The impact of public support to business R&D&I in Spain: evidence and challenges

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Outline:

1. **Public support to business R&D&I in Spain**
2. **What have we learned about the impact of public financial aid on Spanish firms?**
3. **Methodological challenges for Spanish databases**

1. Public support to business R&D&I in Spain

Several types of public intervention:

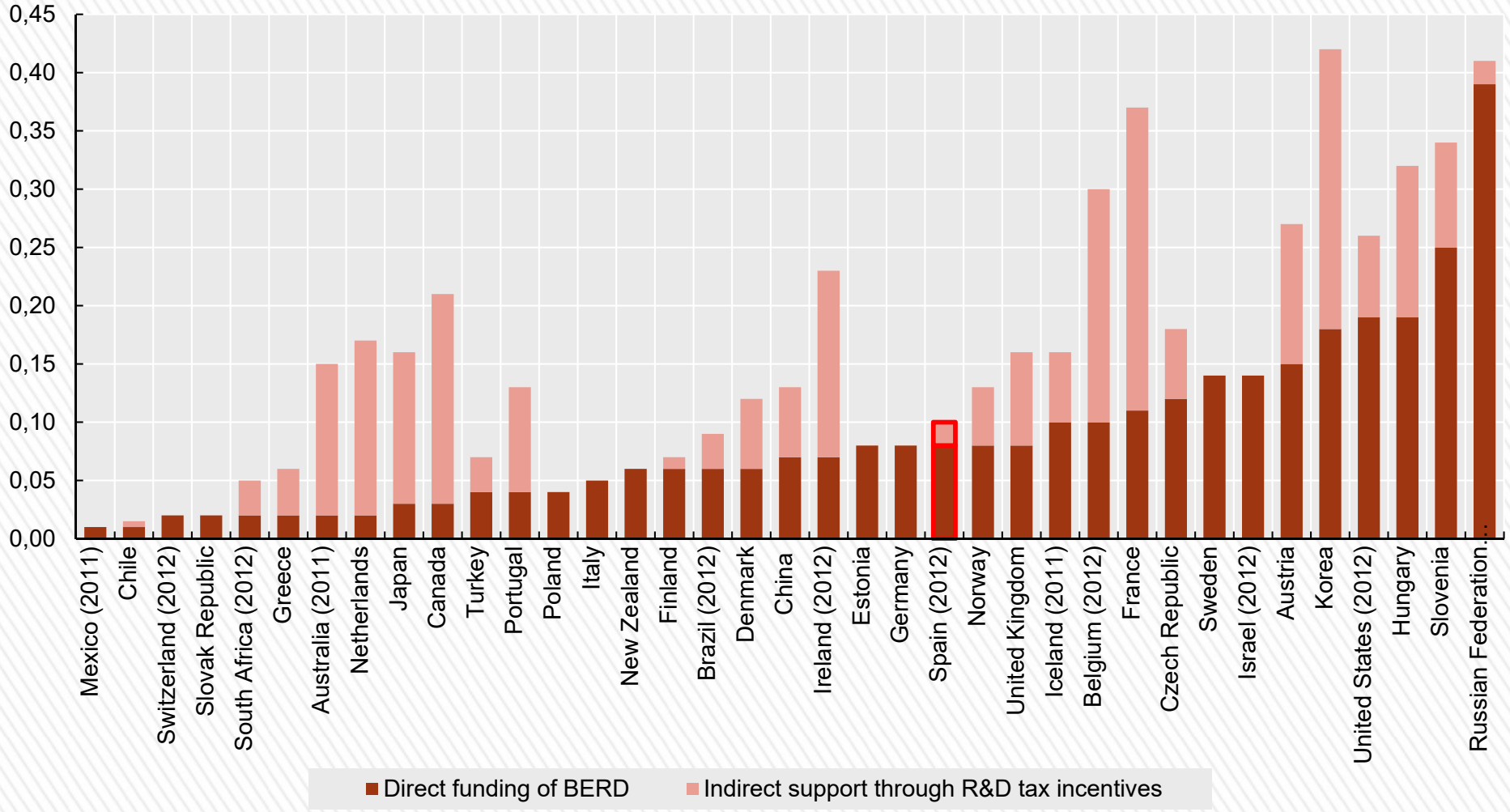
- **Public procurement**

- **Non-financial aid**
  - Regulation (requirements for start-ups, environmental regulation, patent system,...)
  - Information and advice
  - Search of partners for joint research projects
  - Diffusion of technology (technology transfer between public and private sectors, networking...)
  - S&T human resources
  - …

