Research, Innovation and Productivity: Direct and Indirect Impacts of the 2008 French R&D Tax Credit Reform

Preliminary Results

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Abstract:

- In 2008, a reform of the French R&D tax credit led to a large increase of firms' corporate tax deductions, from 1.7 billion € in 2007 up to 4.2 billion € in 2008 and 5.6 billion € in 2013.
- This paper intends to investigate the effects of this reform on firms' R&D investments, and beyond on their innovation and productivity performances.
- It is based on an unbalanced firm panel data mainly constructed from the three 2004, 2008 and 2012 waves of the French Community Innovation Survey (CIS), matched with the R&D tax credit management database (GCIR) and the annual R&D surveys (ERD).
- It endeavors to identify the direct and indirect impacts of the 2008_reform, by trying to implement the so-called CDM framework as in Raymond and al (2015).

- Raymond W., J. Mairesse, P. Mohnen and F. Palm, 2015: "Dynamic Models of R & D, Innovation and Productivity: Panel Data Evidence for Dutch and French Manufacturing", European Economic Review, 78, 285-306.

- Keywords: Research, innovation and productivity; R&D tax credit; Community innovation survey.

THE FRENCH R&D TAX CREDIT (CIR)

The CIR initiated in 1983 was incremental (i.e. based on the increase in R&D spending)

- In 2004, a component in volume (i.e. based on the amount of R&D) has been introduced in parallel to the incremental CIR, with a tax credit rate of 5% (raised to 10% in 2006)
- In 2008, the incremental CIR has been abandoned in favor of a purely volume scheme, with a high rate of tax credit of 30 %
- The 2008 reform led to a large increase of firms' corporate tax deductions, from 1.7 billion e in 2007 up to 4.2 billion e in 2008 and 5.4 billion e in 2012

LITERATURE REVIEW

- Impact of 2008 French tax credit reform on R&D expenses
  - Ex-ante evaluations: Mulkay & Mairesse (2013)
  - Ex-post evaluations: Mulkay & Mairesse (on going)

- R&D impact on innovation and productivity
  - An abundant literature, such as Raymond et al. (2015): a dynamic CDM model for France and Netherlands on Community Innovation Survey (CIS) data

- Impact of the 2008 French tax credit reform on innovation
  - Bozio, Irac & Py (2014) : Impact on R&D expenses and patents

IN THIS PAPER

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- We rely mainly on the Raymond et al. (2015) model, but:
  - we use 2002-2004, 2006-2008 and 2010-2012 CIS data (94-96, 98-00 and 02-04 in Raymond et al. 2015)
  - we model the R&D equation of the CDM framework
  - we introduce the user cost of R&D capital in this eq. (as in Mulkay & Mairesse, 2013 and on going)

- In further work, we will also rely on Hall, Lotti and Mairesse (2008) et Harrison et al. (2014) to investigate the impact on employment.

OUTLINE

- CIR impact on innovation and productivity (dynamic CDM model)
  - R&D equation
  - Innovation equation
  - Productivity equation
  - User cost of R&D capital
- Data
  - Sample
  - Descriptive analysis
- Results
  - Table 1: Main estimates
  - Short and long run impact
  - Estimates using all the CIS innovation measures
  - Sensitivity analysis
- Estimation by firm size (static CDM model)
  - Table 2: Estimates by Firm Size
  - Long run impact by firm size
- Conclusion
- Appendix: Comparison with Raymond and al. (2015)

R&D equation:

$$Log\left(\frac{RD}{L}\right)_{it} = \alpha_1 + \mu_1 \times Log\left(\frac{RD}{L}\right)_{it-1} + \theta_1 \times Log(LP)_{it-1} + \boldsymbol{\beta_1 \times Log(C)_{it}} + \lambda_1 \times Log(L)_{it-1} + \phi_{1s} + \phi_{1t} + \epsilon_{1it}$$

with RD is the R&D investment, L the number of employees, RD/L the R&D intensity, LP the labor productivity (= turnover over employment) and C the user cost of R&D capital

- This equation is estimated at the intensive margin (i.e. on the sample of firms investing on R&D)

Innovation equation:

$$Inno_{it} = \alpha_2 + \mu_2 \times Log(LP)_{it-1} + \beta_2 \times \boldsymbol{Log}\widehat{\left(\frac{\boldsymbol{RD}}{\boldsymbol{L}}\right)}_{\boldsymbol{it}} + \eta \times RD_i^{cont} + \lambda_2 \times Log(L)_{it-1} + \phi_{2s} + \phi_{2t} + \epsilon_{2it}$$

with Inno a CIS measure of innovation, a ^ indicating a predicted value and RDcont a dummy indicating whether the firm invest in R&D

- Alternatively, the square of R&D intensity is added to the specification

Productivity equation:

$$Log(LP)_{it} = \alpha_3 + \mu_3 \times Log(LP)_{it-1} + \beta_3 \times \widehat{\boldsymbol{Inno}}_{\boldsymbol{it}} + \lambda_3 \times Log(L)_{it} + \phi_{3s} + \phi_{3t} + \epsilon_{3it}$$

- Various measures of innovation can be included, possibly simultaneously

User cost of R&D capital

The user cost of R&D capital is calculated according to the following formula:

$$\boldsymbol{C = P^{RD}(\rho + \delta - \pi)(1 - \gamma)}$$

with P^{RD} the R&D price, γ measuring the cost reduction thanks to the R&D tax credit, ρ the discount rate (3%), δ the depreciation rate (15%) and π the inflation rate.

