More and better jobs but not for everyone: the effects of innovation in French firms

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Séminaire Fourgeaud

Paris, 23 septembre 2020

Introduction

- Europe 2020 Strategy relies on the hypothesis of a **virtuous circle between innovation, employment and job quality** : promoting innovation should be a driver of more and better jobs in Europe

- **Empirical analysis** generally confirms a **positive impact of innovation on employment** trends…however, there is **less evidence for job quality** (i.e. wages, contracts, working hours, work environment…), and **effects on workers are heterogeneous** (especially by skill level)

➢ **Further research is need to inform policy debate**

➢ Should take into account **differences by types of innovation, by skill, as well as by industry**

- Our study: based on **a panel of French data at firm-level**

- Undertaken in a wider EU Horizon 2020 project: **QuInnE, *Quality of jobs and INNovation generated Employment outcomes*,** 2015-2018, including both quantitative (EU level, France, Germany, Spain) and qualitative analysis. Published in the *International Labour Relations Review* (2020)

Hypotheses and literature review: innovation and employment at the firm level

- Effects of innovation on employment and job quality
  - Literature shows ambiguous effects of innovation at the firm level: positive for product but heterogeneous for process (labour-saving effect) (Vivarelli, 2014, Calvino & Virgilitto, 2018)
  - Effect of innovation on wages : in theory : neo-classical vs. Keynesian-Schumpeterian approach ; empirical studies: positive effects (Van Reenen, 1997, Aghion et al., 2017)
  - On contracts: a few studies investigate the effects of temporary contracts on innovation and generally find a negative relationship (Franceschi & Mariani, 2016, Kleinknecht et al., 2014, Zhou et al., 2011)
  - On working time: in theory : ambiguous effects ; no empirical studies at firm-level

Hypotheses and literature review: innovation and employment at the firm level

- Heterogeneous effects on workers:
  - By occupation: at the macro level: SBTC or RBTC/polarization ?
  - By industry: most research look only at Manufacturing

- We focus on two issues on which research has been more limited:
  - The effects of innovation on some dimensions of job quality
  - Potential heterogeneity in the employment and job quality effects, by both occupation and industry (Manufacturing and Services)

How to define innovation?

- We rely on measures of innovation as defined in the Oslo manual published by the OECD (OECD, 2005):
  - product innovation
  - process innovation
  - marketing innovation
  - organizational innovation

- These measures of innovation are the ones used in the Community Innovation Survey (CIS) that gathers information on firm's innovation activities in all EU countries every two years.

- Innovation indicators from the Oslo manual are often considered to be better innovation proxies than the traditional measures of R&D expenditures or patenting behavior.

- This article focuses on technological innovation, namely product and process innovation.

How to define job quality?

- In the literature, **job quality is considered as multi-dimensional**, including as main dimensions (Davoine et al, 2008; Munoz de Bustillo et al, 2011):

-wages and income;

-socio-economic security (type of contract, permanent/temporary, full-time/part-time)

-working conditions

-education and training

-work family balance.

- In this article : we **focus on wages and socio-economic security** dimensions (data availability at the firm level)

Databases and variables

- We link three different databases at the firm level (firm ID):
  - Community Innovation Survey (CIS): designed at the European level to collect data on innovation activities in firms (10+ employees) following the Oslo manual definitions of innovation
  - *Déclarations Annuelles de Données Sociales* (DADS) are administrative data on employment collected every year on the basis of establishments' compulsory declarations
  - Fiscal data (FARE): standard accounting data used by the Government to collect taxes on benefits : information on productivity and labor costs

- CIS is available every two years
- Other sources are available every year but there are breaks in the data.

Databases: Community Innovation Survey

- The 2014 CIS survey collects information on firm innovation from 2012 to 2014.