- **Financial aid**
  - Direct: subsidies, loans
  - Indirect: fiscal incentives

Direct government funding of business R&D and tax incentives for R&D, 2013

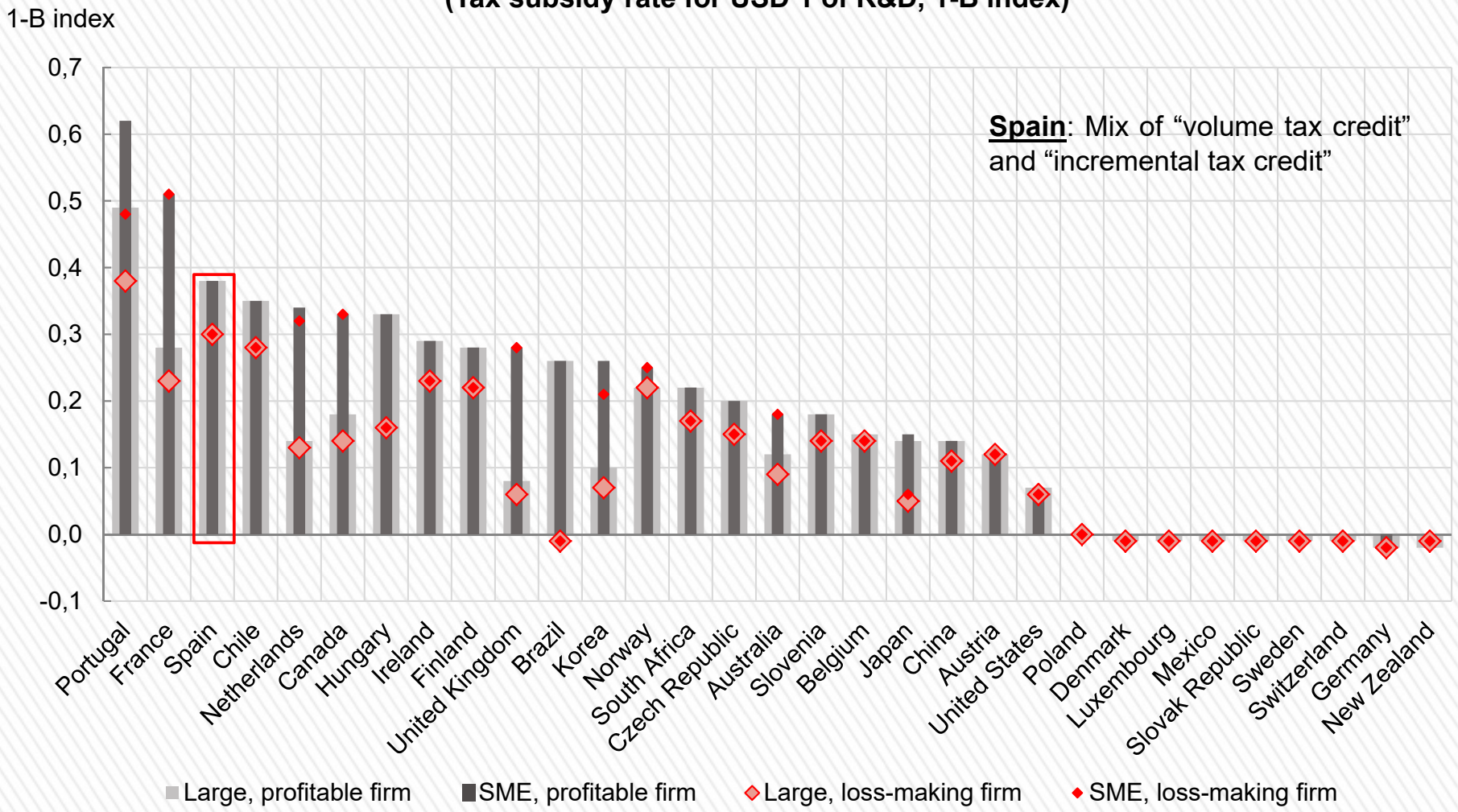
(As a percentage of GDP)



Source: OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2015.

