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The project | Aims and instruments

○ The aim of the original project was developing a method to identify the (sectoral) export threshold, defined as the minimum combination of economic size and productivity such that a firm is able to export

○ The export threshold is defined by using ROC (Receiver Operating Characteristics) analysis which, largely used in other domains (e.g. medicine, machine learning), represents a novelty in economics

○ The conceptual framework was such that it should be possible to:

  ○ Determine the role of productivity and economic size in determining the export threshold
  ○ Measure the distance of each firm from the export threshold
  ○ Identify the class of firms that were more relevant for policies (e.g. potential exporters among domestic firms, bright stars among exporters, fragile exporters)

The project | Outcomes

o The project produced two publications in international journals:

   o Costa, Sallusti, Vicarelli, Zurlo (2019) Over the ROC: Productivity, economic size and firms' export threshold. *Review of International Economics*, 27, pp. 955-980

   o Costa, Sallusti, Vicarelli, Zurlo (2022) Tech on the ROC: export threshold and technology adoption interacted. *Small Business Economics*. https://doi.org/10.1007/s11187-021-00581-7

o Partial results from the project have been used in several Istat's publications:

   o Rapporto sulla competitività dei settori produttivi (2017)

   o Rapporto annuale sulla situazione del paese (2021)

o Spin-offs of the project are also included in two inter-institutional research projects:

   o Istat-Bank of Italy project Traspi (Work Package 2)

   o Istat-Sant'Anna School project The links between firms performance and organizational characteristic

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Background

o There is still a lack of literature focused directly on micro-founded estimates of export threshold or that studies the interaction between size and productivity in affecting firms' export ability. To build the conceptual framework of the work we ground on three main findings of literature:

   o There exists an export threshold in that only firms reaching a minimum productivity level are able to cope with export-related sunk costs and enter international markets (Melitz 2003, *Econometrica*)

   o There is a clear direct relationship between firm size and export (Wagner 1995, *Small Business Economics*; Máñez-Castillejo et al. 2010, *World Economy*)

   o In a world with heterogeneity some exporters may upgrade their technology with delay after entering international markets (Bustos 2011, *American Economic Review*), therefore:

      o Some exporters are less technology-intensive than non-exporters (are they "fragile exporters"?)

      o Mismatch between the sorting of firms in terms of export premia and technological intensity, generating three groups: high-technology exporters, low-technology exporters, low-technology non exporters

Data

We integrate two databases…

o Frame-SBS: information on firms' structure (persons employed, sector, location, belonging to a group) and performance (e.g. turnover, value added, labor costs); it covers all 4.4 million firms operating in Italy

o COE-TEC: information on firms' trade variables (imports, exports by countries of origin/destination)

...with the following restrictions:

o We focus on manufacturing, excluding Tobacco, Refined petroleum products, Maintenance and repair, and Other manufacturing

o We consider only firms with economic relevance (i.e. having positive value added, no less than 1 employee, positive consumption of fixed capital)

The final dataset referring to 2016 contains 208,627 firms, which account for 54% of manufacturing units, 93% of value added, 85% of workers, 84% of export

Export threshold | Concept

o We estimate for each sector a micro-founded export threshold, defined as the minimum combination of productivity and economic size that a firm needs to satisfy to become an exporter

o The approach relies on the ROC (Receiver Operating Characteristics) methodology, which allows to pinpoint, along the distribution of a variable (productivity-economic size combination), a cut-off on whose basis a set of observations (firms) can be classified with respect to a binomial variable of interest (the exporter status)

In this context:

o **Productivity** is considered in terms of value added-per-worker

o **Economic size** is a multidimensional measure, synthesizing (via factor analysis) four firm-level size-related variables: number of workers, turnover, capital intensity, age

Starting from a standard logit model, along the ROC curve each observation is positioned in the space of:

o Sensitivity (probability of true positives)

o 1-Specificity (probability of false positives)