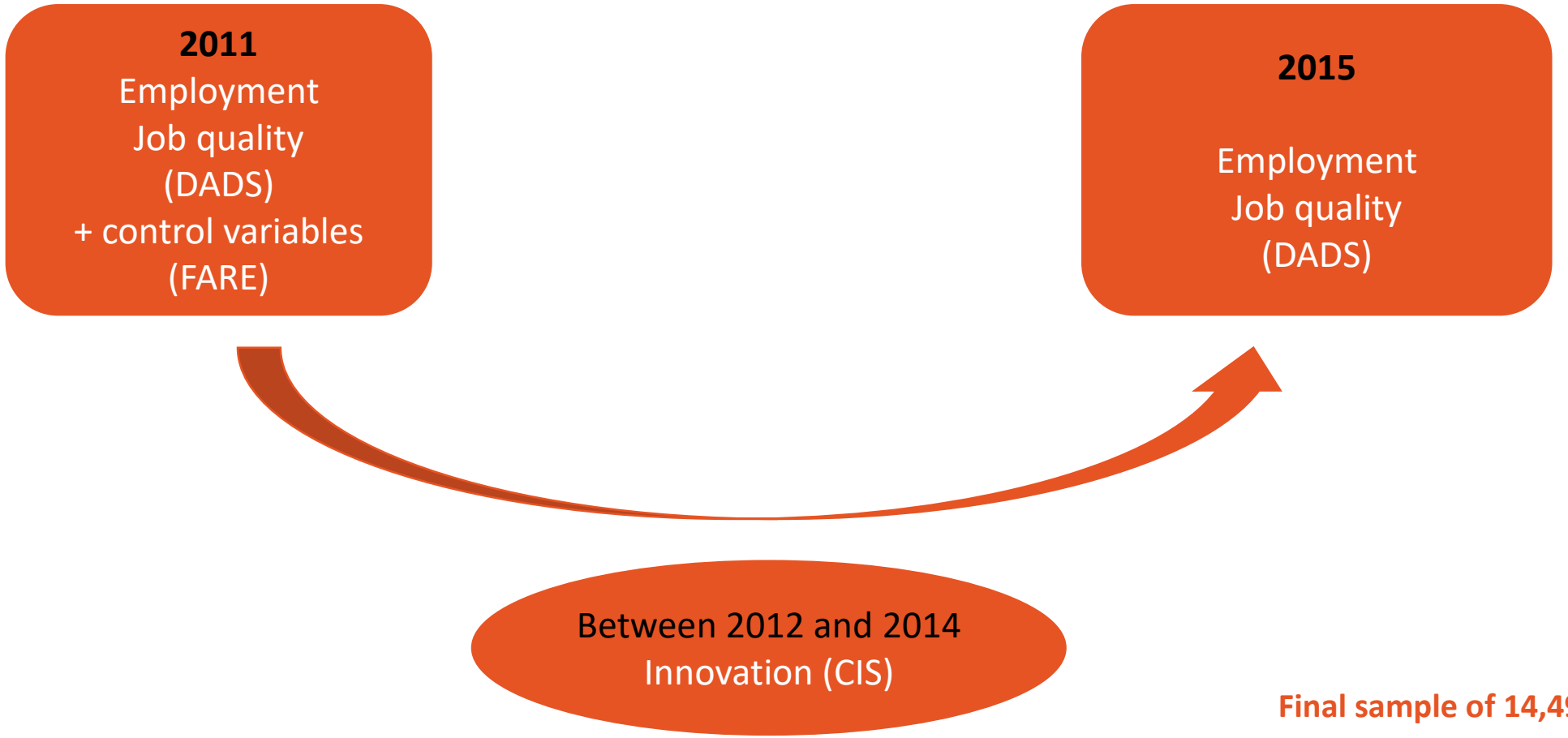
- Innovation is broadly defined as "*the introduction of a new or significantly-improved product, process, organizational method, or marketing method by your enterprise*" ➔ in line with the Oslo manual.

- We consider four innovation variables:
  - **Product innovation (goods or services)** – Question 2.1: "*Did your enterprise introduce new or significantly-improved goods (exclude the simple resale of new goods and changes of a solely aesthetic nature) or new or significantly-improved services?*"
  - **New to the market product innovation** – Question 2.3: "*Did your enterprise introduce a new or significantly-improved product onto your market before your competitors?*"
  - **Product innovation and application for a patent** – Question 2.1 (see above) and Question 11.1: "*Did your enterprise apply for a patent?*"
  - **Process innovation** – Question 3.1: "*Did your enterprise introduce new or significantly-improved methods of manufacturing for producing goods or services, new or significantly-improved logistics, delivery or distribution methods for your inputs, goods or services, or new or significantly-improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing?*"

