping containers. The containers are mostly blue and white, with some red ones. They have various labels and logos, including the Maersk logo (a white star on a blue background). In the background, there is a large blue crane structure with the number '335' on it. The sky is clear and blue. The overall scene is industrial and busy.

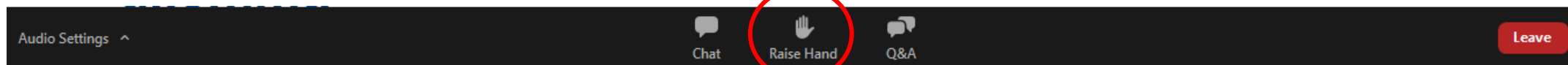
Thank you!



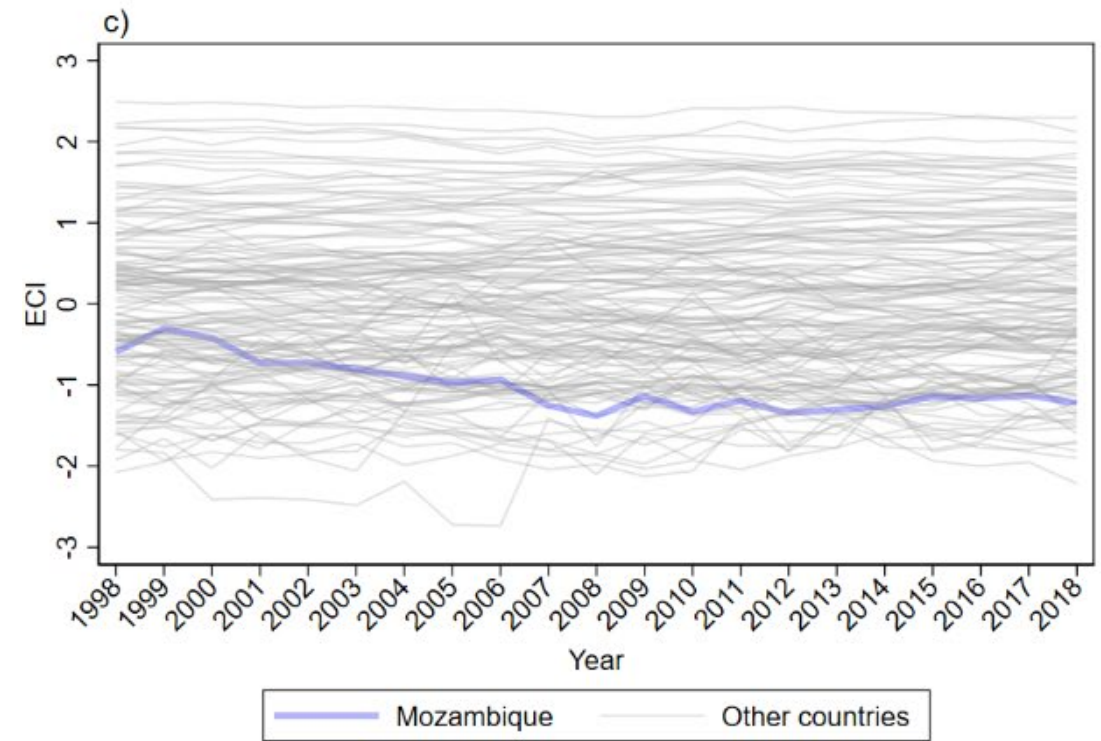
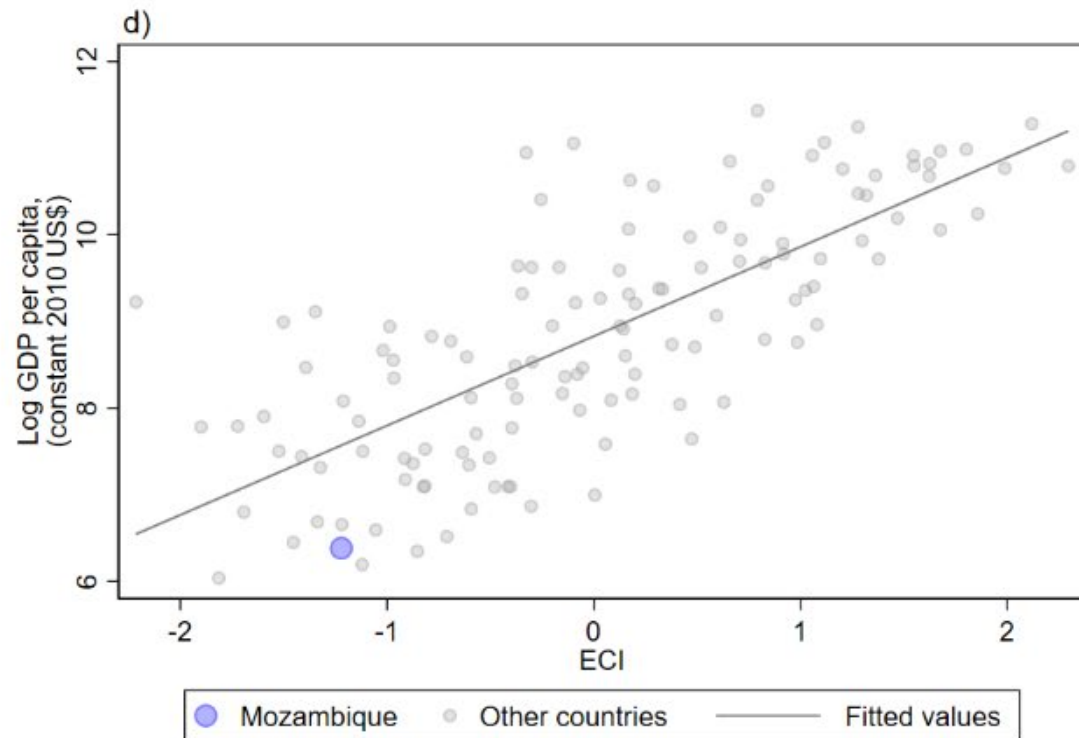
Série de Seminários do Programa Crescimento inclusivo em Moçambique
Crescimento inclusivo em tempos de múltiplas crises