The R&D cost reduction parameter is: $\boldsymbol{\gamma}$**=CIR/RD**

with CIR the amount of R&D tax credit

SAMPLE

- Data sources :
  - CIS waves 2002-2004, 2006-2008 and 2010-2012
  - GECIR database on the same period

- After cleaning, our main estimation sample is an unbalanced panel of 6 068 observations for 2 620 distinct firms
  - With 704 firms observed 3 times, 1 060 observed on 2004-2008 only and 856 on 2008-2012 only
  - 3 324 observations for the dynamic (4 years lags) estimations
  - of which 2 180 observations for the subsample of firms investing in R&D

DESCRIPTIVE ANALYSIS

- The firms of the main estimation sample are:
  - big, with a median of 356 employees and only 169 firms with less of 20 employees
  - usually innovating
  - often investing in R&D: 71% in 2004, 79% in 2008 and 81% in 2012
  - Among the R&D firms, 19 % were benefiting from the R&D tax credit in 2004, 79% in 2008 and 81% in 2012

Table 1: 'Radical' product and service innovation
Innovation: occurence of a product or service new for the market during the last three years

	(1)	(2)	(3)
Variable dépendante	**Intensité de R&D** $(\mathrm{Log}(\mathrm{RD}/\mathrm{L}))$	**Innovation** (Inno)	**Productivité** $(\mathrm{Log}(\mathrm{LP}))$
Estimateur	**MCO**	**Probit**	**MCO**
Intensité de R&D	0.300***		
$(\mathrm{Log}(\mathrm{RD}/\mathrm{L})_{t-1})$	[0.0180]		
Innovation		0.624***	
(Inno_{t-1})		[0.0491]	
Productivité	0.188***	0.00836	0.326***
$(\mathrm{Log}(\mathrm{LP})_{t-1})$	[0.0397]	[0.0207]	[0.0174]
Coût d'usage du capital R&D	**-1.294*** **		
$(\mathrm{Log}(\mathrm{C}))$	[0.180]		
Intensité de R&D prédite		**0.210*** **	
R&D continue		**0.447*** **	
$(\mathrm{RD}^{\mathrm{cont}})$		[0.0640]	
Innovation latente			**0.463*** **
$(\widehat{\mathrm{Inno}})$			[0.112]
Effectif $(\mathrm{Log}(\mathrm{L})_{t-1})$	-0.144***	0.0910***	0.0263*
	[0.0230]	[0.0169]	[0.0142]
Observations	2,180	3,324	3,324
R^2	0.241		0.250
Log Vraisemblance	-3,922	-1,947	-5,111

Robust std errors in brackets; *** p < 0, 01, ** p < 0, 05, * p < 0, 10; Industry and time fixed effects included

Short and long run impact

- The Average Marginal Effect for the probit model are of 0.07 for R&D intensity and 0.21 for lagged innovation

- The long-term elasticities are -1.85 for R&D user cost, 0.09 for R&D intensity and 0.69 for innovation

- A 10% decrease of the R&D capital user cost would:
  - (i) on the short-run, increase R&D intensity by 12.8%, innovation probability by 0.9% and productivity by 0.4%;
  - (ii) on the long-run by 18.3%, 1.6% and 1.1%, respectively

Estimates using all the CIS innovation measures

- A significant positive R&D intensity impact on product and service innovation
  - for 'radical' as well as 'incremental' innovation
  - measured by an occurrence dummy or by the new product and service share in total sales
  - but only radical innovation occurrence has a significant (positive) impact on productivity

- No significant R&D intensity impact on process and organizational innovation

Sensitivity analysis

- Our estimates appear robust to the inclusion of the initial conditions that take into account much of unobserved individual heterogeneity
- The use of predicted values is particularly important:
  - The impact of observed R&D intensity on 'radical' innovation occurrence is 3 times smaller than the impact of predicted R&D intensity
  - The impact of observed innovation occurrence on productivity is not significant
- When using (roughly calculated) R&D capital stock, the estimated user cost elasticity and R&D intensity impact on 'radical' innovation occurrence are twice smaller

Estimation by Firm Size

- In order to increase the number of small firms in the estimation sample, we use a static model. The previous estimation results are robust to this changes of specification and sample
- We estimate the CIR impact on 3 samples according to the number of employees per firm: less than 50, between 50 and 1,500, 1,500 and over
- The proportion of R&D firms and innovative firms is increasing with firm size (from 50% to 67% and from 40% to 60%, respectively) and have increased strongly in 2008 (of 14% and 13%)

