International Centre for Innovation Technology and Education

Solvay Brussels School Economics & Management

ULB

SHARING THE RISK OF INNOVATIVE INVESTMENT:

ASSESSING THE EFFECT OF A NEW EUROPEAN FINANCING INSTRUMENT

Authors

Anabela Santos
Solvay Brussels School of Economics and Management, Université libre de Bruxelles,
iCite - email: asantos@ulb.ac.be

Michele Cincera
Solvay Brussels School of Economics and Management, Université libre de Bruxelles,
iCite and ECARES - email: mcincera@ulb.ac.be

iCite Working Paper 2018 - 29

iCite - International Centre for Innovation, Technology and Education Studies
Université libre de Bruxelles – CP114/05

50, avenue F.D. Roosevelt – B -1050 Brussels – Belgium
www.solvay.edu/iCite

Sharing the risk of innovative investment: Assessing the effect of a new European financing instrument[1]

Anabela Santos
Université libre de Bruxelles, iCite
asantos@ulb.ac.be

Michele Cincera
Université libre de Bruxelles, iCite and ECARES
mcincera@ulb.ac.be

Abstract

Access to finance is a key driver of business activities. It can help firms to grow and innovate. However, due to market failures innovative firms are usually more financially constrained. To improve access to financing for risky but excellent R&D and innovation investment projects, a new debt-financing instrument called "Risk Sharing Finance Facility" was created in 2007, by a joint initiative of the European Commission and the European Investment Bank. Based on a macro-economic analysis, the aim of the paper is to assess the effect of this new debt-financing instrument on enhancing private R&D expenditure. The database used covers the 28 Member States of the European Union in the period 2007-2016. Private R&D decision is estimated by a function of output growth and several R&D policy instruments. The methodological approach is based on a fixed effect model with control function method in order to correct for endogenous bias of Risk Sharing Finance. The results reveal a positive and significant effect of the new EU policy financing instrument on Private R&D expenditure and its rate of return seems to be higher than that of grants or subsidies. Furthermore, in countries where government funding for private R&D expenditure is above the average, the effect of Risk Sharing Finance shows a lower marginal effect. No evidence of significant differences concerning the size of the effect of the new debt-financing instrument is found when differentiating the level of R&D tax incentives.

Keywords: Financing, Innovation, Risk.
JEL classification: O16; O31; G32.

[1]This research has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645884.

Acknowledgments: The authors are grateful to the European Investment Bank (EIB) for the data provided about *Risk Sharing Finance Facility* and *InnovFin - EU Finance for Innovators*. Special thanks go to all participants in periodic meetings of the I3U project.

1. Introduction

Access to finance is a key driver in firms' creation (**Cassar 2004**; **Aghion et al. 2007**; **Kim et al. 2016**), survival (**Tsoukas 2011**) and growth process (**Aghion et al. 2007**; **Rahaman 2011**). Firms need finance to invest in short and long-term assets or for day-to-day business operations. They use finance mainly to develop new products or services, to buy new equipment and machinery, to build or expand their facilities, or to meet daily financial commitments (**Cincera and Santos 2015**). As access to finance is important for firms' activities, it can help them to grow, to start a business or to survive in a competitive market. However, some firms are more financially constrained than others, such as innovative ones (**Lee et al. 2015**; **Santos and Cincera 2017**), due to greater project risk and lower collateral (**Hall and Lerner 2010**). Since capital market imperfections can postpone innovation and restrain growth, public support can fill the gap (**Hyytinen and Toivanen 2005**).

The importance of financing, innovation and growth linkage has placed access to finance at the heart of European Union (EU) strategies in the last decades. To support the Lisbon agenda[2], a new debt-financing instrument to fund R&D and Innovation(RDI) investment called *Risk Sharing Finance Facility* (RSFF) was created in 2007 (**EC 2006**). This instrument was developed in a joint initiative of the European Investment Bank (EIB) and the European Commission, with the aim of providing debt financing for excellent RDI projects (**EC 2006**), which could never been achieved otherwise due to high risk and uncertainty (**EC 2011**). The RSFF was implemented in the period 2007-2013 and its successor for 2014-2020 is included in the debt-financing products of *InnovFin - EU Finance for Innovators*.

The aim of the paper is to assess the effect of the new Risk Sharing debt-financing instrument on enhancing private R&D expenditure funded by the business sector. Analysis is made at the macro-level, so as to capture the direct and indirect effects of the policy tool. The database covers the 28 EU Member States over the period 2007-2016. The various sources of data are Eurostat, the European Investment Bank and the OECD. The methodological approach is based on a fixed effect model with control function method in order to correct for endogenous bias of Risk Sharing Finance. The econometric model is centred on the conceptual framework by **Guellec and van Pottelsberghe** (2000) and **Cincera et al.** (2009), where private R&D expenditure funded by the business sector is explained by output growth and several R&D policy instruments.