OBRIGADA!

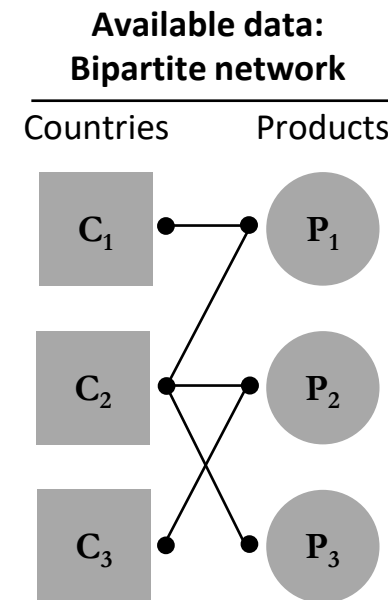
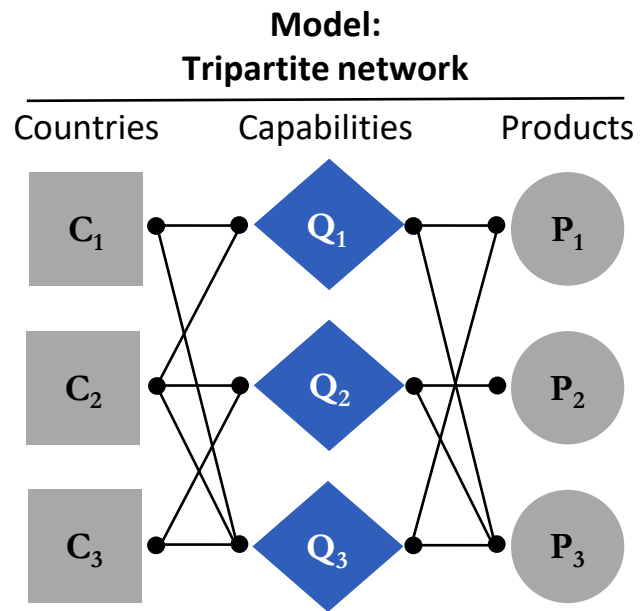
- Segue a sessão de Perguntas e Respostas
- Para fazer uma pergunta, clique em “Levantar a mão” e o moderador/a da sessão ativará o som.



Why do we care about economic complexity?



The hidden capabilities layer in the country-product network



Calculating the Product Complexity Index (PCI)

Adjacency matrix, M_{cp} , defining the country-product network:

$$M_{cp} = \begin{cases} 1 & \text{if } RCA_{cp}^t > 1 \text{ or } \left(\frac{1}{4} \sum_{i=0}^4 RCA_{cp}^{t-i} \right) > 1 \\ 0 & \text{otherwise} \end{cases}$$

where c denotes country, p denotes product, and t denotes year.

