


**Non-technical innovation  
Definition, Measurement & Policy Implications  
Workshop  
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**The employment impact of technological and organizational  
innovations. Firm level evidence (CIS4-Italy)**

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## **The debate on the innovation-employment relationship: a “never ending story” with no conclusive answers**

- Very complex issue which can be tackled from different perspectives and levels of the analysis
  - previous works and reviews (largely referring to the manufacturing sector) show that it is impossible to come-up with a final answer (Petit, 2005; Vivarelli, 1995, Vivarelli & Pianta, 2000, Pianta, 2005)
  - results depend very much on the level of aggregation, type of data, time framework of the analysis
  - difficulty of grasping the net aggregate effect (i.e. all direct and indirect effects at a macro-economic/international level)
  - different contributions and analyses should be used in a complementary way in order to assemble a meaningful interpretative puzzle
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## **First fundamental question: Why making a specific analysis on services?**

Two possible answers:

- a) under-explored area -> lack of evidences and empirical studies (certainly true)
  
- b) specificity of both innovation & the innovation-employment relationships (open issue..... to be explored empirically).

## **Three broad issues in the research agenda**

- a) What we have learnt from the manufacturing industry does also apply to services?
  
- b) Should we change our approach and look at different dimensions, mechanisms, effects?
  
- c) Go for a “synthesis approach”?

**Lessons from studies on the manufacturing sector**

**Do they also apply to services?**

- |  |      |
|--|------|
| 1 Importance of different levels of the analysis (grasp different mechanisms and effects)      | YES! |
| 2 The innovation-employment relationship is part of the long term process of structural change | YES! |
| 3 Role of demand/macroeconomic conditions  | YES! |
| 4 Qualitative effects (skill composition) are more relevant than purely quantitative effects   | YES! |
| 5 Employment effects are different across sectors  | ???  |
| 6 Firm innovation strategies matter  | ???  |
| 7 Different impact of product and process innovations  | ???  |
| 8 Importance of non-tech innov. (organizational changes)                                       | ???  |

# Empirical issues addressed in the paper

1. How do product, process and organizational innovations relate to each other (level and type of complementarity)?

- a) **Do distinct patterns and strategies made of different combinations of product/process/organizational innovation emerge?**
- b) **Does organizational innovation represent a stand-alone strategy or it is linked to a product or process innovation strategies?**
- c) **Are there systematic differences between manufacturing and services industries?**

2. The effects on employment

- a) **What are the (direct and indirect) effects of product, process and organizational innovations on employment in Services?**
- b) **Is the product/process distinction effective in disentangling the different mechanisms and effects of innovation on employment in the Service sector?**
- c) **Are there systematic differences between manufacturing and services industries?**

# Methodology

- Data: Italian CIS4 (2002-2004) - Manufacturing & Services  
(comparative analysis)
- Firm level analysis
- Main CIS variables used:
  - Type of innovation (product/process/organizational/marketing)
  - Effects of tech & non-tech innovation (*product* vs *process* related)
  - Type of innov. input & output (innov. expenditures and innov. sales)
  
  - Employment growth (2002-2004)
  - Sales growth (2002-2004)

## **Main caveats of CIS (and of this study)**

- vary basic information/types of non-tech. and organizational innov.
- cross sectional nature of data and analyses
- difficulty of grasping the aggregate-net effects of innovation – firm level evidence cannot be generalized at a macro level
- no possibility of investigating qualitative effects on employment

## **Major strengths**

- Data representative of all manufacturing and service sectors (across EU)
- Possibility of combining (*good*) data on technological innovations with (*poor*) data on non-technological innovation

# Organisational and marketing innovations (CIS4)

## Organisational innovations

New or significantly improved **knowledge management** systems to better use or exchange information, knowledge and skills within your enterprise

A major change to the **organisation of work** within your enterprise, such as changes in the management structure or integrating different departments or activities

New or significant changes in your **relations with other firms** or public institutions, such as through alliances, partnerships, outsourcing or sub-contracting

## Marketing innovations

Significant changes to the **design or packaging** of a good or service (Exclude routine/seasonal changes such as clothing fashions)