The Area Under ROC Curve (AUC) measures the extent to which the model correctly classifies observation (with respect to casual clustering, i.e. 45° line)
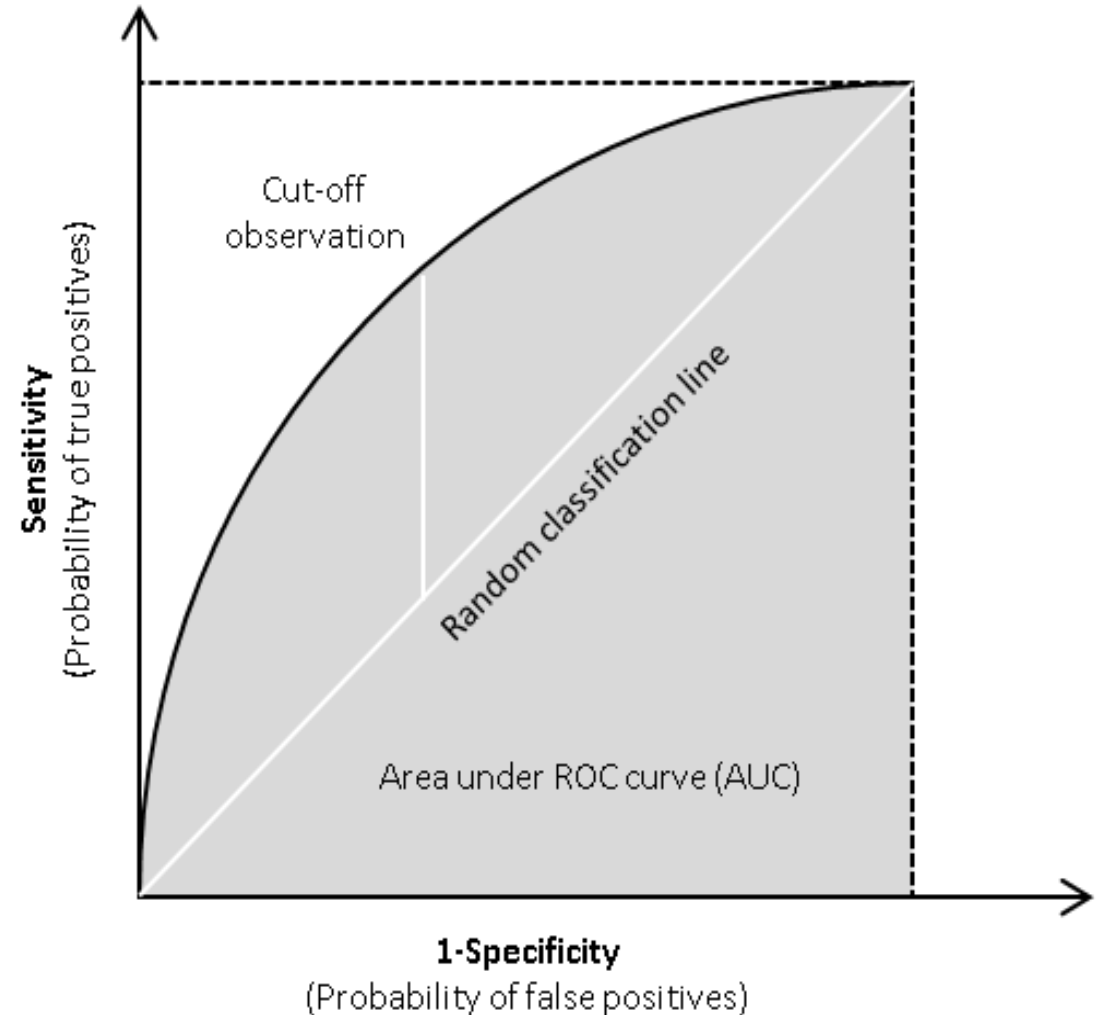
Export threshold | Definition

$$Z^e = \hat{\alpha}_1 S^* + \hat{\alpha}_2 \pi^*$$

- The model is accurate (in all sector accuracy is over 70%)

- The economic size/productivity threshold outperforms the only productivity model à la Melitz

- Each firm can be positioned with respect to the export threshold and the distance between the firm and the threshold can be measured

- The model is also able to define the substitution rate between productivity and economic size in order to afford the threshold level

