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CONCORDi 2021

Industrial innovation for competitive sustainability

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Virtual conference

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1 Title

Technology policy evaluation: The interaction between the financial constraint of firms and level of financial additionality

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Session A: Industrial transition in times of recovery

Principal aim and motivation

The existence of market failures implies that firms underinvest in R&D and often lack access to financial markets. Being one of the justifications for public support.

This study analyses the differentiated effects of the public support for private R&D and innovation (RDI) considering the financial situation of the firm by analyzing two questions .

- **Get firms with financial restriction –and therefore its RDI depend more on public money- more frequently support?**

- **Do such firms show a higher level of financial additionality than the firms with less financial restrictions?**

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Previous literature: 14 studies

14 studies were detected using **20 different indicators** (only 3 indicators were used by more than one study)

- 7 studies analysed the relationship of the **financial restrictions** and the **probability** of **getting support**
- 5 papers analysed the impact of the financial constraints **on the R&D expenditures** (Financial additionality)
- 3 papers analysed the output additionality (impact on the introduction of new products)

✓ The numbers of indicators mentioned in the paper refer to the financial indicators explicitly used to measure its intermediating effect on the policy impact.

✓ Including also the “financial variables” used only as control variables would raise the number 29 different indicators

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Previous literature:Type of indicators

- Five studies included **quantitative variables based on the balance sheet of the firms** (cash flow, level of assets and its liabilities)
- Five papers used a **qualitative self-assessments of the difficulties to access internal and or external funds**
- Four studies are based on **external valuation of the credit worthiness of the firm**
- Two papers used "**ad hoc indicators**" of the "**dependency on external funds**" (like the size of the firm)

Curiously, several papers convert the available quantitative information in a binary variable to analyze its intermediating effect on the policy impact.

Previous literature: results

The results of the effect of the financial restrictions on the degree of participation are not conclusive.

- Ten models showed a positive effect,
- Six a negative effect
- Five a non-significant one.

Moreover, the positive effect seems to be different for SMEs versus large firms.

The moderating role of financial constraints on the level of financial additionality is also unclear

- Seven models show a positive relationship
- Two studies obtained the opposite effect
- Five models showed a non-significant relationship.

Due to the diversity of the type of indicators used in each of the studies it's difficult to explain why such differences exist

Methodology: broad number of indicators on financial constraints

- The existing empirical evidence on the intermediating role of the financial constraints on the policy outcome is scarce, did use a broad range of indicators and its results are often contradictory.
    - The main novelty of this paper is the more comprehensive approach to measure the financial constraints of a firm.
    - Using a broad set of 17 complementary quantitative continuous indicators with data coming directly from the balance sheets of the firms,
    - Reflecting the company's liabilities or indebtedness in relation with their assets and liquidity and some indicators of confidence or image on the future of the firm.

These 17 variables were combined by a factor analysis in seven synthetic variables or factors that were used in the different models.

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Methodology: different complementary models

- A specific mix of methdology is used to answer the before mentioned questions and to create the indicators to measure the financial constrains of the firm

- **Factor analysis** to condense the 17 indicators on the financial constraints

- **Probit**. the estimation of the probability of being supported depending on each of the firm's characteristics, especially its financial constraints

- **Propensity score matching**. A **matching model** for the comparison of supported vs. unsupported companies and thus determine the effect of the innovative aids on firms.

First stage: Probability of being supported

(also used to match supported and non supported firms)

$$Prob = (Aid_i | X = x_i)$$

Second stage: Individual treatment effect (ITE)

(Difference in R&D expenditures by sales for each couple of treated and non treated firms)

$$\widehat{\tau_i} = Y_i^{T=1} - \widehat{Y}_i^{T=0}$$

Third stage: Average treatment effect (ATET) of the public support

$$\tau_{ATET} = \frac{\Sigma_{i=1}^{N} = \tau_i}{N}$$

Fourth stage: Heterogeneity of the Individual Treatment Effect (ITE)

$$\widehat{\tau_i} = \beta_1 Factor1 + \beta_2 F2 + \beta_3 F3 + \beta_4 F4 + \beta_5 F5 + \beta_6 F6 + \beta_7 F7 + X_{i,t-1}\gamma + \varepsilon_i$$