[2] The Lisbon agenda is the development plan for the EU economy for the period 2000 – 2010, where innovation plays an important role for growth and job creation.

The originality and contribution of the paper lies in various aspects. First, to the best of our knowledge, no other study assesses the effect of this new and innovative debt-financing instrument. Second, given some disappointing results of grants or subsidies to enhance RDI investment[3], the paper provides a comparison between the rate of return achieved by Risk Sharing financing and that of government funding for private R&D expenditure. Additionally, an assessment of how other R&D policy tools can enhance the effect of Risk Finance is provided. All together, the study aims to provide new evidence for policy, concerning the most effective way to enhance and foster private R&D investment. Indeed, according to **EC** (2011) if the EU shows lower performance than the US and Japan, as regards the level of R&D expenditure, this is due to the lower levels of private R&D investment.

The paper is divided in 5 sections. After the introduction, Section 2 summarizes the main findings of the literature on risk, investment and financing, as well as providing a description of the new EU financing instruments. Section 3 describes the methodology and database. Section 4 presents and discusses the results of the study. Section 5 concludes and highlights some policy recommendations.

2. Background theory

2.1. Risk, RDI investment and financing

From the corporate finance perspective, the decision to invest depends on the price or cost of such an investment and the required rate of return. The neo-classical long-run model of **Jorgenson** (1963) explains that the investment demand or the desired amount of capital stock is a function of a firm's output and of user capital cost. Firms' output could refer to the expected return of investment (e.g. sales). User capital cost is estimated considering the rate of taxation, interest rate and rate of investment replacement (**Jorgenson 1963**).

Firms can get access to finance by internal or external means. Internal financing comes from cash from firms' business activities (e.g. retaining earnings or selling assets). External financing can come from several sources, such as the firm owner(s) or shareholder(s), financial institutions (banks or lessors), venture capitalists or business angels, the stock market, firms' suppliers (trade credit) and governments (grants and subsidies). Despite all these financing possibilities, all kinds of firms do not have easy access to all financing instruments and on the same conditions. For instance, innovative firms are usually more financially constrained than non-innovative ones (see e.g. **Bah and Dumontier 2001**; **Cincera 2003**; **Aghion et al. 2004**; **Hall 2009**; **Cincera and Ravet 2010**; **Hottenrott and Peters 2012**; **Lee et al. 2015**; **Santos and Cincera 2017**), due to the characteristics of R&D and Innovation (RDI) investment (**Hall and Lerner 2010**).

[3] For example, a crowding out effect of private R&D expenditure, when all or part of public expenditure replaces the firm's own investment (see e.g. **Busom 2000**; **Erden and Holcombe 2005**; **Aerts and Thorwarth 2008**).

Investment in RDI is different from ordinary investment for several reasons. Firstly, most of the costs linked with the former go towards the salaries of scientists and engineers, who generate knowledge, intangible assets and consequently few collateralizable assets (**Hall and Lerner 2010**). They have also associated sunk costs and adjustment costs. Sunk cost refers to the expenditure occurring before a product is even considered for introduction in the market, e.g. to test a product's potential market, which will not be recovered if the project does not go ahead (**Damodaran 2006**). Adjustment costs are all the costs of changing the level of initial investment (**Groth and Khan 2010**), leading to uncertainty about the total amount of investment to achieve the desired output. Additionally, RDI investment also takes time and the achievement of results is sometimes uncertain (**Hall and Lerner 2010**). R&D performers also try to keep some project information secret, in order to avoid knowledge leakages to rival firms, which generates problems of asymmetric information between entrepreneur and investor. However, in the absence of detailed information, project financing may not be forthcoming (**Shah 1994**) or leads to lenders imposing severe conditions on innovative firms. For example, innovative firms pay a higher interest rate (**Bellucci et al. 2014**) and they must provide high collateral or guarantees (**OECD 2014**) in order to reduce lenders' loss in the case of non-payment of the debt by the borrower and considering the observed-risk hypothesis (**Blazy and Weill 2013**). All together, the characteristics of RDI investment associated with uncertainty and risk[4], and the presence of market failures, make financial institutions reluctant to invest in R&D projects compared to more traditional business projects (**Mazzucato 2013**).

