Learning by Exporting and the R&D, Innovation and Productivity Relationship: Evidence from the French dairy industry

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Motivation

The move to a more open economy puts firms under pressure $\longrightarrow$ firms remain competitive by reducing costs or by increasing their efficiency and productivity.

- Literature on firm-level productivity predicts that both international activities and innovation are two central determinants for explaining productivity (growth).

Ample evidence suggests that exporting firms in comparison to firms that only serve domestic markets are more productive, the so called export premium, which can be explained by two main mechanisms:

- Self-selection (Melitz, 2003): model shows that only the most productive firms enter export markets
- Learning by exporting: firms improve their productivity after entering export markets (Castellani, 2002; Silva et al. 2012; Peters et al., 2020))

Motivation

- Empirical evidence usually analyzes the causal effect of exports on productivity (in a reduced way). LBE should be measured using information on the specific mechanisms through which firms acquire knowlege in order to become more productive (Crespi et al., 2008; Aghion et al., 2018; Silva et al. 2012; Aw et al., 2007), which include: investment in maketing, product quality upgrading, dealing with foreign buyers

$$\text{Exporting} \longrightarrow \text{learning} \longrightarrow \text{productivity}$$

$$\text{Exports} \longrightarrow R\&D \text{ investments} \longrightarrow \text{output innovation} \longrightarrow \text{productivity}$$

Motivation

This paper focuses on firms' innovation activities as a LBE mechanism's channel

The *first relationship* goes from exports to innovation activities (e.g., R&D investments) $\longrightarrow$ exposure to a richer source of technology on export markets (Aw et al., 2007); learn from interactions with foreign competitors (Esteve-Pérez & Rodríguez, 2013); customize products (Clerides et al., 1998); deployment of financial resources (Golovko & Valentini, 2011).
A *second relationship* is related to costs reduction and productivity gains

- The importance of the *knowledge production function* (Pakes and Grilliches, 1984)
  - Crépon et al. (1998): the contribution of innovation to productivity growth is disentangled into a contribution of R&D input to innovation output and a contribution of innovation output to the overall firm's output.

Motivation

- Econometric issues in a structural framework:
  - selection bias: exploit differences between innovators and non-innovators, both at the level of R&D expenditure and output innovation activities (e.g., comparing with CIS data/patent (citation) counts)
  - appropriate handling of dynamics of export, R&D, innovation and productivity
  - Omitted variable bias
- Advantage of the data:
  - proper handling of the (panel) data
  - reliability of new products innovation

Why the dairy sector

- Characterized by a global demand that is growing

$\longrightarrow$sector enjoys a sustained increase in aggregate demand especially in Asian countries where population growth combines with a gradual change in diets associated with an overall increase in purchasing power.

- It is a mature exporting industry.
- It is one of the most (labor) productive manufacturing industries.
- Less technology intensive industries but the dairy industry is one of the most innovative; especially, in terms of product innovation.
- Focusing on a specific industry in a given country, we can avoid the potential for cross-industry effects to complicate causality links.

Research questions

- Are exporters more likely to invest in R&D innovation?
- Does higher investment in R&D lead to tigher innovation output
- Is higher innovation output linked to higher productivity?
- What are the effects of policy intervention?

Outline

1. Econometric framework: *Estimation method*
2. Data
3. Results
4. Conclusion

Econometric model

$$\text{export status: } e_t = \left\{ \begin{array}{ll} 1 & \text{if } \Delta E_t\left[V_{t+1}\left(\cdot\right)|\eta_1\right] > C^e\left(e_{t-1}, I_t, \eta_1\right) \\ 0 & \text{otherwise} \end{array} \right\} \quad (1)$$

$$R\&D \text{ choice } d_t = \left\{ \begin{array}{ll} 1 & \text{if } \Delta E_t\left[V_{t+1}\left(\cdot\right)|e_t, \eta_2\right] > C\left(d_{t-1}, e_t, J_t, \eta_2\right) \\ 0 & \text{otherwise} \end{array} \right\} \quad (2)$$

$$\text{new products } z_t = \left\{ \begin{array}{ll} 1 & \text{if } \Delta E_t\left[V_{t+1}\left(\cdot\right)|d_t, \eta_3\right] > C\left(z_{t-1}, d_t, M_t, \eta_3\right) \\ 0 & \text{otherwise} \end{array} \right\} \quad (3)$$

$$\text{Labor productivity } \omega_t = f\left(z_t, \omega_{t-1}, N_t, \eta_4\right) \quad (4)$$