Databases: DADS

- *Déclarations Annuelles de Données Sociales* (DADS) includes variables on:
  - Employment
  - Contract type (fixed-term or permanent)
  - Annual working hours
  - Wages
- These variables are available by occupation (except contract type)
- No information on the work environment

Databases: linking CIS, DADS and FARE



Final sample of 14,491 firms

Methodology

- Innovating and non innovating firms have different structural characteristics (observable and non observable) that may impact on their employment and job quality performance ➔ we combine a propensity score matching model with a difference in differences approach

  - We use a propensity score matching model : innovation is considered as a treatment. For each firm that innovated (between 2012 and 2014) we find an identical counterfactual that did not innovate.
  - As we have a panel, we are also able to control for an individual and unobservable fixed effect that simultaneously affects the treatment and the outcome variables: we use a difference in differences estimator ➔ we observe the variation in the outcome variable between two dates (first difference) and comparing this variation between the treated and untreated firms (second difference).

Methodology

Two steps

- **First step:** we estimate a logit selection model in order to estimate the propensity score.
  - Control variables (determinants of innovation): firm's characteristics (size, age, sector by level of technology, member of a business group) and indicators of economic performance (labour productivity, labour cost).
- **Second step:** we estimate the average effect of the treatment (ATT) on the difference in employment and job quality variation for the treated and the control groups using radius matching estimator.
  - Radius matching with a caliper of 0.00001

Results: Determinants of innovation (first step logit model)

Main effects:

Size of the firm (+)

Industry: manufacturing sector (+) and higher tech (+)

Member of a business group (+)

Age of the firm (-)

Productivity (+)

Labour cost (+)

Same determinants for product, process, product new to the market, product innovation+ patenting

Results: employment and job quality (overall)

- Positive effect of product innovation on total workforce
- This effect is even larger when product innovation comes with a patent application
- Negative effect of process innovation on total workforce

- Effects on job quality are mixed but somehow positive:
  - Product innovation has a positive effect on the number of employees on permanent contracts
  - Process innovation has a negative impact on the number of employees on fixed-term contracts
  - Product innovation also has a positive effect on the total number of hours worked
  - No significant effect on wages

Results: employment and job quality

Dependent variables	Product	Product new to the market	Product patenting firms	Process
Total workforce	5.7 (3.0)*	3.2 (4.0)	14.4 (8.1)*	-5.6 (2.8)**
Open-ended (permanent) contract employees	8.2 (3,0)***	5.7 (4.0)	19.8 (7.8)**	-2.9 (2.7)
Fixed-term contract employees	-1.7 (1,1)	-1.1 (1.2)	-2.0 (2.0)	-3.0 (1.1)***
Average annual hours worked per employee	12.7 (6.8)*	8.6 (7.3)	10.9 (10.0)	0.4 (7.0)
Hourly wages (gross)	-0.0 (0.1)	0.0 (0.1)	0.2 (0.1)	0.0 (0.1)

Source: CIS 2014, FARE 2011 & 2015, DADS 2011 & 2015, *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Results: employment and job quality by occupation

- **Positive effect of product innovation** on the number of managers and professionals and intermediate occupations
- There is a **negative effect of process innovation** on manual and clerical workers

- **Very few significant effects of innovation on job quality** (working time and wages) : product innovation has a negative effect on wages of manual and clerical workers, but a positive effect on their working time.

Results: employment by occupation

Dependent variables	Product	Product new to the market	Product patenting firms	Process
Number of managers and professionals	5.6 (1.6)***	6.5 (2.5)***	15.0 (5.9)**	0.4 (1.6)
Number of intermediate occupations	2.8 (1.1)**	1.3 (1.5)	6.6 (3.3)**	-0.2 (1.0)
Number of manual and clerical workers	-2.8 (2.9)	-4.5 (3.8)	-7.1 (8.4)	-5.8 (2.7)**

Source: CIS 2014, FARE 2011 & 2015, DADS 2011 & 2015, *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Results: job quality by occupation