First approximation of country and product complexity:


$$Diversity = k_{c,0} = \sum_p M_{cp}$$

$$Ubiquity = k_{p,0} = \sum_c M_{cp}$$

where 0 denotes the 0^{th} iteration of the algorithm.

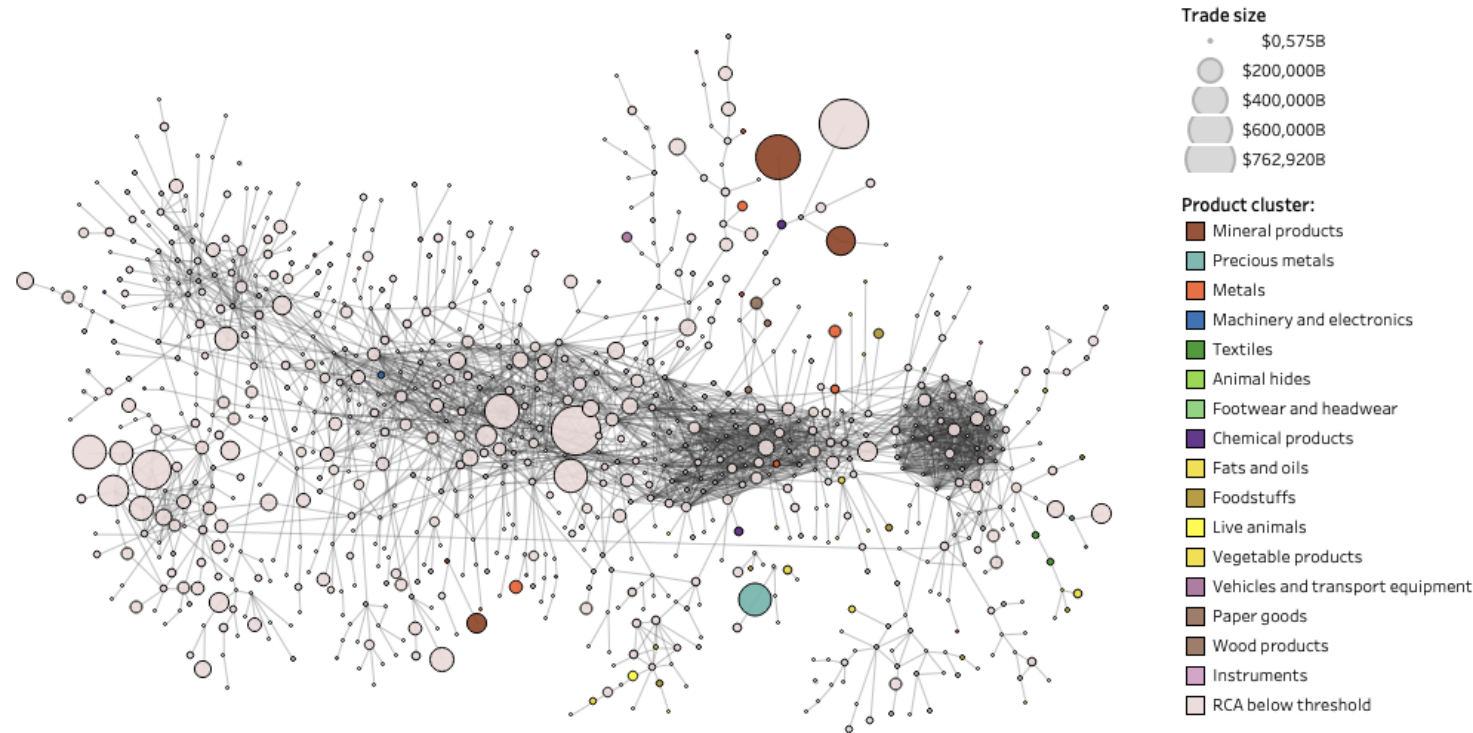
Algorithm (Method of Reflections):

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp} k_{p,N-1}$$

Our Product Complexity Index (PCI)  $k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp} k_{c,N-1}$

where N denotes the N^{th} iteration of the algorithm.