Estimation method

We use maximum likelihood (ML) to estimate the model, following the approach recently proposed by Wooldridge (2005) of handling the individual effects.

$$\begin{aligned} \eta_{1i} &= \alpha_{10} + \delta_{10} e_{i,0} + \delta_1' \overline{\mathbf{x}}_{i1} + \xi_{1i}, \\ &\vdots \\ \eta_{4i} &= \alpha_{40} + \delta_{40} e_{i,0} + \delta_4' \overline{\mathbf{x}}_{i4} + \xi_{4i} \end{aligned} \tag{5}$$

where α_{10} are constants, $\overline{\mathbf{x}}_{i1}$ are vectors including the time averages of the variables, $e_{i,0}$ are the initial values, δ_{10}, δ_1' are the corresponding coefficients (vectors) to be estimated, and $\text{cov}(\xi_{1i} \ldots \xi_{4i})$ are assumed to be dependent but independent of random effects, following normal distributions
$\xi_{1i} | x_{i1} \sim N(0, \sigma^2_{\xi 1})$

We estimate the model using Stata applying the GIlamm program that was developed in Miranda and Rabe-Hesketh (2006). GIlamm uses the adaptive Gauss-Hermite quadrature to approximate the integrals, and the default maximization approach is the quasi-Newton method.

Data issues

Global New Product Database

- GNPD measures *new consumable products* launched; two sources
  - Secondary information sources (Trade shows, press releases, Media, Corporate Intelligence, etc.)
  - Primary information source comes from Mintel shoppers. Information recorded include package, launch type, EC identification, product claims, bar codes, ingredients, nutritional data, product category information,etc.
    - New product: launch type dependent on brand field: new range, line, family of products; direct and less subjective measure

(others type launches are (product differentiation): new variety, new packaging, reformulation, relaunch)

Other data sources

- Data on firm-level characteristics (employment, value-added, intangible assets, R&D, wages, foreign ownership, public support, age) come from FARE
- Data on French exports flows is extracted from CUSTOMS dataset.
- The French dairy industry is defined by the APE, 10.51, and is composed of four sub-industries: 10.51A (Manufacture of liquid milk and of fresh dairy products), 10.51B (Manufacture of butter), 10.51C (Manufacture of cheese), 10.51D (Manufacture of other dairy products).
- Developed a matching procedure so to link new products to *firm-level* (siren 9 digits)