Dependent variables	Product	Product new to the market	Product patenting firms	Process
Hourly wage: managers and professionals	-0.10 (0.20)	-0.09 (0.2)	-0.00 (0.28)	-0.27 (0.18)
Hourly wage: intermediate occupations	0.02 (0.38)	-0.37 (0.37)	-0.53 (0.69)	0.27 (0.32)
Hourly wage: manual and clerical workers	-0.17 (0.09)*	-0.04 (0.10)	-0.06 (0.17)	-0.07 (0.08)
Working time: managers and professionals	2.9 (11.7)	1.2 (11.9)	10.0 (14.7)	-14.6 (10.3)
Working time: intermediate occupations	15.5 (13.8)	4.6 (14.9)	16.3 (20.1)	-0.6 (12.6)
Working time: manual and clerical workers	19.6 (10.3)*	16.3 (11.4)	17.2 (15.9)	2.4 (7.6)

Source: CIS 2014, FARE 2011 & 2015, DADS 2011 & 2015, *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Results: Manufacturing and Services

- **Positive effects are concentrated in Manufacturing**, where product innovation increases employment level, number of hours worked and employment stability (more permanent employment and less temporary employment). Employment effects are stronger for patenting firms.
- **In Services, a clear negative effect of process innovation on employment (total and fixed-term)**. For product innovation, the pattern is less clear : effects are generally insignificant but a positive impact on temporary employment (new to the market innovation only), as well as on hourly wages (patenting firms only).

Results in Manufacturing

Dependent variables	Product	Product new to the market	Product patenting firms	Process
Total workforce	15.7 (3.2)***	9.4 (4.5)**	22.7 (7.6)***	-1.8 (3.1)
Open-ended (permanent) contract employees	16.9 (3.2)***	11.3 (4.4)**	25.1 (7.4)***	-5.2 (3.0)
Fixed-term contract employees	-2.8 (0.9)***	-4.0 (1.2)***	-3.9 (2.1)*	-2.0 (0.9)**
Average annual hours worked per employee	25.6 (10.0)**	16.2 (9.9)	5.0 (11.3)	-5.3 (8.6)
Hourly wage (gross)	-0.2 (0.09)*	-0.1 (0.1)	0.1 (0.1)	0.1 (0.1)

Source: CIS 2014, FARE 2011 & 2015, DADS 2011 & 2015, *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Results in Services

Dependent variables	Product	Product new to the market	Product patenting firms	Process
Total workforce	-1.3 (5.4)	-4.1 (7.8)	4.6 (23.4)	-15.4 (5.5)***
Open-ended (permanent) contract employees	2.4 (5.4)	-0.4 (8.1)	18.0 (22.4)	-8.4 (5.4)
Fixed-term contract employees	0.1 (2.5)	4.0 (2.2)*	4.0 (3.4)	-5.2 (2.7)*
Average annual hours worked per employee	8.7 (12.3)	4.7 (13.4)	13.0 (21.4)	0.6 (15.9)
Hourly wage (gross)	-0.0 (0.1)	0.1 (0.1)	0.6 (0.4)*	-0.04 (0.1)

Source: CIS 2014, FARE 2011 & 2015, DADS 2011 & 2015, *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Summary of the results

- **Effects of product innovation are positive on employment and some dimensions of job quality** (stability of contracts and number of hours worked) but these effects are mainly concentrated in Manufacturing
- Positive effects of product innovation **are generally larger when innovation is new to the market or comes with a patent application**
- Process innovation has **negative effect** on employment and this effect is concentrated in Services
- **Manual and clerical workers are generally disadvantaged, with insignificant or negative effects of product and process innovation (on employment, wages).**
- More **'radical' innovations in Services** seem to have somehow different effects: more temporary contracts and higher wages

Conclusion: is there a virtuous circle between innovation, employment and job quality?

- The answer is mixed!
  - Positive effects of product innovation but effects of process innovation are mixed
  - Innovation also has a positive effect on employment stability but other job quality effects are generally not significant
  - Not all social groups benefit from firm innovation, as lower-skilled workers are less positively affected in terms of employment and wages
  - The positive effects of innovation appear mainly in Manufacturing while innovation in Services can lead to more flexible employment

- Innovation brings more and better jobs in some cases BUT there is room for public intervention that should focus on the consequences of innovation for the individuals and in sectors where its effects are notably less positive