The Product Space network



Proximity

The proximity (edge), $\varphi_{p,p'}$, between product p and p' (nodes) is the minimum of the pairwise probabilities that the products are co-exported by countries.

$$\varphi_{p,p'} = \min\{P(M_{c,p} = 1 | M_{c,p'} = 1), P(M_{c,p'} = 1 | M_{c,p} = 1)\}$$

Calculating Density and Opportunity Gain Index (OGI)

Density

- Density, $d_{c,p}$, measures the extent to which a product p relies on the same capabilities as the products the country c is currently exporting.
- $d_{c,p}$ is the sum of the proximities between p and all the products that country c is exporting with an $RCA > 1$.

$$d_{c,p} = \frac{\sum_c M_{c,p'} \varphi_{p,p'}}{\sum_{p'} \varphi_{p,p'}}$$

Opportunity Gain Index

- The Opportunity Gain Index, $OGI_{c,p}$, measures the extent to which a new product can open up links to more complex products.
- It measures how close a new product is to other not-exported products, weighted by the complexity of those products.

$$OGI_{c,p} = \sum_{p'} \frac{\varphi_{p,p'}}{\sum_{p''} \varphi_{p',p''}} (1 - M_{c,p'}) PCI_{p'}$$

Weighting scheme

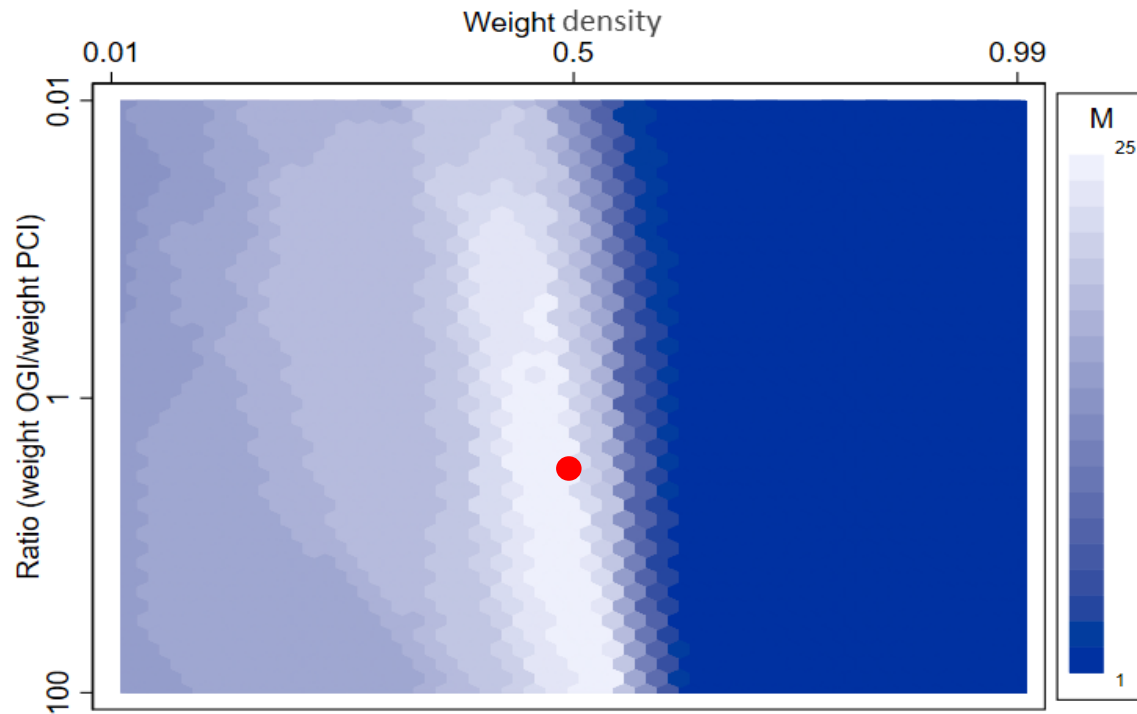
To evaluate the structural transformation-potential of each product, we combine all three measures into one variable by assigning a weight to each (normalized) measure and summing the weighted measures.

Strategy	Component	Weights		
		Density	PCI	OGI
Leverage & Support ($0.1 < RCA < 1$)	Low-hanging fruits (short run)	0.45	0.25	0.30
	Strategic bets (long run)	0.20	0.20	0.60
Diversify & Scale ($RCA < 0.1$)	Low-hanging fruits (short run)	0.65	0.15	0.20
	Strategic bets (long run)	0.50	0.10	0.40

We select the **25 products** with the highest score from each strategy and are left with **84 products** due to some overlap.

We document a high volatility of the results depending on the weighting scheme applied

Co-occurrence of selected target products when comparing applied weights in Diversify & Scale (strategic bets) strategy to all other possible weighting schemes.



● Applied weighting scheme

Implications:

- Lack of documentation of volatility is a significant shortcoming of previous studies.
- Conclusions should primarily be drawn at the sector level, where volatility is smaller.