R&D Tax Credits

(Tax subsidy rate for USD 1 of R&D, 1-B index)

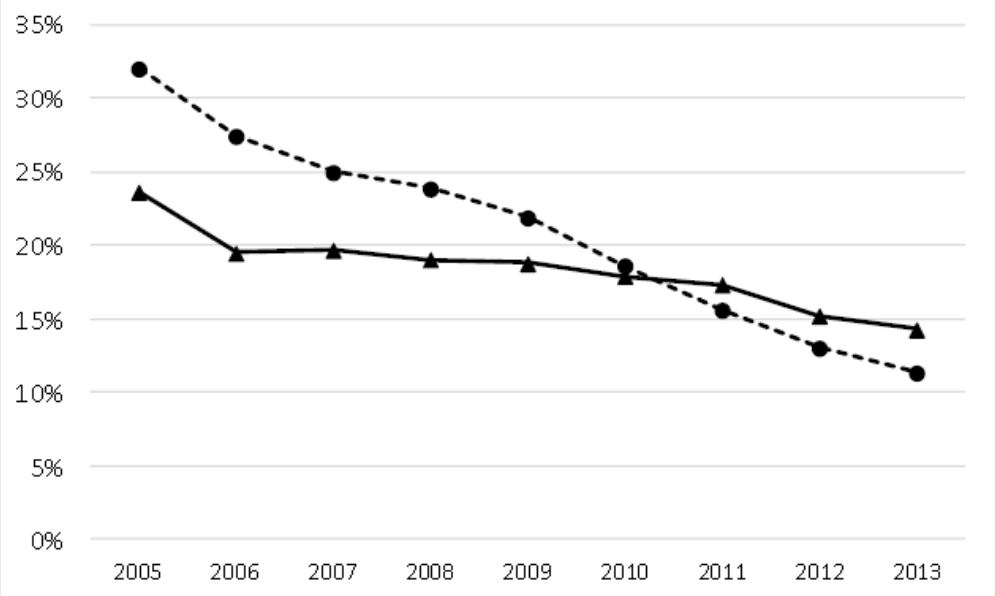


Source: OECD (2010c): OECD Science, Technology and Industry Outlook

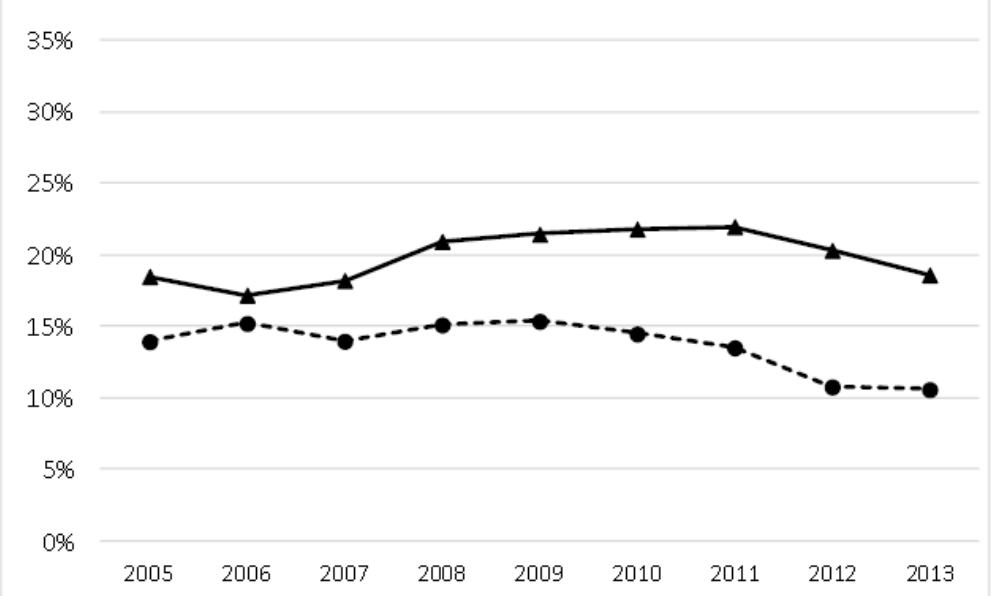
The tax subsidy rate is calculated as 1 minus the B-index. The B-index measures the before-tax income needed to break even on one dollar of R&D outlays and is calculated for representative small and large corporations. The tax subsidy rate is reported for a profitable firm able to claim tax credits/allowances. The subsidy rate calculations only include expenditure-based tax incentives and do not account for income-based tax incentives.