New or significantly **changed sales or distribution methods**, such as internet sales, franchising, direct sales or distribution licenses



# Relevance of (& complementarity between) technological and non-tech. innovations

**ONLY  
PROD.**

**ONLY  
PROC.**

**PROD &  
PROC.**

**ONLY TECH. M: 29.8% S: 22.7%**

**ONLY ORG.**

**ONLY MKT**

**ORG. & MKT**

**ONLY  
NON-TECH**

M: 30.9%

S: 39.5%

**BOTH: M: 39.3% S: 37.8%**

## Innovation modes: results from a cluster analysis

| Clusters       | Type of tech. innov. |            |               | Type of non-tech. innov. |           |           |
|----------------|----------------------|------------|---------------|--------------------------|-----------|-----------|
|                | Only Proc.           | Only Prod. | Prod. & Proc. | Only Mkt                 | Only Org. | Org & Mkt |
| Prod. Oriented |                      | 63.6%      |               | 43.9%                    |           | 20.3%     |
| Proc. Oriented | 65.0%                |            |               | 5.4%                     |           | 51.8%     |
| Org. Oriented  | 23.6%                | 8.5%       |               |                          | 100.0%    |           |
| Complex        |                      |            | 100.0%        | 6.4%                     | 31.9%     | 41.3%     |
| All sample     | 25.7%                | 11.3%      | 25.0%         | 8.8%                     | 43.2%     | 26.8%     |

## Sectoral characterization of innovation modes

|               | Proc. Oriented | Org. Oriented | Prod. Oriented | Complex | Total |
|---------------|----------------|---------------|----------------|---------|-------|
| Services      | 24.50%         | 43.80%        | 10.40%         | 21.30%  | 100%  |
| Manufacturing | 28.70%         | 27.40%        | 15.50%         | 28.40%  | 100%  |

## Effects of technological innovations (CIS4)

- Increased range of good or services
- Entered new markets/increased market share

→ *Product related effects*

- Improved flexibility of production/service provision
- Reduced labour costs per unit output
- Reduced materials and energy per unit output

→ *Process related effects*

## Effects of non-technological innovations (CIS4)

- Improved quality of your goods or services
- Reduced time to respond to customer/supplier needs

→ *Product related effects*

- Reduced costs per unit output

→ *Process related effects*

- Improved employee satisfaction/reduced employee turnover

**Innovation expenditure & output indicators****Dominant cluster (expected)****Manufacturing****Services**

|  |   |                  |     |
|--|---|------------------|-----|
| % turnover from innovative sales                                 | ⇒ | Product          | ??? |
| % of innovation exp. related to the acquisition of new equipment | ⇒ | Process/organiz. | ??? |
| Total innov. exp per employee (log)                              | ⇒ | Complex/product  | ??? |

**Sectors****Dominant cluster (expected)****Manufacturing****Services**

|                       |   |                  |     |
|-----------------------|---|------------------|-----|
| Science based         | ⇒ | Complex/Product  | ??? |
| Specialized suppliers | ⇒ | Product          | ??? |
| Scale intensive       | ⇒ | Process/organiz, | ??? |
| Supplier dominated    | ⇒ | Process/organiz, | ??? |