According to **Hölzl and Peneder** (2013), imperfections in capital markets are the second cause of underinvestment in innovation activities and firms face financing constraints as a result of asymmetric information. Asymmetric information in the financial markets is due, on one hand, to the risks and uncertainties inherent to R&D activities (**Cincera and Ravet 2010**), and on the other hand, to the entrepreneur's difficulty in providing a clear and credible commitment to the investor (**Hölzl and Peneder 2013**). When the quality of a project is not easily recognized, investors refuse credit or raise the interest rate due to the higher project risk (**Hölzl and Peneder 2013**). Public intervention aims to fill the financial gap (**Arrow 1962**; **Falk 2007**; **Un and Montoro-Sanchez 2010**; **Afcha and López 2014**; **Radas et al. 2015**), in order to stimulate firms' expenditure on R&D and Innovation (RDI) and to improve social well-being. Indeed, according to **Arrow** (1962), in a free market, the production of knowledge is less than socially desirable, because firms tend to underinvest in R&D activities due to risk, uncertainty and profit maximization criteria.

The importance of innovation, as an instrument leading to competitiveness and economic growth (**Hasan and Tucci 2010**; **Galindo and Méndez 2014**), has placed it in practically all firms'

[4]Uncertainty happens when information to estimate the probability of a situation is insufficient or unavailable, making it unquantifiable and unpredictable (**Toma et al. 2012**). This concept is different from risk, which is associated with the probability of an unsuccessful event or non-achievement of targets (**Silva 2017**). Furthermore, uncertainty exists when we have a lack of certainty about the future and risk when we cannot control certainty (**Toma et al. 2012**; **Silva 2017**).

strategy and public policy guidelines. To stimulate innovation in the EU new financing instruments were created, such as *Risk Sharing Finance Facility* for the period 2007-2013 and *InnovFin – EU finance for innovators* for 2014-2020.

2.2. New EU financing instruments

With the seventh Framework Program[5] (FP7), the European Commission through a partnership with the European Investment Bank (EIB) launched the *Risk Sharing Finance Facility* (RSFF) in 2007. The RSFF was designed, within the framework of the Lisbon strategy for growth and jobs, aiming to improve access to finance for SMEs (**EC 2006**) and to help creditworthy firms with a highly risky project to access to a bank loan (**Koch 2010**). It was created in a European context characterized by a lack of funding for outstanding R&D projects[6], a lack of private investment in R&D[7] and market failures concerning the financing of R&D investment due to risk (**Malo 2009**).

Through capital allocation and provision, the risk for potential loss through the non-repayment of loans by the borrower or beneficiary is covered (**Koch 2010**). This allows the EIB to provide additional loans to borrowers and/or guarantees to financial intermediaries (which in turn make loans available to beneficiaries of RDI investment projects). This debt-based financial instrument supports investments in RDI projects with high innovation potential that might otherwise not occur, due to the high risk (**EC 2011**). The RSFF covers RDI projects whose risk is comparable to the following categories, used by global ratings agencies for sovereign and corporate debt: from 'BBB-' to 'B-' of Standard & Poor's and Fitch and from 'Baa3' to 'B2' of Moody's (**EC 2011**).

For the period 2007 – 2013, almost €2 Billion, coming from FP7 and EIB contributions, was allocated for risk provisioning purposes of RDI projects, which would support additional financing of about €10 Billion (**EESC 2007**) and support additional private investment in RDI of about €30 Billion (**Avice et al. 2013**). In this way, it is expected that each euro provided by the partners (EC/FP7 and EIB) to risk coverage or participation will be translated into five euros of debt-financing (leverage effect) and that each additional euro of RSFF loan will be converted in three additional euros of RDI investment (multiplier effect). This multiplier effect happens because private investment and finance are also encouraged since the beneficiary must provide a share of the investment from their own resources or from other investors (**EC 2011**). Indeed, the maximum EIB loan amount was up to 50% of the total project cost (**Malo 2009**). Furthermore, once a project

[5] The FP7 is the EU research and innovation funding for 2007 – 2013.

[6] Despite the availability of national funding in the European Member States and a European Research budget under FP7 (**Malo 2009**).

[7] Especially when EU performance regarding R&D investment as a percentage of GDP (1.8%) and R&D funded by the private sector (55%) are compared with the US (2.6% and 64%), Japan (3.3% and 77%) or South Korea (2.8% and 75%) – values of 2006 extracted from **EUROSTAT** website.

is selected by the EIB, it becomes more attractive and reliable for other private investors (**EC 2011**), as a "certification effect" of project quality and firm credibility. This means that positive externalities (**Avice et al. 2013**) and catalytic effects on other sectors (**EC 2016**) are also expected.