Effects on wages by sector

	Manufacturing	Services
Managers and professionnals	NS	NS
Intermediate professions and technicians	Patenting (-)	NS
Clerical and support workers	Product (-) / New to the market (-)	Product (-) / Process (-) / Patenting (+)
Blue-collar workers	NS	Process (-)

Innovation characteristics of our database

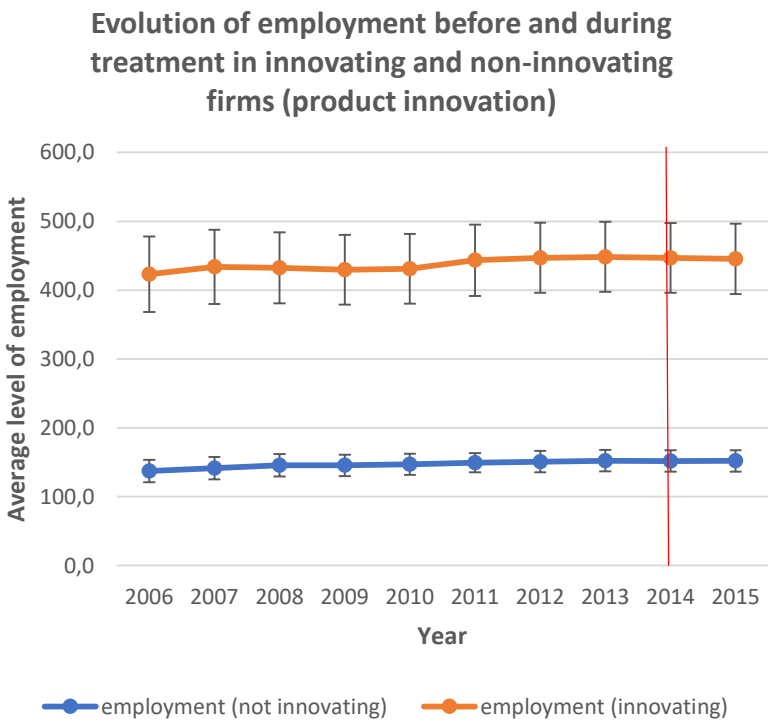
Type of innovation	Total	Manufacturing	Services
Product innovation	27.6%	42.1%	26.2%
Product innovation new to the market	18.9%	31%	16.8%
Product and patenting firms	7.3%	16.8%	3.6%
Process innovation	27.5%	40%	24.7%

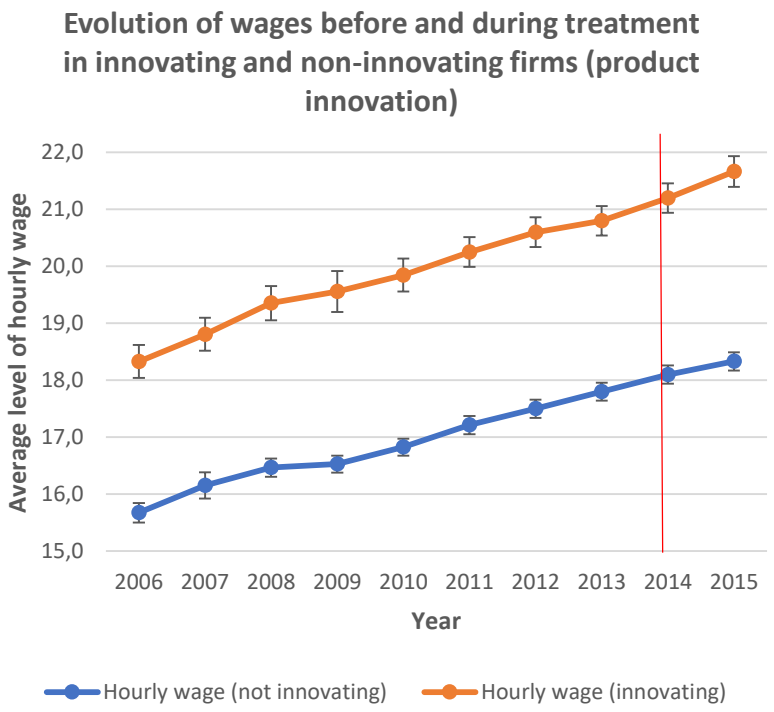
- The firms in the sample represents 28% of the total value added in 2014
- The firms in the sample employs 17% of the total employment in 2014