- The definition of a technology line may allow for a finer classification of firms
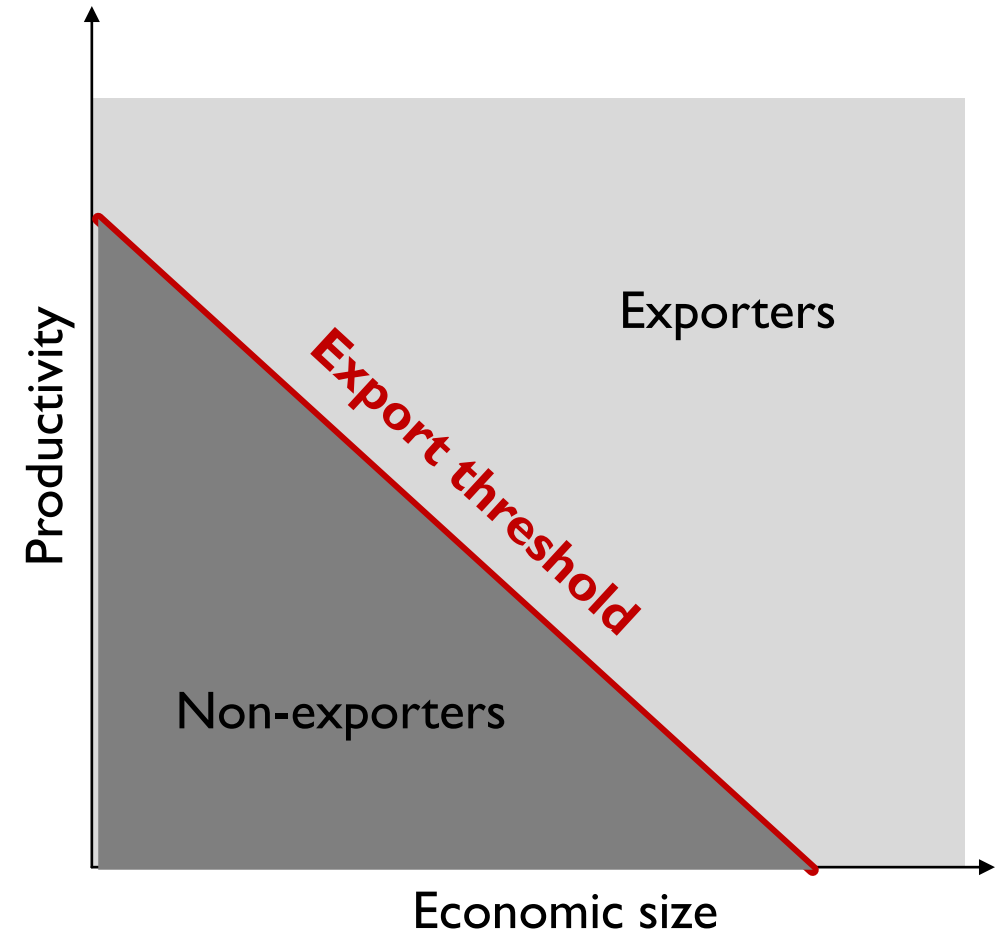
Technology line | Concept

Why the Technology line:

o Possible mismatch between the conditions required to export and the adoption of an advanced technology may emerge (Bustos 2011, AER; Lileeva and Trefler 2010, QJE; Bertschek et al. 2016, RWE)

o Some exporters are fragile, in that they (still?) display the same (low) technology of non-exporters

o To investigate such mismatch, the firms' positioning within the industry in terms of technology level needs to be taken into account

The **technology line** is estimated for each industry as the combination of productivity and economic size that a firm needs to achieve in order to have a level of technology at least equal to that of the export threshold firm

$$Z^t = \hat{\alpha}_1 S^* + \hat{\alpha}_2 \pi^*$$

# Thresholds interacting | A new taxonomy of firms

The relative positioning of the export threshold and the technology line defines a four-class taxonomy:

o **Natural exporters** ($Z^e_i > Z^e$ and $Z^t_i > Z^t$): high-tech firms that are productive and/or "large" enough to export

o **Fragile exporters** ($Z^e_i > Z^e$ and $Z^t_i < Z^t$): low-tech firms that are productive and/or large enough to export (improving intensive margin)

o **Potential exporters** ($Z^e_i < Z^e$ and $Z^t_i > Z^t$): high-tech firms that are neither productive or/nor large enough to export (improving extensive margin)

o **Domestics** ($Z^e_i < Z^e$ and $Z^t_i < Z^t$): low-tech firms that are neither productive or/nor large enough to export