## Innovation profiles of different clusters (probit estimates) – Manuf. & Services

|                                       | Product  | Process  | Organisational | Complex  |
|---------------------------------------|----------|----------|----------------|----------|
| <b>Effects of tec. innovation</b>     |          |          |                |          |
| Product related                       | 0.033**  | -0.088** |                | 0.065**  |
| Process related                       | -0.103** | 0.064**  |                | 0.090**  |
| <b>Effects of non-tec. innovation</b> |          |          |                |          |
| Product related                       |          | -0.077** | 0.116**        | 0.0508** |
| Process related                       |          | -0.017   | 0.012          | 0.012    |
| Job satisfaction                      |          | -0.041** | 0.050**        | -0.012   |
| <b>Innovation exp. &amp; output</b>   |          |          |                |          |
| % turn. from innov. sales             | 0.127**  |          |                | 0.665**  |
| % mac expenditure                     | -0.111** | 0.193**  |                | -0.065** |
| Inn. Exp per employee (log)           | -0.007*  | -0.015** |                | 0.028**  |
| <b>Firms size classes (employees)</b> |          |          |                |          |
| _19                                   | 0.032**  | 0.049**  | -0.015         | -0.072** |
| _20_49                                | 0.030*   | 0.024    | 0.040*         | -0.075** |
| _250_more                             | -0.003   | -0.049*  | -0.087**       | 0.114**  |
| Group                                 | 0.015    | 0.00546  | -0.048**       | -0.030   |
| <b>Sectoral dummies</b>               |          |          |                |          |
| S&T Based services                    | -0.014   | 0.010    | 0.246**        | -0.006   |
| Scale intensive services              | -0.014   | 0.089*   | 0.215**        | 0.127**  |
| Supplier dominated services           | -0.005   | 0.138**  | 0.293**        | 0.010    |
| Sc. Based                             | 0.066**  |          |                | 0.054    |
| Scale intensive                       |          | 0.185**  | 0.185**        | 0.005    |
| Specialized supplier                  | 0.046**  | -0.040   | 0.143**        | 0.029    |
| Supplier dominated                    | -0.002   | 0.254**  | 0.092**        |          |
| Observations                          | 5170     | 5170     | 8213           | 5170     |
| Succ. classified                      | 86.87%   | 78.94%   | 72.76%         | 74.97%   |

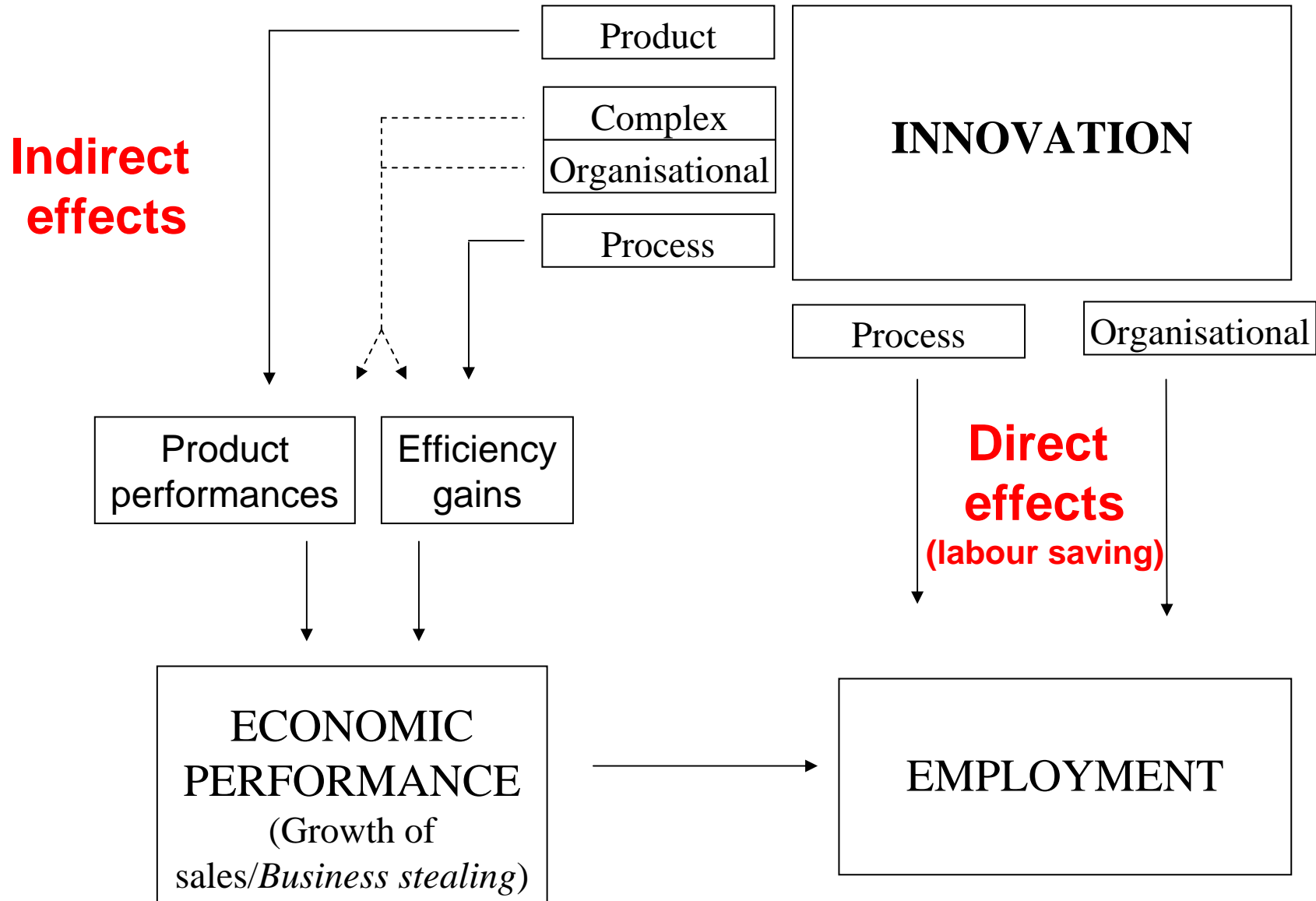
\* significant at 5%; \*\* significant at 1% - Marginal effects are reported in table