Our study:

- We use the volatility simulation to purposefully identify products at either side of the cut-off.

Calculating the export potential of products and markets

Gravity equation:

$$T_{int}^{\{p\}} = \exp \left(\alpha^{\{p\}} + \boldsymbol{\beta}^{\{p\}'} \ln \phi_{in} + \gamma_{it}^{\{p\}} + \theta_{nt}^{\{p\}} \right) \times \varepsilon_{int}^{\{p\}}$$

Export potential in one target product:

$$\hat{T}_{Moz,nt}^{\{p\}} = \exp \left(\hat{\alpha}^{\{p\}} + \hat{\boldsymbol{\beta}}^{\{p\}'} \ln \phi_{Moz,n} + \hat{\theta}_{nt}^{\{p\}} \right)$$

where $\hat{\alpha}^{\{p\}}$, $\hat{\boldsymbol{\beta}}^{\{p\}'}$, and $\hat{\theta}_{nt}^{\{p\}}$ are respectively the estimates of $\alpha^{\{p\}}$, $\boldsymbol{\beta}^{\{p\}'}$, and $\theta_{nt}^{\{p\}}$.

We leave out importer-year fixed effects when predicting export potential.

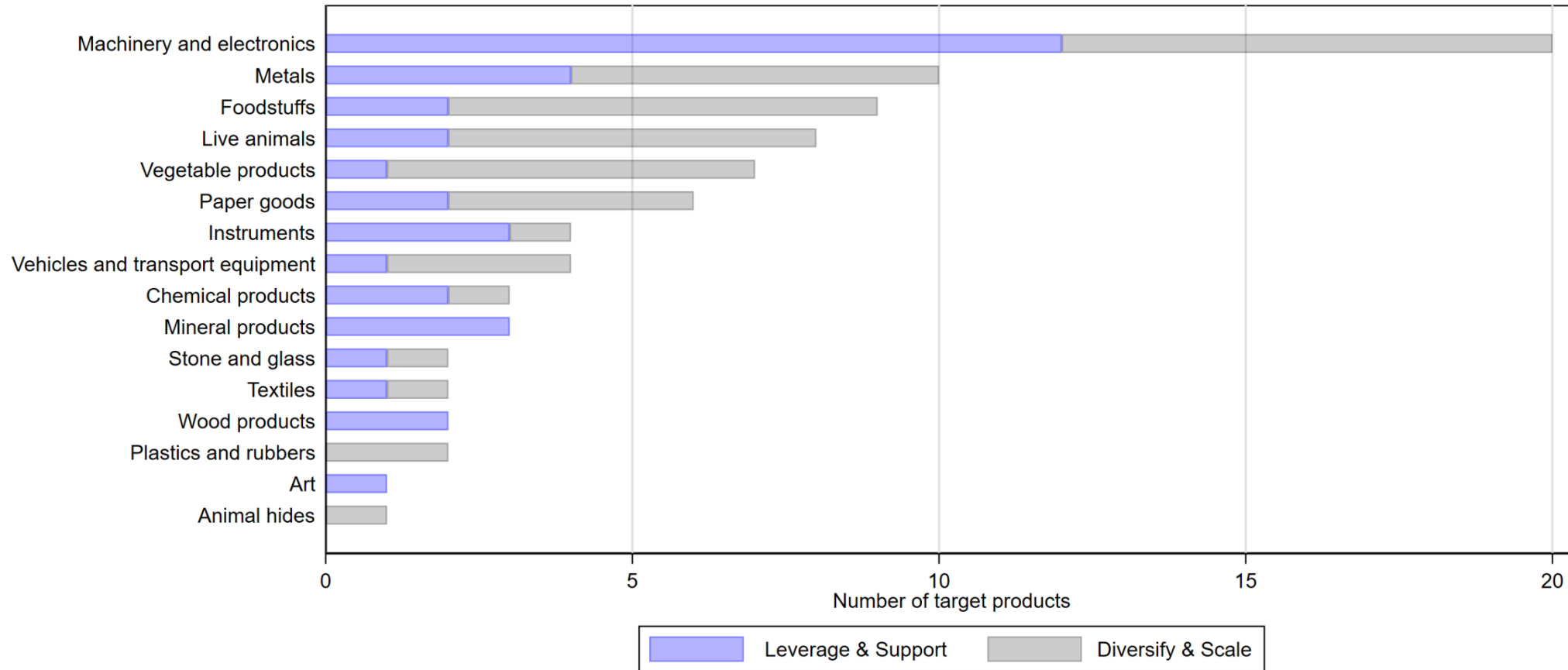
Market export potential (MEP):