Percentage of firms with public support for R&D at different government levels

SMEs (with 200 or less employees)



Large firms (with more than 200 employees)



With Autonomous and Local Administrations funding

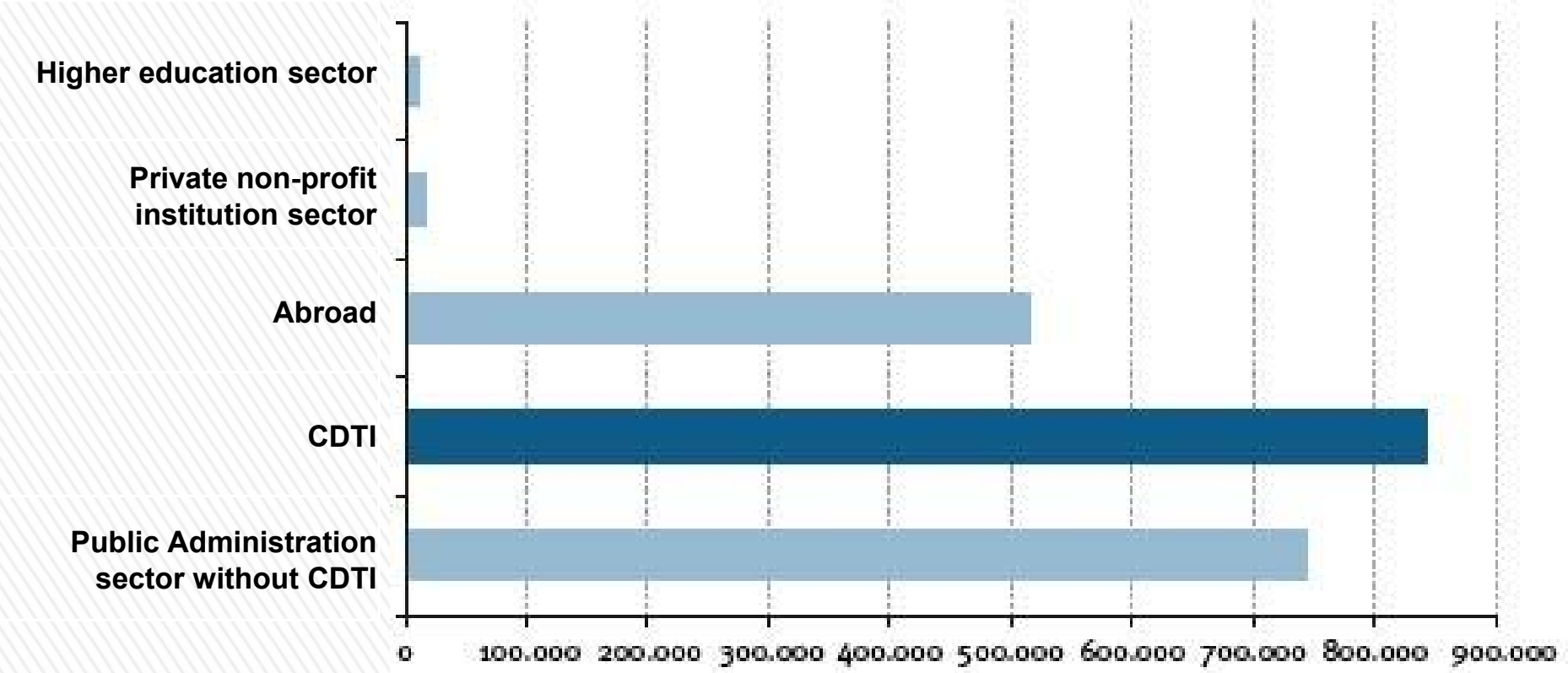
With Central Government funding

Source: **Busom and Velez (2016, FECYT)**

The role of CDTI

The Centre for the Development of Industrial Technology (CDTI) is a Public Business Entity, answering to the Ministry of Economy and Competitiveness, which fosters the technological development and innovation of Spanish companies. It is the entity that channels the funding and support applications for national and international R&D&i projects of Spanish companies.

Non-business sources of funding of firms' R&D spending in 2013 (thousands of euros)



Source: CDTI Annual Report 2014

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Objectives of impact evaluation

Main research question: does public R&D spending complements or displaces private R&D spending? does public R&D induce additional private R&D investment beyond the level that would have been performed anyway?

The international evidence is ambiguous, with results supporting both a (total or partial) crowding-out and a crowding-in (additionality) effect of public subsidies on private R&D investments. **García-Quevedo (2004, KYKLOS)**, **Zúñiga-Vicente, Alonso-Borrego, Forcadell & Galán (2012, J ECON SURV)**.