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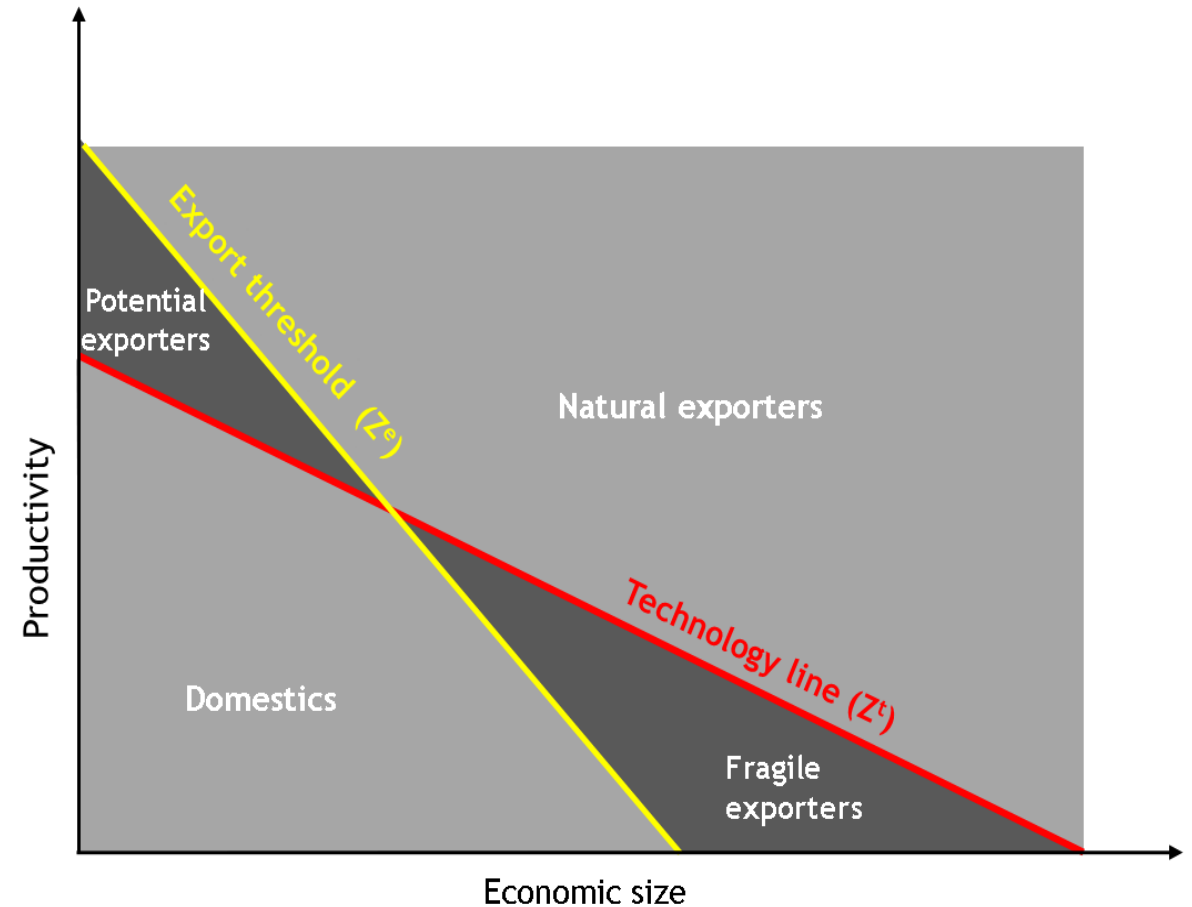
Thresholds interacting | A new taxonomy of firms

o The taxonomy allows to study the characteristics of firms by class and stress peculiarities (under-productivity, under-sized, other features) in order to provide information for possible selective policies