## Innovation profiles of different clusters (probit estimates) - Services

|                                       | Product  | Process  | Organisational | Complex |
|---------------------------------------|----------|----------|----------------|---------|
| <b>Effects of tec. innovation</b>     |          |          |                |         |
| Product related                       | 0.027**  | -0.068** |                | 0.064** |
| Process related                       | -0.094** | 0.058**  |                | 0.079** |
| <b>Effects of non-tec. innovation</b> |          |          |                |         |
| Product related                       |          | -0.061** | 0.131**        | 0.026   |
| Process related                       |          | 0.001    | -0.021*        | 0.009   |
| Job Satisfaction                      |          | -0.062** | 0.071**        | -0.001  |
| <b>Innovation exp. &amp; output</b>   |          |          |                |         |
| % turn. from innov. sales             | 0.123**  |          |                | 0.624** |
| % mac expenditure                     | -0.065** | 0.119**  |                | -0.046  |
| Inn. Exp per employee (log)           | -0.007   | -0.013*  |                | 0.028** |
| <b>Firms size classes (employees)</b> |          |          |                |         |
| _19                                   | 0.026    | 0.031    | -0.029         | -0.038  |
| _20_49                                | 0.076    | 0.040    | 0.023          | -0.070* |
| _250_more                             | -0.008   | -0.044   | -0.058         | 0.070*  |
| Group                                 | 0.022    | -0.002   | -0.049*        | -0.015  |
| <b>Sectoral dummies</b>               |          |          |                |         |
| S&T based                             |          |          | 0.139**        | -0.004  |
| Scale int. services                   | -0.011   | 0.072    |                | 0.135** |
| Supply dom. services                  | -0.005   | 0.132**  | 0.082**        |         |
| Observations                          | 2207     | 2207     | 3938           | 2207    |
| Succ. classified                      | 87.36%   | 77.57%   | 69.27%         | 73.81%  |

\* significant at 5%; \*\* significant at 1% - Marginal effects are reported in table

# The employment impact of innovation at a firm level



# The model (two simultaneous equations)

## 1. Labour effects equation (rate of change of employment):

$$\Delta L_{it} = \alpha_1 \text{Proc} + \beta_1 \text{Org} + \gamma_1 \Delta \bar{Y}_{it} + \lambda_1 \log(L_{it-1}) + \delta_1 \pi_{it-1} + \varphi_1 \text{ind} + \varepsilon_{it}$$

Process only
Organis. only
Growth of sales
Size in t-1
Productivity in t-1
Industry dummies

Direct effects (-)
Indirect effects (+)

## 2. Economic performance equation (rate of change of turnover):

$$\Delta Y_{it} = \sum_{i=1}^4 \phi_i \text{Cluster} + \rho \text{herf} + \psi \text{dem} + \lambda_2 \log(L_{it-1}) + \delta_2 \pi_{it-1} + \varphi_2 \text{ind} + \eta_{it}$$