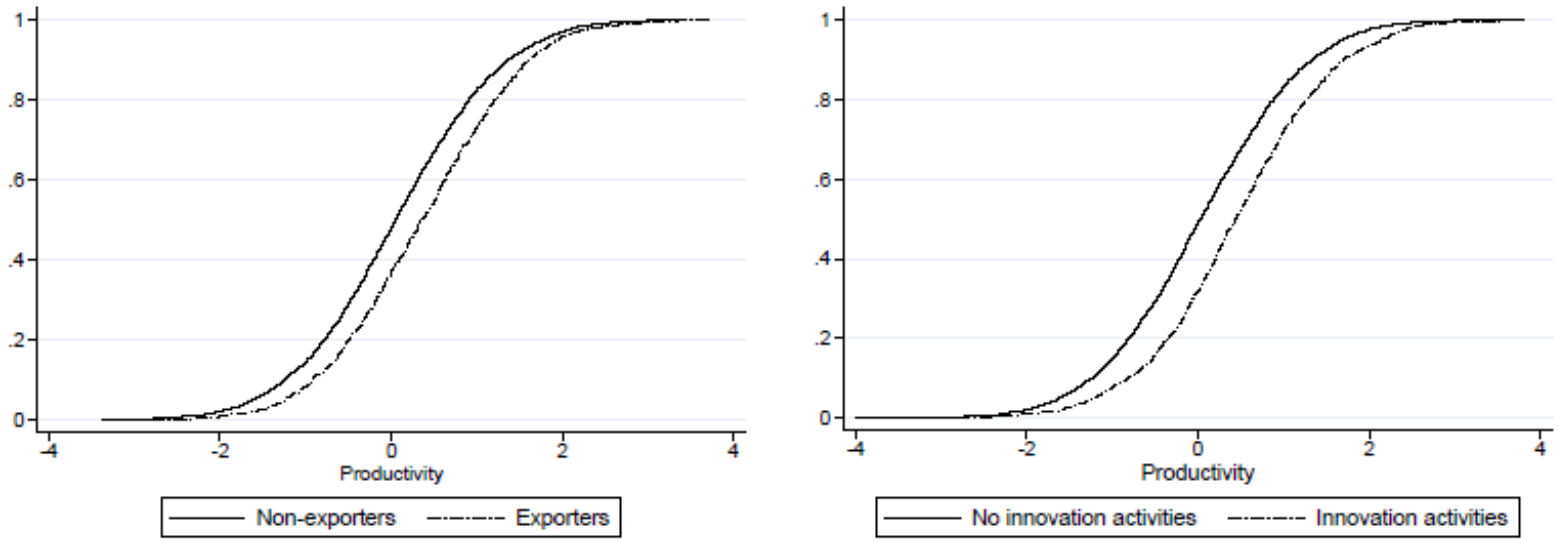
Table 1: Variables description and Descriptive statistics

Variable	Definition	Mean	Standard Deviation		
			Overall	Between	Within
Dependent variables					
Productivity	Value-added per employee, in log	4.171	0.626	0.589	0.308
Innovation output	1 if firm i has introduced at least one new products	0.206			
Innovation input	1 if firm i has invest in innovation activities	0.297			
Export status	1 if firm i has a positive trade flows	0.276			
Explanatory variables					
Capital	Tangible asset per employee, in log	5.024	1.078	1.091	0.313
Size	Number of employees, in log	2.373	1.711	1.738	0.238
Market share	Domestic market share, in log	-8.259	1.887	1.939	0.289
Age	Age of the firm	39.558	34.165	34.165	1.883
Wage	Cost of labor per employee, in log	3.781	0.440	0.368	0.275
Public	1 if firm i has received public funding for intangible invest.	0.359			
Foreign ownership	1 if firm i is a subsidiary of a foreign company	0.043			
Part of a group	1 if firm i belongs to a group	0.065			
R&D spillover	(innovating input firms)/(total firms) for firms in same sub-industry, excluding firm in question	0.253	0.033	0.029	0.019
Export spillover	(exporting firms)/(total firms) for firms in same Region, excluding firm in question	0.194	0.076	0.072	0.025

Source: data from `FARE`, `GNPD` and `CUSTOMS` datasets, authors' calculations.

Notes: The number of employees is in full-time equivalents.