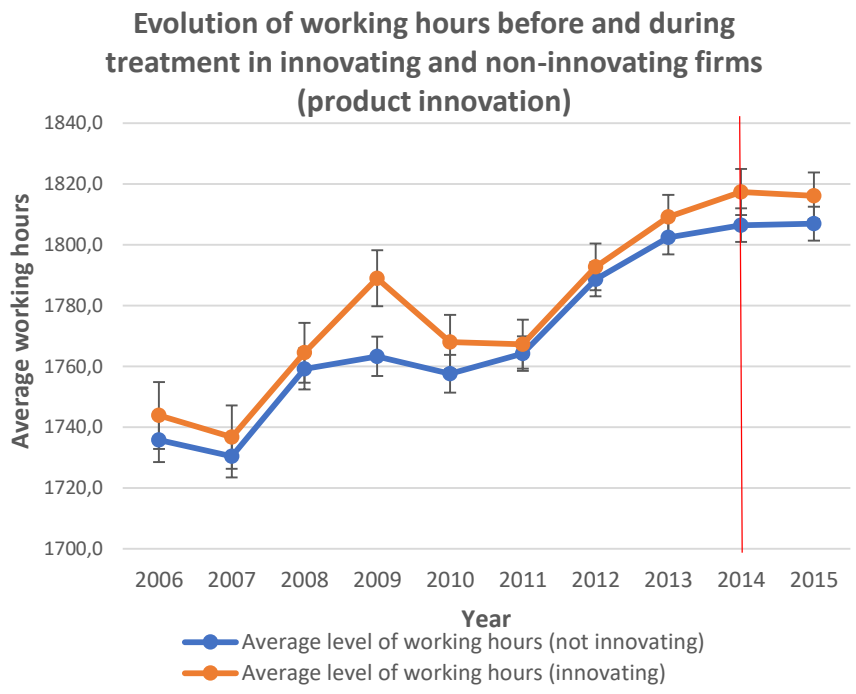
- Product or process innovation involved in R&D activities (occasionally or continuously): **65.8%**
- Product or process innovation involved continuously in R&D activities: **38.9%**

Robustness checks

- Common trend assumption







Robustness checks

- We run a balancing test to compare the mean of the control variables for the treated and untreated firms and thus the reduction in the selection bias before and after matching

- The results show that after matching there are no average differences in the control variables between the treated (innovating firms) and control (non-innovating firms) groups ➔ the selection model does then reduce the bias between treated and untreated firms