Other questions:

- Determinants of firms' participation in public programmes.
- Other effects on:
  - R&D strategies (the decision to undertake R&D activities, make/buy,…)
  - technological results (innovations, patents…)
  - economic performance (productivity, sales, employment…)
  - social welfare

2. What have we learned about the impact of public financial aid on Spanish firms?

Studies using firm-level or project-level data:

a) Determinants of firms' participation in single public programmes

b) Impact of tax credit system

c) Impact of national direct support

d) Impact of supra-national direct support

e) Mix of instruments

f) R&D&I policy and economic crisis

a) Determinants of firms' participation in public programmes:

Acosta & Modrego (2001, RES POLICY) – Concerted Projects under the National R&D Plan

Heijs (2003, RES POLICY) - CDTI low interest loans for R&D

Blanes & Busom (2004, RES POLICY) – R&D subsidies

Heijs (2005, SCI PUBL POLICY) - CDTI low interest loans for R&D

Corchuelo & Martínez-Ros (2008, HACIENDA PUBLICA ESP) – Tax credits

Barajas & Huergo (2010, EINT) – R&D cooperative projects within the EU Framework Programme

Huergo & Trenado (2010, REV IND ORGAN) - CDTI low interest loans for R&D

Rojas & Huergo (2016, SMALL BUS ECON) – CDTI Neotec programme for NTBFs

Results: relevant role of:

- **Goals of public agencies**: specific type of "candidates"
- **Firm characteristics**: size, lack of information, lack of resources (financing constrains, domestic ownership…), technological capabilities (human capital, experience in R&D…), sector of activity (low-tech/ high-tech, R&D based), level of internationalization (export activity), age, cooperation…
- **Project features**: technological and economic potential of the proposal
- **Characteristics of entrepreneurs**: human capital, links to public system of R&D, motivation, planning.

b) Impact of tax credit system:

Corchuelo (2006, REV ECON APL-SPAIN)

Romero & Sanz (2007, HACIENDA PUBLICA ESP)

Marra (2008, HACIENDA PUBLICA ESP)

Busom, Corchuelo & Martínez-Ros (2010, Análisis sobre Ciencia e Innovación en España)

Valadez, Heijs & Buesa (2011, PEE)

Database:

- **ESEE (Spanish Survey on Business Strategies):** panel survey of manufacturing firms located in Spain for 1990-2014. It's oriented towards capturing information about firms' strategies. From 2001, the ESEE includes specific questions about tax credits:

  "State whether the company knows and applies tax breaks to R&D and technological innovation"

  "State the total value of the tax breaks which it has applied in Company Tax for year XXXX. Specify those referred to R&D and technological innovation".

  - 1990-1998. R&D performers (C-2006)
  - 1991-1999. Persistent R&D performers (6 years) (M-2008)
  - 1990-2001. R&D performers (R&S-2007)
  - 2001-2002. R&D&I performers (B&C&MR-2010, V&H&B-2011)

Results:

- **Fiscal incentives are effective to stimulate private R&D investment of manufacturing firms:**

	Concept of elasticity	SMEs	Large firms
C-2006	Price elasticity of technological effort	1.4	1.6
R&S-2007	Price elasticity of R&D investment	0.98-1.01	
M-2008	Price elasticity of R&D investment	1.44-1.82	0.84-0.89
V&H&B-2011	Price elasticity of innovation investment	0.88	0.72

- The effectiveness is higher in firms with liquidity restrictions (C-2006)
- However, financial constraints are negatively correlated with the use of tax credits (B&C&MR-2010)
- Estimated short-run elasticities are lower than estimated long-run elasticities (M-2008)

c) Impact of national direct support:

Busom (2000, EINT)

González, Jaumandreu & Pazó (2004, RAND J ECON)

Herrera & Heijs (2007, REV ECON APL-SPAIN)

González & Pazó (2008, RES POLICY)

Busom & Fernández-Ribas (2008, RES POLICY)

Arqué-Castells & Mohnen (2015, J IND ECON)

Huergo, Trenado & Ubierna (2016, TECHNOL FORECAST SOC)

Databases:

- **Specific survey** + list of applicants for CDTI subsidies**:** Year 1988 (B-2000)
- **ESEE**: information on the amount of public funding received. From 1998, the ESEE includes a question that asks firms whether they sought external financing without success.
  - 1990-1999 (G&J&P-2004, G&P-2008)
  - 1998-2000 (H&H-2007) Sample of firms with R&D expenditures.
  - 1998-2009 (AC&M-2015)