o The approach allows to position each firm according to its distance from both thresholds. In this case, even within the same class, each productive unit can be further classified based on its positioning
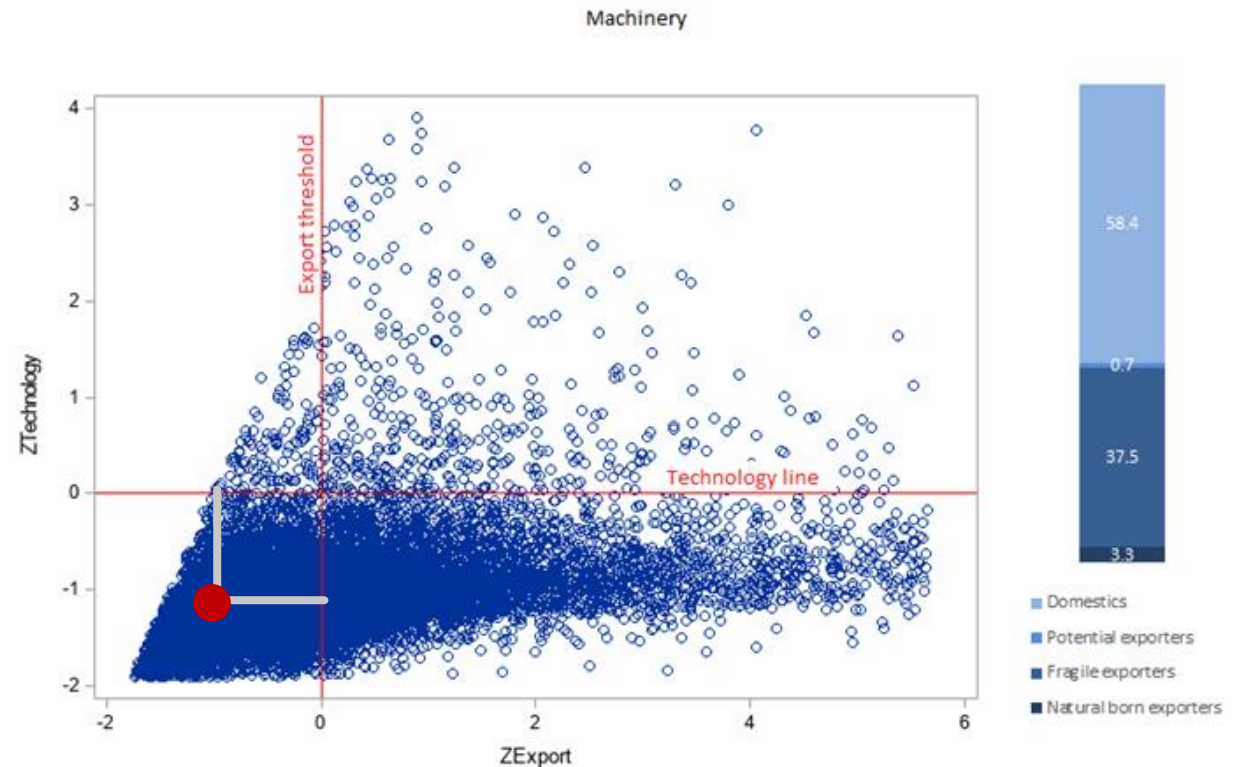
Conclusions

o We provide a new methodology to study business units according to their export orientation and technology

o Our classification is especially important from a policy-making point of view, as it allows for a new breakdown of exporters and non-exporters and for (potentially) more selective policies:

   o **Fragile exporters** are low-tech exporting firms, comparable to that particular set of exporting firms that have not yet adopted the higher technology, as pointed out by the literature
   o **Potential exporters** are high-tech non exporting firms, a new class of firms identified by our approach: non-exporting enterprises which are more likely to become exporters

o Possible further developments should include:

   o The building-up of a theoretical framework that involves the interaction between economic size and productivity in determining the export threshold
   o The analysis of the role of exogenous factors (e.g. administrative barriers, credit issues, business cycle)
   o The analysis of the variation of the export threshold over time and according to the country of destination

thank you.

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