ARE ROBOTS STEALING OUR JOBS?

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Today alarm…

- Recently, the arrival of 3D printing, self-driving autonomous cars (Tesla, Apple, Google) and widespread robots has raised again a fear of a new wave of 'technological unemployment'.
- Brynjolfsson and McAfee, A., 2011, "*Race Against the Machine:* : the root of the current employment problems is not the Great Recession, but rather a "Great Restructuring" characterized by an exponential growth in computers' processing speed having an ever-bigger impact on jobs, skills, and the whole economy.
- Moreover, not only agricultural and manufacturing employment appears at risk, but employees in services - including cognitive skills - are no longer safe (see, for instance, how Uber - just a software tool - is fully crowding out taxi companies). Frey and Osborne (2013) predict that 47% of the occupational categories are at high risk of being automated, including a wide range of service/white-collar/cognitive tasks such as accountancy, logistics, legal works, translation and technical writing, etc.

It is an atavistic fear: Ned Ludd and Captain Swing against textile and threshing machineries

Captain Swing **by Eric Hobsbawm and George Rudé, New york, Pantheon Books, 1968**

RICARDO'S SURPRISE

"….the opinion, entertained by the labouring class, that the employment of machinery is frequently detrimental to their interests, is not founded on prejudice and error, but is conformable to the correct principles of political economy"
(Ricardo, 1951, vol 1, p. 387; third edition, 1821)

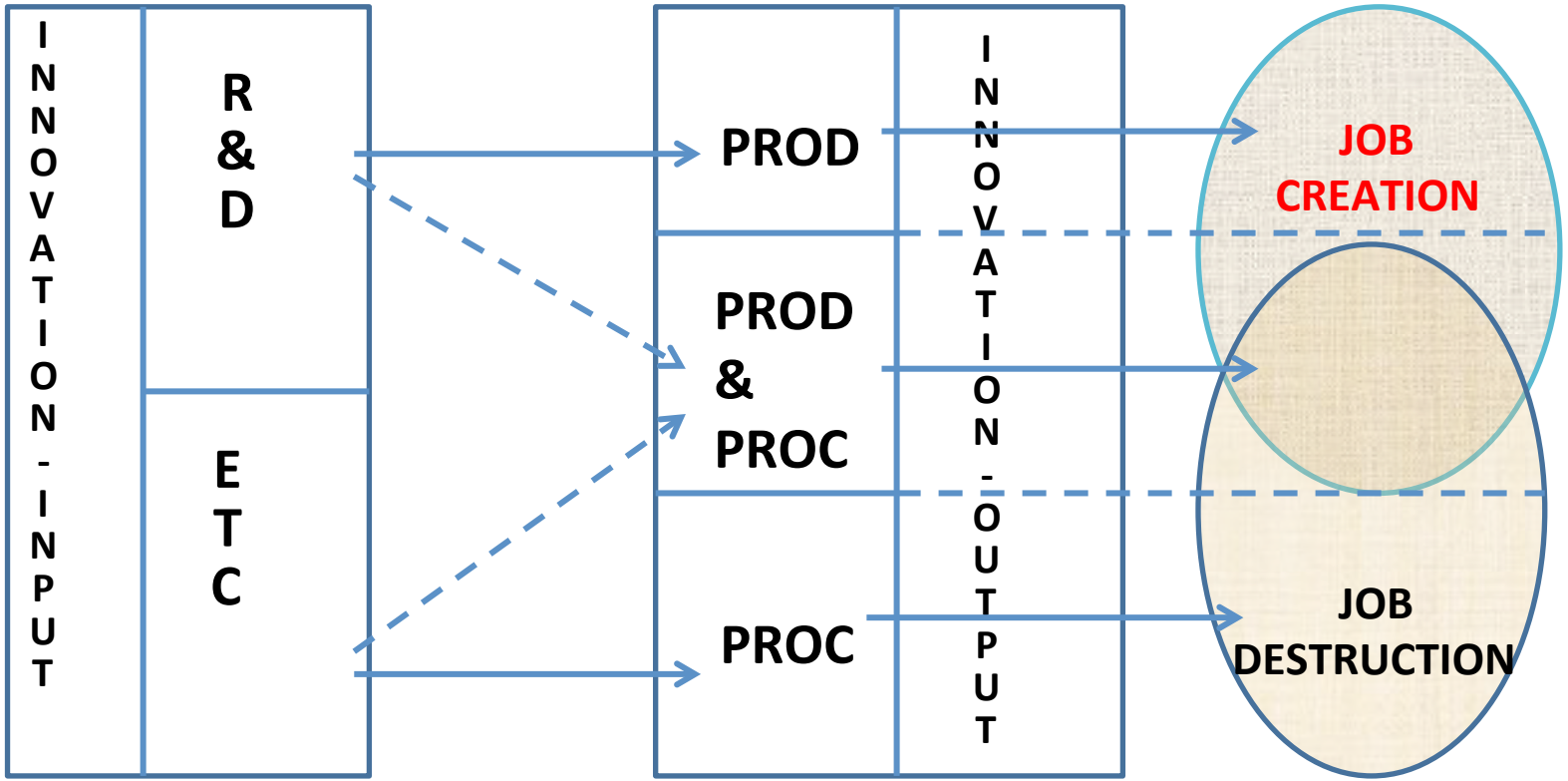
However, technological unemployment is considered an exception, occurring only when output does not grow, otherwise a "**compensation**" (through price and income market mechanisms) always occurs.