Balancing test on product innovation matching

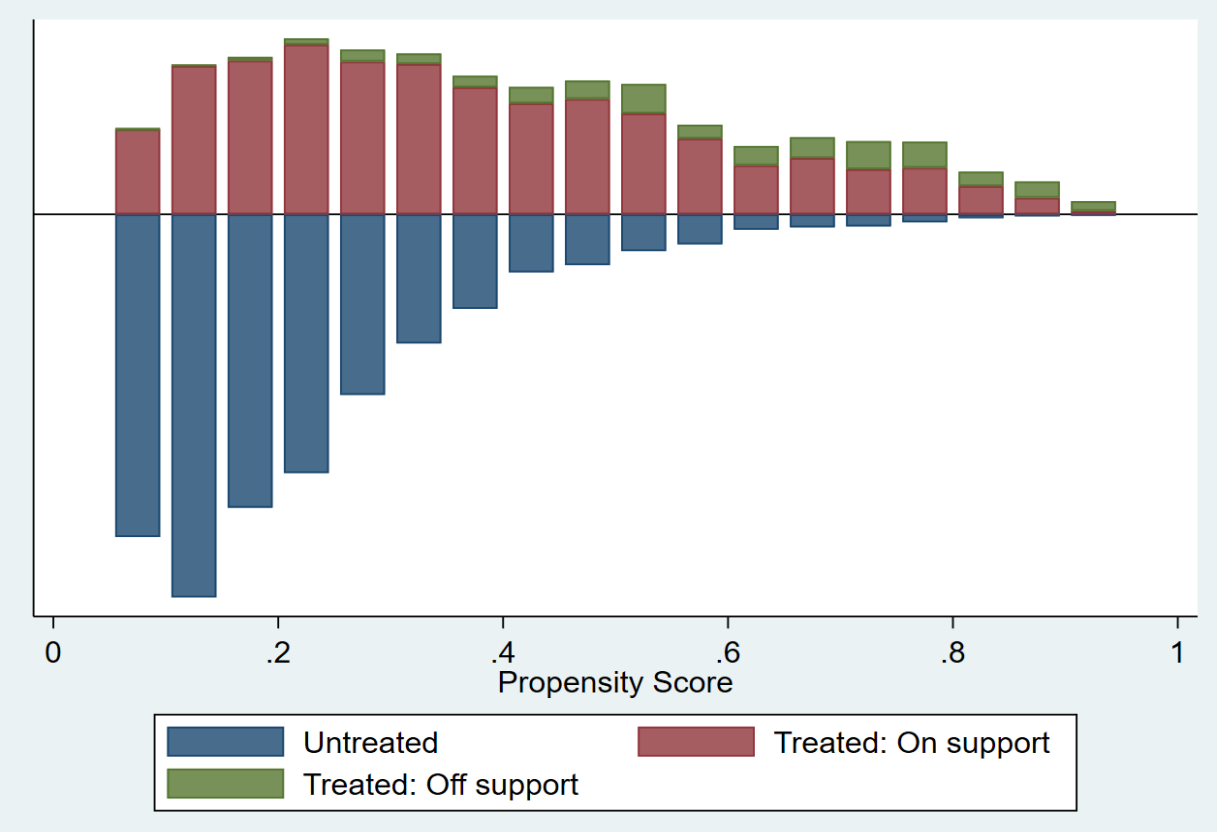
	Mean	*Mean*		*t-test*	
Variables	**Treated**	**Control**	**% bias**	**T**	**p>t**
Sector by technology (ref. less knowledge-intensive services)					
High-tech manufacturing	0.02	0.02	0.1	0.04	0.97
Medium high-tech manufacturing	0.12	0.12	-0.1	-0.05	0.96
Medium low-tech manufacturing	0.14	0.14	-0.1	-0.02	0.98
Low-tech manufacturing	0.19	0.19	0.0	0.02	0.99
Knowledge-intensive services	0.26	0.26	-0.0	-0.01	0.99
Size (ref. 10-19 employees)					
20 to 49	0.22	0.23	-0.2	-0.09	0.93
50 to 499	0.40	0.40	0.4	0.14	0.89
500 to 999	0.08	0.08	-0.3	-0.12	0.90
>1000	0.06	0.06	0.2	0.09	0.93
Age (ref. lowest quartile)					
2nd quartile	0.23	0.23	0.3	0.13	0.90
3rd quartile	0.25	0.25	0.3	0.11	0.91
Top quartile	0.28	0.28	-0.0	-0.01	0.99
Productivity (ref. lowest quartile)					
2nd quartile	0.21	0.20	0.3	0.14	0.89
3rd quartile	0.27	0.27	-0.4	-0.15	0.88
Top quartile	0.36	0.36	0.2	0.07	0.94
Labor cost (ref. lowest quartile)					
2nd quartile	0.20	0.20	0.5	0.24	0.81
3rd quartile	0.28	0.28	-0.3	-0.11	0.90
Top quartile	0.38	0.38	-0.1	-0.03	0.98
Member of a business group (ref. no)					
Yes	0.64	0.64	-0.1	-0.06	0.95

Robustness checks

Radius matching with a caliper of 0.00001

➔ Precise matching between treated and control firms

➔ Between 12.6% and 18.8% of firms drop out of the support: off-support firms have higher propensity scores but no comparison firms



Robustness checks

- Different types of matching were tested:
  - Radius matching with a larger caliper of 0.001
  - Kernel matching
- Regressions were run on the previous wave of CIS (2012 linked to DADS and FARE 2009 and 2013)
- Regressions were run on a sample of firms which were present in both waves of CIS (2012 and 2014):
  - Effect of innovations in the 2012-2014 period on changes in employment and JQ between 2011 and 2015 introducing as a control a dummy for innovation in the previous 2010-2012 period
  - Effect of repeated similar innovations (2010-2012 AND 2012-2014) vs. no innovation on changes in employment and JQ between 2009 and 2015