Databases (cont.):

- **Spanish Innovation Survey:** no access to information on the amount of public funding received.
  - 1996-1998. Sample of manufacturing firms with innovation expenditures in 1998 (B&FR-2007)
  - 2002-2005. Sample of innovative firms (H&T&U-2016)

- **CDTI-Loans database**: Information on proposals to the CDTI low-interest loan system
  - 2002-2005. Technological Development Projects, Technological Innovation Projects and Concerted Industrial Research Projects (H&T&U-2016)

Results:

- **In general, public aid increases private R&D effort** (B-2000, G&J&P-2004, H&H-2007, G&P-2008). However, for some companies, a full crowding-out between public and private spending cannot be rejected (B-2000, 30%)

- **The impact is both on the decision to undertake R&D and the magnitude of R&D investment:**
  - **Some companies**, mainly small firms in low-tech sectors, **would stop innovative activities without the subsidy** (G&J&P-2004, G&P-2008) .
  - With an expected funding of less than 10% of R&D expenditures, almost 50% of the big non-performing firms will switch to performing innovative activities. On the contrary, inducing 30% of the small firms to carry out R&D implies expected support accounting for up to 40% of the expenses (G&J&P-2004).

Results (cont.):

- **Firms can be induced persistently to perform R&D activities by means of public direct support:**
  - One-shot trigger subsidies cause a substantial increase in both the share of R&D firms and average R&D expenditures (AC&M-2015)
  - Firms supported through CDTI loans are approximately 25 percentage points more likely to self-finance their R&D investments than non-supported firms. The stimulus effect is larger for SMEs than for large firms and also higher for manufacturing than for services (H&T&U-2016).

- **Public R&D programmes trigger a behavioral change in firms' R&D partnerships** (B&FR-2007)
  - Public support significantly increases the chances that a firm will cooperate with a Public Research Organization.
  - Public support also increases the likelihood that a firm will establish private partnerships, but to a smaller extent and only when firms have intangible knowledge assets.

d) Impact of supra-national direct support:

Bayona-Sáez & García-Marco (2010, RES POLICY)

Barajas, Huergo & Moreno (2012, J TECHNOL TRANSFER)

Barajas, Huergo & Moreno (2016, J SMALL BUS MANAGE)

Databases:

- **Eureka Program database:** contains data on the projects undertaken under the initiative, including the names of participating firms (BS&GM-2010)

- **CDTI-Programa Marco database:**
  - Information about all the proposals, eventually granted or not, in which at least one Spanish firm participated between 1995 and 2005. This period covers part of FP4 (1994–1998), all of FP5 (1999–2002) and part of FP6 (2003–2006) (B&H&M-2012)
  - Information about the SME-specific measures of the sixth FP (rejected and supported projects) and the participants (B&H&M-2016)

- **AMADEUS database:** includes balance sheet and profit/loss data from a sample of approximately 200,000 European firms (BS&GM-2010)

↕ Same origin

- **SABI database:** contains the company accounts of more than 1,000,000 Spanish firms (B&H&M-2012, 2016)

Results:

- **The completion of a Eureka project has a positive influence over firm performance measured as return over assets, although the effect does not manifest itself until a year after project completion** (BS&GM-2010).
  - Manufacturing firms follow this general pattern; however, the effect in non-manufacturing firms is already apparent during the year of completion.

- **EU-financed RJVs have a positive impact on the technological capacity of Spanish firms, captured through intangible fixed assets** (B&H&M-2012):
  - The effect is not as direct as in other public programmes.
  - **5 years** after the project is awarded aid, the ratio of intangible fixed assets over employment increases almost 40%.