A CRITIQUE

"This neo-classical general equilibrium framework can be said to correspond most closely to present-day traditional economic views on technical change and employment. Technological change may indeed result in some temporary unemployment, but with efficiently operating labour and capital markets there is no basic economic problem arising from the introduction of new technology"

(Freeman, C. and Soete, L., ***Work for All or Mass Unemployment***, London: Pinter, 1994, p.25)

EMPIRICALLY:



PREVIOUS MICROECONOMETRIC STUDIES (1)

The **advantage** of the firm-level analysis is the possibility to better proxy technological change and innovation and to deal with large datasets; the **disadvantage** is that we cannot take into account the complex (intersectoral) nature of the compensation theory.

CROSS-SECTION STUDIES

Entorf-Pohlmeier, 1990: **positive** impact of product innovation, West Germany.

Zimmermann, 1991: **negative** impact, West Germany.

Klette-Førre, 1998: not clear-cut (**negative**) impact of R&D intensity, Norway .

Brouwer *et al*., 1993: **negative** effect of R&D, **positive** of product innovation, the Netherlands.

Cross section analyses (mainly based on OLS and or probit) are severely limited by **endogeneity** problems, cannot take into account the **unobservables** and may over-estimate the positive impact of innovation because of the **business stealing** effect.

Since the second half of the ’90s, attention has been moved to **longitudinal datasets and panel methodologies** (GMM-DIF; GMM-SYS; LSDVC).

PREVIOUS MICROECONOMETRIC STUDIES (2)

LONGITUDINAL STUDIES

Van Reenen, 1997: **positive** impact of innovation, UK.

Doms *et al.,* 1997: **positive** effect of advanced manufacturing technologies, US.

Smolny, 1998: **positive** impact of product innovation, West Germany.

Greenan and Guellec, 2000: **positive** effect of innovation at the firm-level, but negative at the sectoral level (still positive for product innovation), France.

Greenhalgh *et al.,* 2001: **positive** impact of R&D, UK, but **only in the High-Tech**.

Piva and Vivarelli (2005): **positive** impact of innovation, Italy.

Harrison *et al.* (2008): **positive** effect of product innovation and (slightly) **negative** of process innovation (strong compensation in **services**), Germany-France-UK-Spain.

Hall *et al* (2008): **positive** impact of product innovation , Italy.

Lachenmaier and Rottmann (2011): **positive** impact of innovation (including process innovation), no sectoral differences, Germany.

Coad and Rao (2011), **positive** impact of innovation, stronger for fast-growing firms, US (data only from **high-tech manufacturing**).

Bogliacino *et al* (2012), **positive** impact of R&D, but **only in services and high-tech manufacturing,** not in the more traditional manufacturing sectors.