Table 2: Estimations by firm size

Innovation: occurrence of a product or service new for the market during the last three years

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Sample	< 50			50 ≤ and 1,500 <			≤ 1,500		
Dep. variable	R&D intensity $(Log(RD/L)_{it})$	Innovation $(Inno_{it})$	Productivity $(Log(LP)_{it})$	R&D intensity $(Log(RD/L)_{it})$	Innovation $(Inno_{it})$	Productivity $(Log(LP)_{it})$	R&D intensity $(Log(RD/L)_{it})$	Innovation $(Inno_{it})$	Productivity $(Log(LP)_{it})$
Estimator	OLS	Probit	OLS	OLS	Probit	OLS	OLS	Probit	OLS
User cost of R&D capital $(Log(C)_{it})$	-2.294***			***-1.679****			***-1.456****		
	[0.134]			[0.139]			[0.539]		
R&D intensity		***0.412****			***0.185****			***0.282****	
$(Log(\widehat{RD/L})_{it})$		[0.0317]			[0.0380]			[0.101]	
R&D dummy		***0.430****			***0.770****			***0.766****	
(RD_{it}^{cont})		[0.0495]			[0.0353]			[0.109]	
Innovation			***0.138****			***0.577****			***2.227****
$(\widehat{Inno}_{it})$			[0.0491]			[0.0658]			[0.480]
Employment $(Log(L)_{it})$	-0.613***	0.167***	-0.126***	-0.119***	0.192***	0.0405***	-0.337***	0.120*	-0.0331
	[0.0446]	[0.0265]	[0.0156]	[0.0242]	[0.0135]	[0.0115]	[0.127]	[0.0663]	[0.0760]
Observations	5,800	11,664	11,664	7,263	12,072	12,072	621	926	926
Log-likelihood	-11,469	-6,396	-15,401	-14,889	-7,212	-17,787	-1,341	-516.4	-1,727

Robust std errors in brackets; *** p < 0, 01, ** p < 0, 05, * p < 0, 10; Industry and time fixed effects included

Long run impact by firm size

- The Average Marginal Effect of R&D intensity for the probit model are of: 0.128 if < 50, 0.063 if 50 <= and < 1,500, 0.089 if >= 1,500

- A 10% decrease of the R&D capital user cost would: (i) in the small firms, increase R&D intensity by 22.9%, innovation probability by 2.9% and productivity by 0.4%; (ii) in the medium size firms, increase by 16.8%, 1.2% and 0.7%, respectively; and (iii) in the large firms by 14.6%, 1.3% and 2.9%

CONCLUSION

- Our estimation results confirm an impact of the R&D tax credit on R&D intensity
- According to our estimates, a decrease of about 15% (i.e. from 8% in 2004 to 24% in 2008) of the user cost of R&D capital would induce:
  - in four years, an increase of R&D intensity of 19.2%, of 'radical' product and service innovation probability of 1.4% and of labor productivity of 0.6%
  - in the long run, an increase of R&D intensity of 27.7%, of 'radical' product and service innovation probability of 2.4% and of labor productivity of 1.7%

CONCLUSION

- The CIR impact on R&D intensity is higher for the small firms, but the impact of innovations on productivity is stronger for large firms. Thus, the CIR impact on productivity is higher for large firms

- An important continuation would be to mobilize new data in order to improve the user cost of capital measure and then be able to identify the CIR impact at the extensive margin

Comparison with Raymond and al.

	Lopez & Mairesse		**Raymond et al. (2015)**			
			Table 4 - France		Table 4 - Netherlands	
	(1)	(2)	(3)	(4)	(3)	(4)
Dependent variable	Innovation ($Inno$)	Productivity ($Log(LP)$)	Innovation ($Inno$)	Productivity ($Log(LP)$)	Innovation ($Inno$)	Productivity ($Log(LP)$)
Estimator	Probit	MCO	Probit	MCO		
Innovation	0.454***		0.070*		0.020	
($Inno_{t-1}$)	[0.0802]		[0.042]		[0.068]	
Productivity	0.014	-0.117***	0.000	0.531***	0.004	0.319***
($Log(LP)_{t-1}$)	[0.0206]	[0.0265]	[0.006]	[0.056]	[0.010]	[0.066]
R&D intensity	**0.0565*** **		**0.010**		**0.069*** **	
($Log(RD/L)_{t-1}$)	[0.0143]		[0.011]		[0.018]	
R&D dummy	**0.573*** **		**0.208*** **		**0.233*** **	
(RD^{cont})	[0.0550]		[0.027]		[0.037]	
Latent innovation		**0.504*** **		**0.074*** **		**0.121*** **
propensity ($\widehat{Inno}$)		[0.106]		[0.020]		[0.029]
Observations	3,324	3,324	2,505		1639	
Log-likelihood	-1,945	-4,898	-5,049		-3,921	