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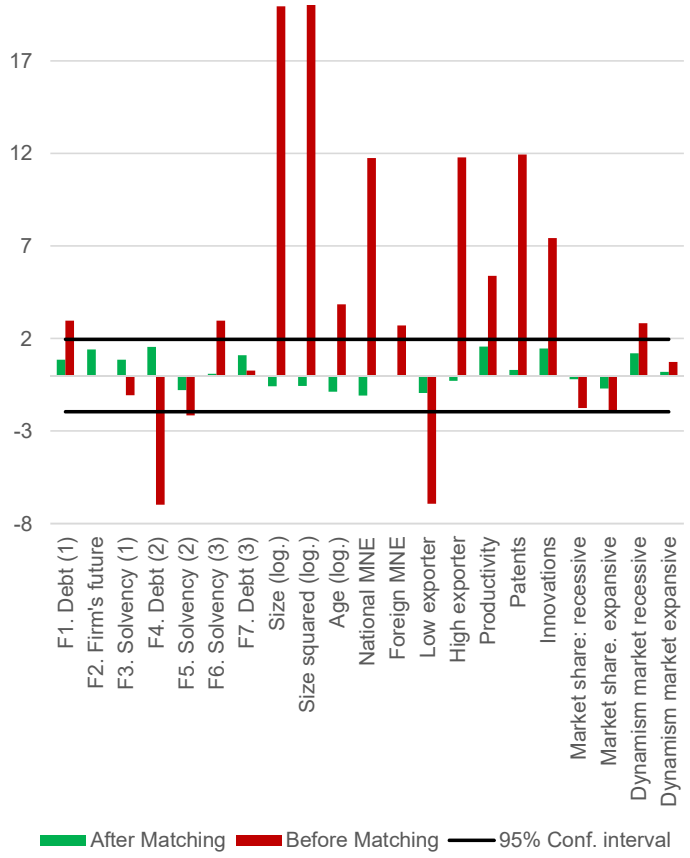
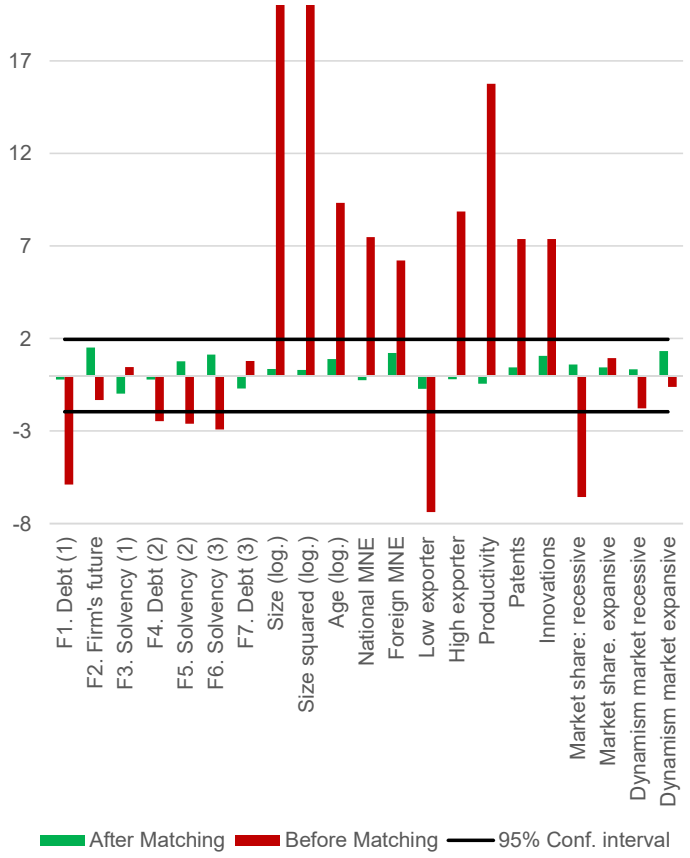
Quality of matching: mean-test