$$MEP_n = \sum_{p,t} \hat{T}_{Moz,nt}^{\{p\}}$$

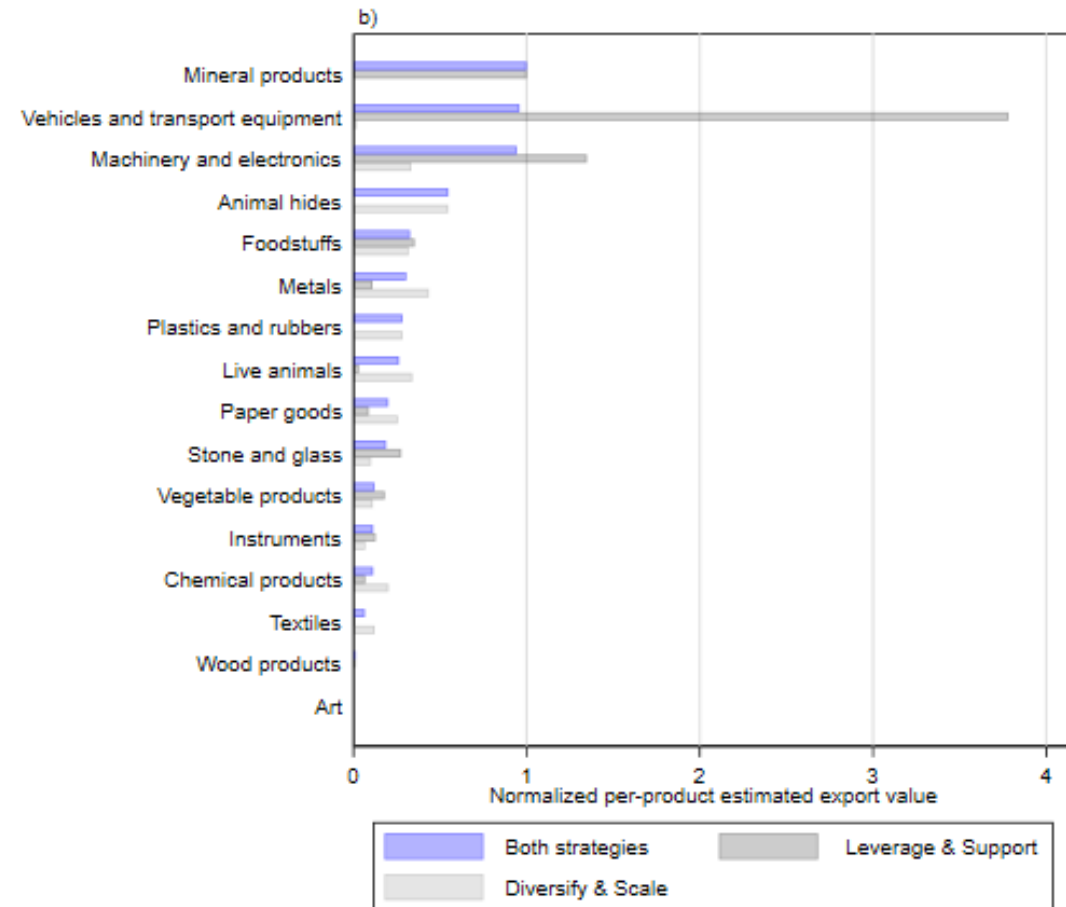
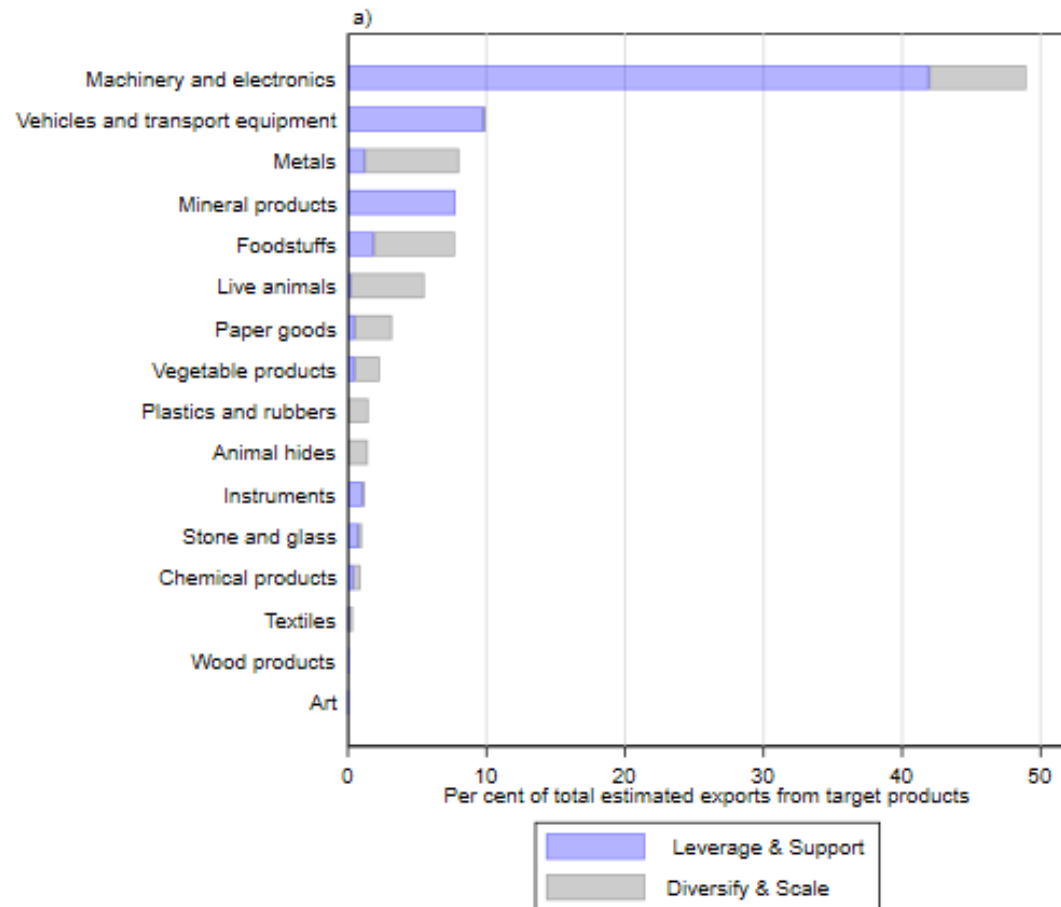
Product export potential (PEP):