Herfindahl Index
(Lack of) Demand for innovative Prod.\Serv.
Size in t-1
Productivity in t-1
Industry dummies



## Estimation strategy

Three-stage least square estimation:

1<sup>th</sup> Develops instrumented values for  $\Delta Y_{it}$  (to address the endogeneity problem)

2<sup>nd</sup> Obtains consistent estimates for the covariance matrix of the equation disturbances

3<sup>rd</sup> Performs a GLS-type estimation using the covariance matrix estimated in the second stage and with the instrumented values in place of the right-hand-side endogenous variable  $\Delta Y_{it}$  (to take into account the simultaneity of  $\Delta L_{it}$  and  $\Delta Y_{it}$ )

## The employment impact of innovation: estimation results

|                         | <b>Manufacturing</b>   |                     | <b>Services</b>        |                        |
|-------------------------|------------------------|---------------------|------------------------|------------------------|
|                         | EMPL.<br>GROWTH<br>(%) | SALES GROWTH<br>(%) | EMPL.<br>GROWTH<br>(%) | SALES<br>GROWTH<br>(%) |
| <b>Direct effects</b>   |                        |                     |                        |                        |
| Only process            | 0.237                  |                     | 0.411                  |                        |
| Only organisational     | 0.423                  |                     | 0.162                  |                        |
| <b>Indirect effects</b> |                        |                     |                        |                        |
| Complex                 |                        | 5.637***            |                        | 5.005***               |
| Process                 |                        | 3.322***            |                        | 1.182                  |
| Product                 |                        | 2.180**             |                        | 2.571*                 |
| Organisational          |                        | 4.555***            |                        | 2.706***               |
| VAR% SALES (fitted)     | 0.271***               |                     | 0.192***               |                        |
| Herfindahl index        |                        | 11.926***           |                        | 20.135***              |
| Lack of demand          |                        | -1.269***           |                        | -0.550**               |
| Ind_dummies             | 0.117                  | 0.000***            | 0.000***               | 0.000***               |
| Size (log emp. 02)      | -5.342***              | -1.423***           | -4.659***              | -0.122                 |
| Productivity 02         | 0.007***               | -0.004***           | 0.003***               | -0.003***              |
| Constant                | 24.466***              | 11.452***           | 26.303***              | 2.389**                |
| Observations            | 7061                   | 7061                | 7338                   | 7338                   |
| R-squared               | 0.2054                 |                     | 0.1443                 |                        |

•significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Industry dummies are included in both equations: Industry dummies coefficients refer to the p-value of a test of the joint significance of industry fixed effects.

# Synthesis of results

## 1. Presence of very different innovation modes (both Manuf/Services)

- Even when non-technological-innovations are brought into the picture, the product/process distinction is still effective in identifying different innovation strategies (both in Manuf. & Services)
- Two different product-driven innovation modes:
  - one simply based on the mere introduction of product innovation
  - a more “complex” and “innovative” one, made of a combination of different and complementary types of innovation (product, process and organizational)
- Presence of a “pure organizational innovation mode” that is particularly relevant in Services

## **2. The employment impact of innovation (synthesis of results)**

- No negative (labour displacing) direct effects (both Manuf. & Services).
- Innovation exerts its impact on employment in an indirect way
  - > improving the competitive performances of firms (growth of sales/business stealing)

and more in particular:

- Product related strategies (when complemented with process and organizational innovations) show the strongest employment impact (both M & S)
- The employment impact of process innovations is positive only in the Manufacturing sector
- The introduction of stand-alone organizational changes emerges as a very effective innovation strategy able to generate new jobs (surprisingly more in Manuf. than in Services).

# Some implications...

Further support to the adoption of a “synthesis approach” to the study of innovation to be extended to the innovation-economic performance-employment relationships

Very challenging research agenda both on a conceptual and on an empirical ground

Need of overcoming the asymmetric state of art in the study and measurement of technological and organizational activities

- While concepts, definition and data-set on firms’ technological activities are rather settled and widely available, the same does not apply to organizational innovations
- Future advancements in this research area will crucially depend on the possibility of integrating robust and meaningful data on both technological and organizational innovation