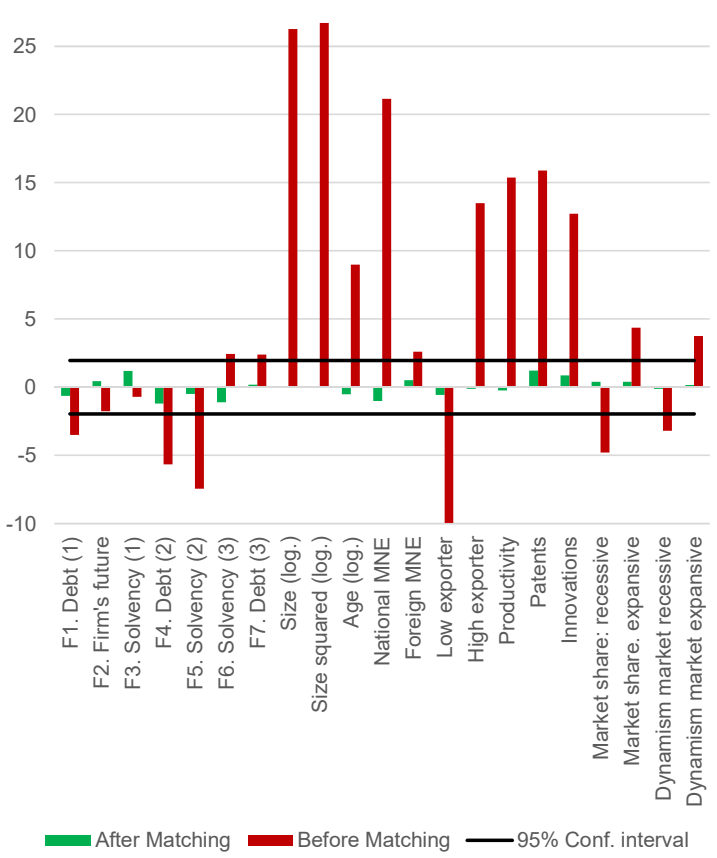
Only Subsidies



Only Tax credits



Tax credits and subsidies



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Data and variables

We use data from the “Spanish Survey of Business Strategies” (**ESEE**) for the period **2004-2016** with over **13.000 observations** of innovative firms

Dependent variables :

- First stage: PROBIT model on the **dummy variable** that takes a value of 1 if the company has **received certain type support** (only subsidies, only tax incentives and both treatments simultaneously)
- Second stage: MATCHING model calculate the individual treatment effects (ITE) of the support on **R&D expenditure intensity** (expenditures in R&D over sales (ERDs))
- Third stage: Regression model on the ITE to identify the role played by the financial variables as a determinants of the heterogeneity of the policy effects. **Which type of firms show a below or above average effect**

Independent variables: 17 indicators of the financial situation of the firm synthesized in 7 factors

Independent variables: Control variables (structural characteristics, markets, etc)

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Financial constraints
A factor analysis

Seventeen financial variables
(obtained from the firms' balance sheets)

Seven factors
(each with two or three variables)

Three main groups
(debt, solvency and growth)

Factors	Variables included in the factor
Factor 1. Debt (1): as percentage of total funds	Short-term debt divided by total funds
	Total debt divided by own funds
	Total amount of own funds divided by total funds
Factor 4. Debt (2): as percentage of own funds	Short-term debt divided by own funds
	Long-term debt divided by own funds
	Cash flow* divided by own funds
Factor 7. Debt (3): costs in "interest rates"	Average cost of long-term debt with credit institutions
	Current cost of long-term debt with credit institutions
Factor 3. Solvency (1): liquidity in terms of cash flows	Cash flow* divided by short-term external debt
	Cash flow* divided by total external debt
Factor 5. Solvency (2): liquidity in terms of turnover ratios or sales	Sales divided by total liabilities
	Sales divided by total external debt
Factor 6. Solvency (3): liquidity in term of non-current assets	Fixed capital divided by total liabilities
	Fixed capital divided by own funds
Factor 2. Firms' future potential (Growth rates)	Change in liabilities between two periods
	Change in sales between two periods
	Change in value added between two periods

Independent variables: Other determinants of the ERDs

(control variables to create a “ceteris paribus” situation)

Structural features

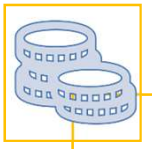
- Age
- Size and squared size
- Productivity
- Property
- National MNE
- Foreign MNE
- Individual firms

Market dynamism and behaviour

- Changes of the market share
- Growth of the market
- Export behaviour

Innovative indicators

- Patents
- Innovations
- Technological effort



Financial structure

- Debt
- Solvency
- Growth prospect

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Determinants of the participation:

Probit model

	(1)		(2)		(3)	
VARIABLES	**Tax credits only**		**Subsidies only**		**Policy Mix**	
	dy/dx	**S.E**	**dy/dx**	**S.E**	**dy/dx**	**S.E**
F1. Debt (1): as percentage of total funds	**-0.027*** **	**0.008**	**0.006**	**0.007**	**-0.024*** **	**0.007**
F4. Debt (2): As percentage of own funds	**-0.002**	**0.007**	**-0.017*** **	**0.006**	**-0.004**	**0.006**
F7. Debt (3): Costs in "interest rates"	**0.006***	**0.006**	**-0.001**	**0.005**	**0.002** **	**0.001**
F3. Solvency (1): Liquidity in terms of cash flows	**-0.017**	**0.014**	**-0.022**	**0.016**	**-0.063*** **	**0.017**
F5. Solvency (2): Liquidity in terms sales or turnover ratios	**-0.018** **	**0.008**	**0.004**	**0.004**	**-0.019*** **	**0.007**
F6. Solvency (3) : Liquidity in term of non-current assets	**0.004**	**0.007**	**0.020*** **	**0.005**	**0.022*** **	**0.006**
F2. Firms' future potential (Growth rates)	**0.002**	**0.003**	**-0.002**	**0.007**	**0.006**	**0.007**
S. traditional consumer goods	-0.014	0.023	-0.022	0.019	-0.064***	0.022
S. intermediate goods suppliers	0.015	0.030	0.027	0.023	-0.017	0.026
Sector of specialised suppliers	0.027	0.027	0.057***	0.022	0.012	0.024
Sector of scale-intensive and assembly-intensive goods.	0.114***	0.031	0.015	0.030	0.058**	0.027
National MNE	-0.014	0.021	0.032*	0.019	0.055***	0.018
Foreign MNE	-0.066***	0.019	-0.052***	0.018	-0.070***	0.019
Age (log)	0.016	0.013	-0.006	0.011	0.003	0.011
Size (log.) t-1	0.182***	0.040	0.070***	0.025	0.092***	0.030
Size squared (log.) t-1	-0.011***	0.004	-0.002	0.002	-0.003	0.003
Productivity (log.) t-1	0.062***	0.014	0.015	0.011	0.053***	0.014
Market share: recessive	-0.054***	0.018	-0.026*	0.014	-0.011	0.015
Market share. expansive	-0.007	0.015	-0.038***	0.014	0.007	0.012
Dynamism market recessive	0.006	0.015	0.036***	0.013	-0.007	0.014
Dynamism market expansive	-0.020	0.016	0.020	0.015	0.009	0.014
Low exporter	-0.034*	0.019	-0.016	0.016	-0.028*	0.017
High exporter	0.016	0.017	0.027*	0.015	0.023	0.015
Patents t-1	0.035**	0.014	0.029**	0.012	0.040***	0.012
Technological effort t-1	0.011***	0.003	0.016***	0.003	0.017***	0.003
Innovations t-1	0.041***	0.013	0.027**	0.011	0.060***	0.011
Observations	5,598		5,393		5,548	
Wald test dummies						

Determinants of financial additionality:

OLS regression on the ITEs

VARIABLES	Dependent variable: Pooled ITEs for R&D intensity (1)	(2)	(3)	(4)	(5)	(6)
Subsidies only	0.007***	0.007***	0.007***	0.005**	0.006***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Policy Mix	0.013***	0.013***	0.012***	0.012***	0.012***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Sector traditional consumer goods	-0.003*	-0.002	-0.003	-0.003	-0.004**	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Sector intermediate goods suppliers	-0.002	-0.003	-0.004	-0.003	-0.004	-0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Sector of specialised suppliers	0.006*	0.005*	0.004	0.005	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Sector of scale-intensive and assembly-intensive goods.	-0.004	-0.005	-0.006**	-0.005*	-0.006**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
National MNE	0.005**	0.004*	0.002	-0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Foreign MNE	-0.000	-0.000	-0.000	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Age (log)	-0.003*	-0.003*	-0.003**	-0.003**	-0.002	-0.003*
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Size (log) t-1	-0.037***	-0.038***	-0.038***	-0.042***	-0.041***	-0.041***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Size squared (log) t-1	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Productivity (log) t-1	-0.004**	-0.005**	-0.005**	-0.005**	-0.009***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Market share recessive		0.001	0.002	0.001	0.001	0.001
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Market share expansive		0.002	0.001	0.001	0.001	0.001
		(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Dynamism market recessive		-0.007***	-0.008***	-0.009***	-0.009***	-0.009***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Dynamism market expansive		-0.004	-0.004	-0.005*	-0.005*	-0.005*
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Low exporter		-0.003	-0.003	-0.003	-0.003	-0.003
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
High exporter		0.001	0.001	0.001	0.001	0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Patents t-1			0.010***	0.010***	0.009***	0.009***
			(0.002)	(0.002)	(0.002)	(0.002)
Innovations t-1			0.001	0.002	0.002	0.002
			(0.002)	(0.002)	(0.002)	(0.002)
F1. Debt (1): as percentage of total funds				**0.001**	**0.001**	**0.001**
				(0.001)	**(0.001)**	**(0.001)**
F4. Debt (2): As percentage of own funds				**-0.008*** **	**-0.008*** **	**-0.008*** **
				(0.001)	**(0.001)**	**(0.001)**
F7. Debt (3): Costs in "interest rates"				**-0.005** **	**-0.005** **	**-0.005** **
				(0.002)	**(0.002)**	**(0.002)**
F3. Solvency (1): Liquidity in terms of cash flows					**0.013*** **	**0.013*** **
					(0.003)	**(0.003)**
F5. Solvency (2): Liquidity in terms sales or turnover ratio					**-0.001**	**-0.001**
					(0.001)	**(0.001)**
F6. Solvency (3): Liquidity in term of non-current assets					**-0.001***	**-0.002***
					(0.001)	**(0.001)**
F2. Firms' future potential (Growth rates)						**-0.003** **
						(0.001)
Constant	0.182***	0.190***	0.191***	0.198***	0.241***	0.243***
	(0.028)	(0.028)	(0.027)	(0.027)	(0.031)	(0.031)
Observations	2,659	2,659	2,659	2,659	2,659	2,659
R-squared	0.083	0.088	0.105	0.136	0.145	0.146
Sectoral dummies	2.587**	2.093*	2.335*	2.350*	2.234*	2.022*
Time dummies	0.585	0.911	0.998	0.797	0.730	0.741
Test: Subidy only=Policy Mix	5.995**	4.964**	5.024**	6.583**	7.321***	7.009***

Main conclusions: factors on solvency

Probability of participation versus short and long term solvency

The factors that reflect the short-term solvency level (turnover rates of the debts by sales or cash flows show that **less solvent firms have a higher probability to participate**.

- Consequently, the companies that could really need public support in order to finance R&D activities do get more frequently additional support.

On the contrary the factor that reflecting the long-term solvency of the firm indicate that **the most solvent firms –in terms of fixed assets- get more frequently support**.

- This could be in line by the earlier conclusions about picking up the winners

Main conclusions: factors on solvency

The relationship between **the financial additionality effect** versus short and long term solvency is not clear. Each of the three factors show a different relationship

- A higher level of cash flows or short term liquidity (F3) implies a **slightly higher level of additionality.**
- A higher level of liquidity in terms of sales or fixed assets (F6) is correlated with a **lower impact on the R&D expenditures**.
- The liquidity in terms of the sales or the turnover ratio is **not statically related with the additionality effect**.

Therefore, the future lines of research should analyse more in depth such contradictory effects which were also found in the earlier empirical evidence.

Main conclusions: factors of indebtedness

The level of indebtedness

The results shows a **negative discrimination** of the companies with a **higher level of indebtedness** and this bias cannot be justified in terms of the lack of financial additionality **because such firms have an on average level of financial additionality**

Two reasons could **explain this lower degree of participation** of the more indebted firms.

- The public agencies could have a conservative selection process avoiding **the subsidize** companies with a higher level of indebtedness.
- In order to assure that the public funds goes to firms that guarantee the successful development of the support activities.
- This picking up the winner strategy mentioned before is also reflected by some control variables of the model.

- A substantial number of the more indebted firms cannot apply for tax advantages because probably they have a low level of benefits or including losses.

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Main conclusions: factors of indebtedness

- **The costs of indebtedness:**
  - Firms that reflect a higher level of costs of their debt are positively discriminated by policy makers however, their the financial additionality is lower for such firms.
  - Probably the costs of extra investments is too high to incentive the firm for extra R&D expenditures

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Thank you!