The RSFF is medium and long term loan financing (up to 10 years or even more), which does not include any subsidy element and does not concern risk capital as venture capital (**Malo 2009**). The interest rate paid by beneficiaries is based on market-rated loans and includes a risk-margin taking into account the risk profile of the project or beneficiary (**Malo 2009**). However, RSFF loan pricing has an attractive financing cost due to EIB 'AAA' rating[8] and its not-for-profit lending policy (**Malo 2009**). Additionally, terms and conditions are flexible, namely concerning the repayment period, which is adapted to project implementation and beneficiary capacity.

The beneficiaries of RSFF are all legal entities of any size and ownership, including Mid-Caps and large corporates, SMEs, research institutes, universities, collaborative structures or joint ventures (**EESC 2007**). Access to EIB financing is on the basis of *first-come, first-served* (**Koch 2010**). There is no call for applications and no formal application requirement, but the investment project must be technically and economically viable and the beneficiary must be creditworthy. The EIB experts assess the request for financing on the basis of project description and objective, business plan, financial projections and the beneficiary's past financial statements.

The eligible RDI project costs include capital expenditure for tangible assets (e.g. plant, equipment and machinery) and intangible assets, research staff costs, incremental working capital needs, acquisition of intellectual property rights and other related operating expenses (**Malo 2009**). The R&D budgets or investment programme can be cumulated over 3 or 4 years (**Malo 2009**). The eligible cost categories are fundamental research, definition stage/feasibility studies, industrial research, pre-competitive development activity, pilot and demonstration projects and innovation (**Malo 2009**). RSFF funding covers all the phases of the R&D project from fundamental research to commercialization, whereas grants do not usually cover this last phase.

For the period 2014 – 2020 and under H2020[9], the successor of RSFF is *InnovFin - EU finance for Innovators*. This offers a greater product range than RSFF, covering several debt and equity instruments. The *InnovFin* appears as a solution proposed to put in place EU level financial instruments to attract private finance, under Commitment 10 of the Innovation Union[10], and to close the market gap in RDI investment (**EC 2015**).

[8] This score corresponds to the evaluation of EIB credit risk level of Moody's. A 'AAA' rating is the lowest level of credit risk. Since the EIB finds the capital for its loans in the capital markets, this rating allows it to have access to capital at a lower cost.

[9] The H2020 is the EU research and innovation programme for 2014 – 2020.

[10]The Innovation Union is one of the seven flagship initiatives of the Europe 2020 strategy for smart, sustainable and inclusive growth.

3. Methodology and data

3.1. Methodological framework

The aim of the paper is to assess the effect of the new EU debt-financing instrument, based on the risk-sharing principle, on stimulating private R&D expenditure in the business sector. The study covers the 28 EU Member States in the period 2007 - 2016. The analysis is made at the country level, since data at the firm (or beneficiary) level are not available for confidential reasons.

In our conceptual model (1) private R&D expenditure funded by the business sector ($BerdByBus_{i,t}$) is a function of the debt-financing instrument ($RiskSharing_{i,t}$) and of a set of control variables which explain the private R&D investment decision ($X_{i,t}$). All variables are indexed to country i and year t. The Risk Sharing variable includes the amount of financing provided by EIB to borrowers under *RSFF* (2007-2013) and debt product of *InnovFin* (2014-2016), where the year-data corresponds to the year of signing the contract. Information about the allocation of funding by years is not available.

$$BerdByBus_{i,t} = f(Risk\ Sharing_{i,t},\ X_{i,t}) \qquad (1)$$

The selection of control variables ($X_{i,t}$) to include in the model (1) is based on the framework of **Guellec and van Pottelsberghe** (2000) and **Cincera et al.** (2009), where R&D expenditure funded by the business sector is explained by output growth and different R&D policy instruments. Output growth is measured by the evolution of Gross Value Added (GVA). The main R&D policy instruments are the funding provided by government for R&D expenditure in the business sector (BerdByGov), R&D expenditure by Government (GovRd), R&D expenditure in the higher education sector (HigRd) and R&D tax incentive (B-Index).[11] Time dummy (τ_t) and country fixed (α_i) are also included in order to capture the economic cycle and country characteristic, regarding for example institutional factors and tax policies. All these variables, together with Risk Sharing, are expected to pick up all the determinants of private R&D investments, which are driven by technology push (such as the costs of R&D, technological opportunity and knowledge spillovers) and demand pull (i.e. the demand for new technologies) factors. For instance, grants, subsidies, R&D tax credit and access to loans on better conditions can influence the cost of R&D. Therefore, our econometric model also contains the framework of **Jorgenson** (1963), where investment decision depends on the cost of capital and output growth.