Figure 1: Cumulative distribution of productivity

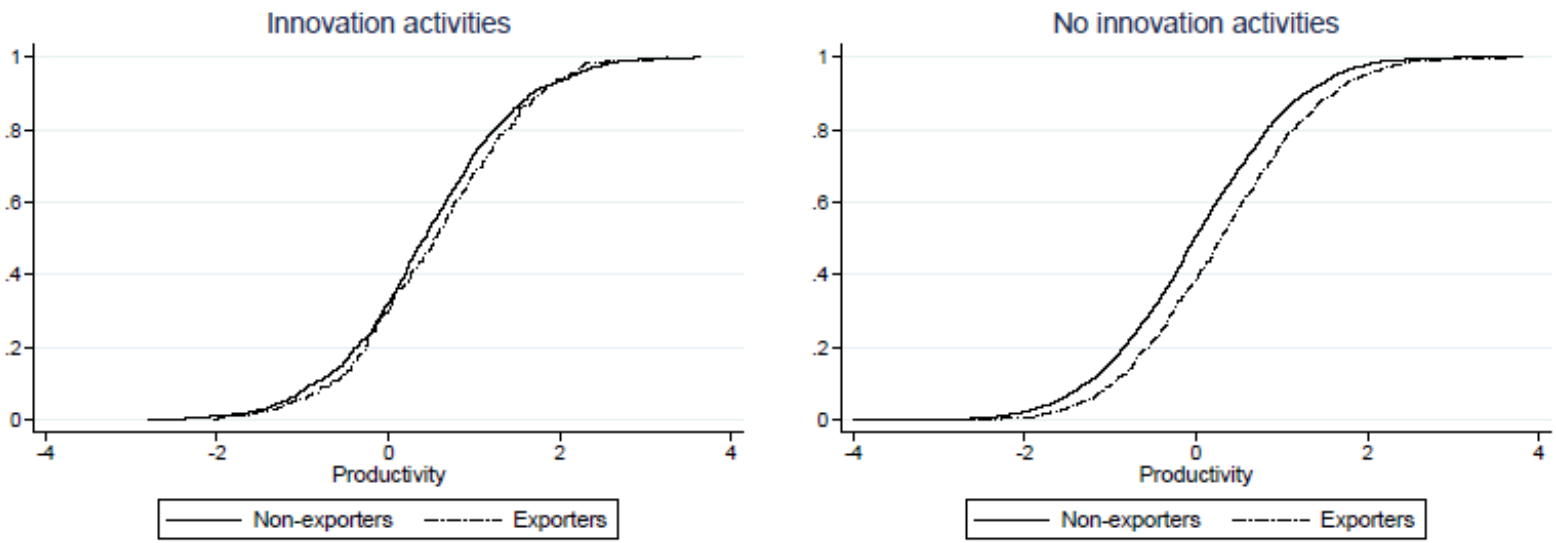


(a) Exporting or not

(b) R&D or not

Note: Productivity distributions are drawn by regressing labor productivity on industry-year fixed effects and then plotting the residuals.

Figure 2: Cumulative distribution of productivity



(a) Exporting or not

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Note: Productivity distributions are drawn by regressing labor productivity on industry-year fixed effects and then plotting the residuals.

FIML estimate of the model, 2015

Endogenous variables	Export partic.	R&D invest.	Innovation output	Labor product.
Param. of int. (α_j)		0.370^{***}	0.273^{**}	0.052^{**}
		[0.083]	[0.026]	
Lag. dep. var. (γ_j)	1.523^{***}	0.694^{***}	0.344^{***}	0.330^{***}
	[0.185]	[0.166]	[0.034]	
Endogenous entry export				
Param. of int. (α_j)		0.006	0.060^{**}	0.120^{**}
Lag. dep. var. (γ_j)	0.067^{***}	0.093^{***}	0.050^{***}	0.331^{***}

Internal validity

- Testing granger non-causality test: productivity to innovation output, from innovation output to R&D investment and from R&D investments to export participation confirms a unidirectional relationship from exporting to R&D investment and from innovation output to productivity
  - $H_0 : f(z_{it}, z_{i,t-1}, \omega_{it-1}) = H_0 : f(z_{it}, z_{i,t-1})$ is for each of the stages strongly not rejected

Conclusion

- Show a strong persistence in each of the stages (exports, R&D, innovation output, productivity), even after controlling for unobserved heterogeneity:
  - Exports (R&D): barriers-to-entry, sunk costs prevent firms from exiting export (R&D) markets and may be less costly in comparison to abandon such activities
  - new products: :"success breeds succes" hypothesis
  - productivity: can reflect the slowing decrease of knowledge; smaller values reflect larger depreciation

- Probability to export increases with firm size, market share and exports spillovers
    - unobserved heterogeneity is a key factor for export participation (68% variation)
- Probability of doing R&D increases significantly with exports, firm size, firm age and public support
    - unobserved heterogeneity is a key factor for R&D (38% variation)
- we find that firms' incentive to introduce new product increase with R&D investment, market share, firm size and R&D spillover
    - unobserved heterogeneity explain more than 60% of unexplained variation in new product introduction.
- labor productivity is function of (+) innovation output and capital intensity while (-) for firm age, capital intensity and the number of employees.
- unobserved heterogeneity is less prominent for productivity