EMPIRICAL TESTS

- **H1**: consistently with the previous literature, **R&D** expenditures should be related to an increase in employment at the firm's level;
- **H2**: in contrast, **ETC** should be related either to a decrease in firm's employment or should display a non-significant effect (main **novelty**);
- **H3:** consistently with the previous literature, innovation variables should be more positively related to employment in the **high-tech** sectors rather than in the low-tech ones;
- **H4:** innovation variables should be more positively related to employment in the **large firms** rather than in the SMEs, which are more commonly located in low-tech sectors and are dominated by ETC and process innovation.

THE ITALIAN DATASET

- **CIS data** representative at both sectoral and firm size level of the entire population of Italian companies with more than 10 employees.
- **Four CIS waves**: CIS3 (1998-2000 period), CIS4 (2002-2004), CIS6 (2006-2008) and CIS7 (2008-2010); CIS5 has been excluded since it was mainly conducted through an administrative way, resulting in incomplete and mainly interpolated data.
- In order to get relevant economic information, CIS data have been merged with the Italian Statistical Business Register (**ASIA**), created by the Italian national statistical office (ISTAT).
- Sub-sample of **innovators**: firms declaring that they had introduced either product or process innovation, or had started innovative projects.
- **Final workable sample**: 265 medium-large **manufacturing** firms over 4 periods (947 observations).
- Due to an excessive collinearity between value added and capital formation (ρ=0.83) in this dataset, we decided to test a simplified version of the ideal specification, **dropping the investment variable**.
- Hypotheses H3 and H4 will be investigated using the **OECD classification** (Hatzichronoglou, 1997) splitting manufacturing sectors into high- and low-tech sectors, and the **EU threshold of 250 employees** splitting firms into small and medium enterprises (SMEs) and large ones.

THE SPANISH DATASET

- **Survey on Business Strategies** (*Encuesta Sobre Estrategias Empresariales, ESEE*) gathering extensive information on around 2,000 **manufacturing** companies operating in Spain and employing at least ten workers, representative for each two-digit NACE-CLIO sector.
- In this study we use data for the period **2002-2013** and select our working database from an initial sample of 63,648 firm-year cells.
- Firstly, we checked for **missing values** for the variables relevant to our empirical analysis; secondly, we discarded all firms involved in M&A; thirdly, we retained only those firms that have invested in **R&D** at least once in their life and have invested in **ETC** at least once in their life; Fourthly - given the target to estimate a dynamic equation - we retained only firms for which **two consecutive lags of the dependent variable** were available.
- Finally, **R&D** has been lagged two years while **ETC** one year; this structure of **lags** takes into account that innovation may need some time to have an impact on employment and that this delay is shorter for ETC - that is directly embodied in new machineries - while longer for R&D expenditures.
- We ended up with an **unbalanced panel of 517 firms over 12 years**.

RESULTS

- **H1**: this hypothesis is **weakly confirmed** by the estimates based on the Italian data and not confirmed when the Spanish data are used; on the whole, a generalized labour-friendly nature of R&D expenditures is not detectable; in case, the magnitude of the positive impact is very small.
- **H2**: this hypothesis is **confirmed** by our estimates: ETC never exhibits a labour-friendly nature and in one case (within the Spanish SMEs) turns out to generate a significant labour-saving impact.
- **H3**: this hypothesis is **strongly confirmed** on the basis of our regressions: in the Italian case, the positive employment impact of the total innovation expenditures and of the sole R&D expenditures is totally due to high-tech firms, while in the Spanish case, the job-creation impact of R&D expenditures (after being assessed as not significant with regard to the entire sample) becomes highly significant when attention is focused on the high-tech firms.
- **H4**: this hypothesis is **confirmed** by our estimates based on the Italian CIS data (both total innovation expenditures and R&D are significant with regard to the large firms and not significant for the SMEs), **but not** by the regressions based on the Spanish ESEE data where the R&D variable is not significant for both the large companies and the

KEY FINDINGS AND POLICY IMPLICATIONS

- The job-creation impact is often negligible in magnitude.
- However, R&D may fosters labor-friendly product innovation that leads to job creation. R&D subsidy is a good policy.
- The job-creation impact of innovation is limited to product innovation and to the high-tech sectors. Need for structural policies.
- Process innovation may displace labor and create technological unemployment. Need for labor and education/training policies.
- Moreover, safety nets are necessary for the possible job losses due to process innovation in non-high-tech sectors and SMEs.
- Industrial and innovation policies that support R&D and product innovation, especially in high-tech sectors, can foster job creation.