- **Being an SME involved in a supported RJV increases the ratio of intangible fixed assets over employment** and, indirectly, EBITDA per employee and labour productivity (B&H&M-2016):
  - These effects are effective **3 years** after the end of the project, confirming that SMEs are involved in market-oriented R&D projects.
  - Although this kind of supported RJV affects the performance indicators of SMEs the same as it does for big companies, the extent of R&D projects, and consequently the time period for their impact, tends to be shorter.

e) Mix of instruments:

Busom & Fernández-Ribas (2007 Atlanta Conference on S&T&I Policy)

Santamaría, Barge-Gil & Modrego (2010, RES POLICY)

Bayona-Sáez, Cruz-Cázares & García-Marco (2013, TECHNOL ANAL STRATEG)

Romero-Jordán, Delgado-Rodríguez, Álvarez & Lucas-Santos (2014, SMALL BUS ECON)

Busom, Corchuelo & Martínez-Ros (2014, 2016, SMALL BUS ECON)

Huergo & Moreno (2017, MPRA Paper 54218)

Databases:

- **Spanish Innovation Survey** (not provided information on the amount of public funding).
  - 1996-1998. Sample of manufacturing firms with positive innovation expenditures (B&FR-2007).
  - 2003–2005 and 2006–2008. Sample of firms that intend to innovate (B&C&MR-2014)
  - 2002-2005. Sample of innovative firms (H&M-2017).
- **Science and Technology Office administrative database**: information on accepted and rejected cooperative R&D projects under the PROFIT initiative. 2000-2003 (S&BG&M-2010)
  - The confidentiality rules provide only restricted access to the database and particularly to information on individual organizations and project evaluations.
- **CDTI-Loans database**: 2002-2005 (H&M-2017)

Databases (cont.):

- **ESEE:**
  - 1992-2005. Sample of 457 large firms (BS&CC&GM-2013)
  - 1995-2005. Sample of 941 firms (RJ&DR&A&LS-2014)
  - 2001-2008. Balanced panel of 779 firms (B&C&MR-2016)

Results:

- **Firms' participation in European and national R&D programs is largely driven by different factors.** Ex-post, there is no significant overlap of R&D policies between these two government levels (B&FR-2007).

- **The source of the funding –regional, state and other (UE)– influences whether large firms select the make, buy or make–buy strategy.** The effect of public funding on the R&D strategy selection lasts longer for state and regional funds than for other funds (BS&CC&GM-2013)

- **When funding R&D cooperative projects, the public agency uses subsidies and loans to address different objectives** (S&BG&M-2010)
  - Some projects close to the market are well supported through loans, while basic research projects receive only selective support in the form of subsidies.
  - The public agency selectively favors partnerships with universities and technology institutes through the award of subsidies. However, there seems to be less incentive for large consortia.
  - There is significant diversity in the selection and funding of technological areas. There also are significant regional differences among financed projects.

Results (cont.):

- **Considerably low impact of tax credits and public grants on the R&D investment of Spanish manufacturing firms** (RJ&DR&A&LS-2014)
  - Tax credits are mainly considered by large firms that use them as a reduction in the tax burden in the corporate tax, while SMEs use public grants to alleviate financial constraints.

- **Subsidies may be better suited than tax credits to encourage firms, especially young knowledge-based firms, to start doing R&D** (B&C&MR-2014)

- **There is true state persistence of participation in R&D subsidy and tax credit programs** (B&C&MR-2016)
  - Unobserved heterogeneity accounts for about 41 % of the unexplained variance of the composite error in the case of subsidies and 29 % in the case of tax credits.
  - Highly productive firms within a given industry are more likely to obtain subsidies; the use of tax credits, in contrast, is unrelated to a firm's productivity.

- **Being awarded any type of direct aid** –national loans, national subsidies or supra-national subsidies– **increases the probability of conducting R&D activities**. (H&M-2017)
  - In terms of being supported through a unique instrument, the greatest effect corresponds to the case of European grants (impact is more than three times larger than the one of loans).
  - The hypothesis of full crowding-out of private R&D is rejected for all types of support. The impacts of subsidies and loans reinforce each other when they are jointly awarded to SMEs. However, for large firms we cannot rule out the existence of crowding-out effect between subsidies and loans.

f) R&D&I policy and economic crisis

Cruz-Castro, Holl, Rama & Sanz-Menéndez (2015, IPP working paper)

Cruz-Castro & Sanz-Menéndez (2016, TECHNOL FORECAST SOC)

Busom & Vélez (2016, FECYT)

Holl & Rama (2016, EUR PLAN STUD)

Database:

- **PITEC**
  - 2008-2012 (CC&H&R&SM-2016, H&R-2016),
  - 2005-2013 (B&V-2016)

Results:

- **The fiscal consolidation measures adopted have reduced the capacity of governments to direct the public R&D system** (CC&SM-2016)
  - The reduction of salaries, funding and new positions has resulted in stagnation. Spanish public research organizations (PROs) are poorly equipped to resist the crisis. PROs should be given more managerial autonomy and the ability to set priorities.