$$PEP_p = \sum_{n,t} \hat{T}_{Moz,nt}^{\{p\}}$$

Distribution of 84 identified target products across product sector and weighting strategy



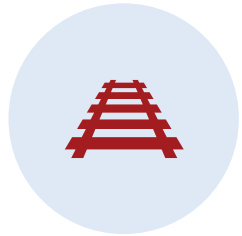
Estimated export revenue from the 84 identified target products averaged across product sector and weighting strategy (normalized values)



Some principles and thoughts on industrial policy

- **Industrial policy is only warranted under market failures:** We believe that there are higher externalities in some sectors, because the capabilities acquired to produce in those sectors are important in other new industries.
- **Invest in capabilities – not products** (unless you only care about export revenue).
- **Use the analysis as a roadmap:** We cannot directly observe capabilities in trade data. The sectors identified in our research is a roadmap to guide the search for the exact capabilities missing in Mozambique's scrabble game. This requires further analyses.
- **Sequential implementation:** Our analysis allow is to vary how much we value the closeness of products (ease of implementation). Mozambique could develop a sequential implementation of industrial policies, targeting “low-hanging fruit”-sectors first.

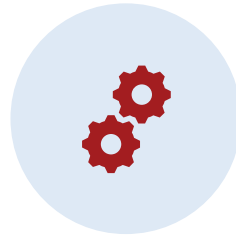
Obstacles for the industrial policy to be successful



HARD AND SOFT
INFRASTRUCTURE



PRIVATE AND PUBLIC
RELATIONS



RELIABILITY



COMMUNICATION
BETWEEN GOVERNMENT
AGENCIES



ETC.

No solution fits all



Learn to adapt to the new technologies - manage the risk



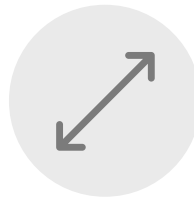
Balancing the role of the market, state and civil society. *The state plays a crucial role, through LIT policies.*



Development on a broader front – *services, manufacturing, agriculture and natural resources*



Democratic accountability and improved private/public relations



Involvement in GVCs should not be a sole focus, yet not neglected either.

If the developing countries just complete simple tasks, such as assembling components, they do not build institutions, know-how or a consumer market to maintain industries which all in all delimit the purpose.



Regional integration

What makes manufacturing special?