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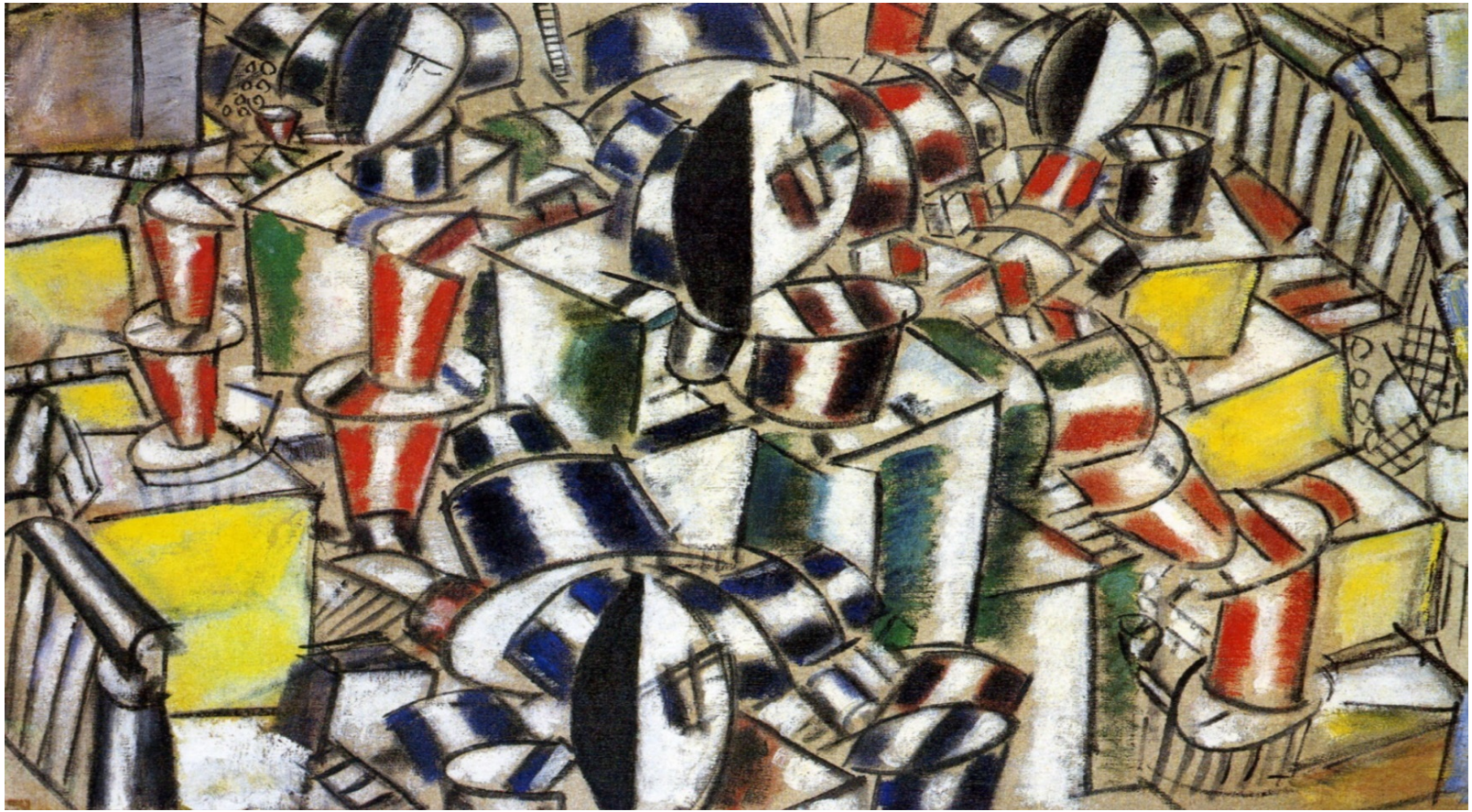

THANK YOU