Results (cont.):

- **The impact of the crisis on firms' innovation expenditures differs depending on:**
  - **firm size and the access to public subsidies** (B&V-2016, CC&H&R&SM-2015):
    - Firms with access to public funding in the pre-crisis period were less likely to abandon innovation activities during the downturn (CC&H&R&SM-2015).
    - SMEs were more affected by the trajectory of their sales, but those receiving public subsidies were less likely to abandon innovation projects, at least prior to 2009 (B&V-2016).
  - **regional economic size and the type of the regional innovation system** (CC&H&R&SM-2015, H&R-2016):
    - Regional R&D spending only reduces innovation abandonment rates in regions where a strong system of knowledge exploitation is in place (CC&H&R&SM-2015)
    - Companies located in the Basque Country were more likely to persist in innovative activities during the 2008 crisis and even to increase these activities. This regional effect is especially significant for SMEs (H&R-2016)

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Methodological challenges for Spanish databases

ESEE (Spanish Survey on Business Strategies): panel survey of manufacturing firms located in Spain for 1990-2014. It's oriented towards capturing information about firms' strategies.

Pros	Cons
o Supported by SEPI Foundation. Formal protocol of access. o Representative of manufacturing firms. Efforts to minimize attrition o Long panel database: 1990-2014. Variables reflecting the firms' life cycle (mergers, absorptions, splitting,…) o Extensive information about technological activities (follows Olso Manual) • Information on the amount of public funding received by each firm • From 1998, question that asks firms whether they sought external financing without success • From 2001, specific questions about tax credits o Extensive information on other firms' strategies and some accounting data	o Cost: 2,2-4,4€ per field/year o Not services firms o Specific sectoral classification (20 sectors) o Impossibility of merger with other databases (no tax codes, names or addresses of the firms) o R&D: Not information at project-level

Spanish Innovation Survey/PITEC: Same source but two different databases.

- Innovation in companies Survey: Spanish version of the Community Innovation Survey
- PITEC: Technological Innovation Panel. Constructed from a sample of the innovation survey.

Pros

Innovation in companies Survey

- Carried out by INE. Compulsory answer. Yearly since 2002.
- Targeted to manufacturing and services firms.
- Follows Oslo Manual. Allows for international comparisons.
- Most complete database about R&D&I activities of Spanish firms:
  - Information about the sources and quantities of public funding
  - From 2011, question about the magnitude of public "loans" to finance intramural R&D
  - 2007-2013, questions about the knowledge and use of fiscal incentives (last 4 years)
- After signing a formal agreement, original data can be analyzed by researchers in secure environments at INE.

PITEC

- Supported by FECYT. Formal (and free) protocol of access through: https://icono.fecyt.es/PITEC/Paginas/por_que.aspx
- Information on manufacturing and services firms.
- Panel structure: 2003-2014.
- Representative of large firms (with more than 199 employees) and firms with internal R&D expenditures
- Control samples of SMEs without innovation expenditures/only with external R&D:
  - In 2014, with the aim of reducing the reporting burden: new procedure that allows keeping certain units rotate inactive and therefore not surveyed in certain years.

Cons	
Innovation in companies Survey	**PITEC**
o Not accounting information. Only qualitative information about financial constraints. Not information about whether a firm applied for but did not obtain direct support	o Not accounting information. Only qualitative information about financial constraints. Not information about whether a firm applied for but did not obtain direct support
o Not information at project-level	o Not information at project-level
o Not explicit protocol of access. Merger with other databases subject to formal agreement, that can imply an economic cost	o Not all fields in the innovation survey are in PITEC: Not information about fiscal incentives.
o Due to statistical confidentiality, the anonymized microdata files provided to users in secure environments at INE. Problems to align the objectives of academic researchers with the length of the contract.	o Impossibility of merger with other databases (no tax codes, names or addresses) o Anonymization of a set of variables (Turnover, Investment, Number of employees, Innovation expenditures and Number of R&D employees) o Almost no new firms in the panel since 2005 o Limited utility for regional analysis

Methodological challenges:

- Matching of firm-level and project-level information.
- Matching of administrative data with survey data.
- Completing the information of accounting databases with information about technological activities (innovation expenditures, patents, citations, inventors…).
- Establishing formal protocols of access to databases on administrative data (about policy instruments) of public organisms.
- Using information about the cost of public programmes (social welfare).
- Keeping the representativeness of databases at regional level.
- Getting relevant information about NTBFs.