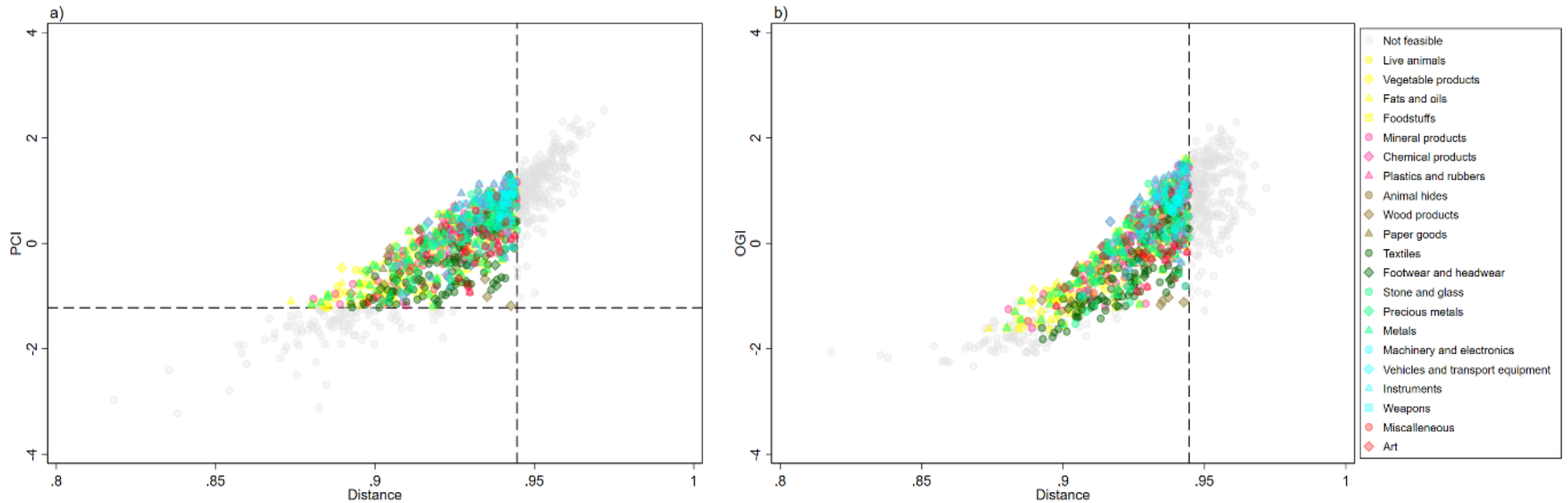
MANUFACTURING INDUSTRIES EXHIBIT STRONG UNCONDITIONAL CONVERGENCE IN LABOUR PRODUCTIVITY

HIGH LABOUR-INTENSIVE AND HIGH PRODUCTIVE (INCLUSIVE GROWTH)

LARGE LEARNING SPILL OVERS (LEARNING BY DOING, LEARNING BY EXPORTING)

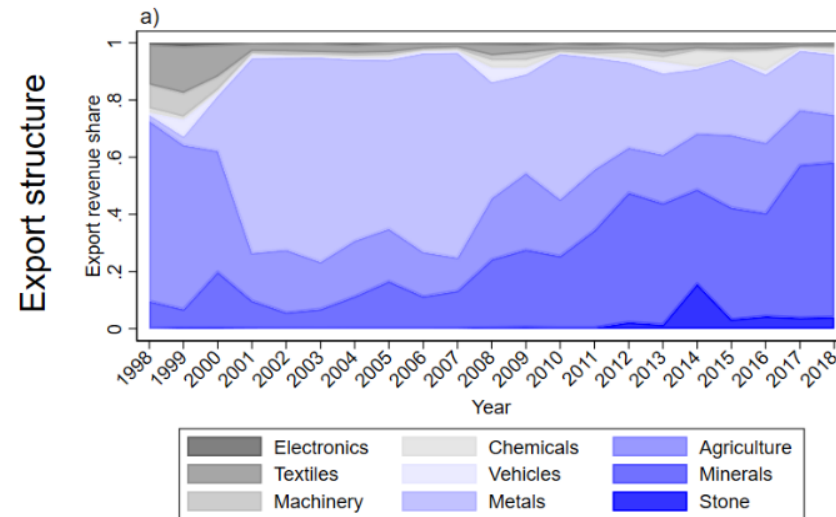
SPILL OVERS TO OTHER SECTORS (SERVICES), AS WELL AS INSTITUTIONS

Relationship between distance and i) complexity and ii) opportunity gain



Economic complexity in Mozambique

Time trend



Current pattern (2018)