The final model is expressed in equation (2), where all the variables except the B-index are expressed in Purchasing power parity (PPP) and deflated by GDP price index (base year 2016). All variables are also expressed in logarithms. Following **Guellec and van Pottelsberghe** (2000), the four policy tools are also lagged one year.

[11]More details about each R&D policy instruments are provided in the next section.

$$l\_BerdByBus_{i,t} = \beta_1 l\_Risk\ Finance_{i,t} + \beta_2 \Delta l\_GVA_{i,t} + \beta_3 l\_BerdByGov_{i,t-1} + \beta_4 l\_GovRd_{i,t-1} + \beta_5 l\_HigRd_{i,t-1} + \beta_6 l\_BIndex_{i,t-1} + \tau_t + \alpha_i + e_{i,t} \quad (2)$$

The model (2) is estimated using Fixed Effect (FE) estimators. To correct for potential endogenous bias of Risk Finance we combine FE with Control Function (CF) methods.[12] The conceptual framework of the CF is similar to standard IV methods, such as two stage least squares (2SLS), however, with some advantages (**Wooldridge 2015**). For example, with a 2SLS we are not able to delimit the number of instrumental variables since, in addition to the identified instrument(s), all the exogenous variables included in the model are also used, whereas with the CF we are able to make this selection.[13]

The CF is a two-step procedure, where in the first step the endogenous variables are estimated using a vector of exogenous variables ($z_{i,t}$) and the reduced form of residuals ($v_{i,t}$) is obtained. The second step implies including the residuals as an explanatory variable in the main model, in addition to exogenous and endogenous variables. The residuals coefficient (ρ) shows the direction and size of bias due to endogeneity and the *t* statistic test of this variable tests the null hypothesis of the existence of endogeneity (i.e. if the coefficient is statistically significant this means that the variable is not exogenous).[14]

Taking into account the inclusion of an additional variable (the residuals of Risk Finance equation estimation - $v_{i,t}$), the model (2) is re-written as expressed below in equation (3). The vector of exogenous variables ($z_{i,t}$) used to estimate the endogenous variable Risk Finance are dummy year and country fixed effects.[15] They are expected to capture all the country characteristics and economic cycle able to influence the demand for this debt-financing instrument.

$$l\_BerdByBus_{i,t} = \beta_1 l\_Risk\ Finance_{i,t} + \beta_2 \Delta l\_GVA_{i,t} + \beta_3 l\_BerdByGov_{i,t-1} + \beta_4 l\_GovRd_{i,t-1} + \beta_5 l\_HigRd_{i,t-1} + \beta_6 l\_BIndex_{i,t-1} + \rho_1 v_{i,t} + \tau_i + \alpha_i + e_{i,t} \quad (3)$$

[12] Usually, the use of difference GMM of **Arellano and Bond** (1991) is not appropriate due to the small size of our sample. However, we also estimated our model (2) using differences GMM and considering Risk Finance endogenous but the instruments used with this approach are not valid (results available on request), which led us to use the alternative method to correct for endogeneity, namely Control Function approach.

[13] Nevertheless, as a robustness test, we also estimated the model (2) using Fixed-Effect IV regression (also called 2SLS). The main instruments used are the lagged variables of the endogenous variables, namely Risk Finance, and the lag of Risk Finance is used as the main instrument. The result of the Sargan-Hansen test (Table C1 in Appendix C) reveals that the set of instruments used is not valid.

[14] For more details about the CF approach see **Wooldridge** (2015).

[15] We also test different specifications for the Risk Finance equation, namely including its lags or adding the output growth or BerdByBus (results available on request), but the Wald test indicates that the only model which fits the data well is the one including only time dummy and country fixed effects.

As a robustness test and taking into account the definition of BerdByBus provided by **OECD** (2015) – for more details see Table 1 -, we also estimated the equation (3) using two alternative measures for the dependent variable. The first one consists of subtracting the amount of Risk Finance from BerdByBus. However, this approach has also several issues: i) we do not know the repartition of Risk Finance by year and we subtract all the amount of Risk Finance in the year of signing the contract; ii) Risk Finance could fund expenditure not counted as R&D expenditure, but linked with execution of the investment project. For both reasons, this analysis is only made on the basis of a complementary one. The second alternative dependent variable is the entrepreneur self-perception of the country's innovation capacity, extracted from the Global Competitiveness Index. This sub-index is used to confirm the effect of Risk Finance on innovation using a different proxy variable.

3.2. Data source and description

The data used in the study come from several sources. The amount of financing provided by EIB to borrowers under *RSFF* (2007-2013) and *InnovFin* (2014-2016) was provided by EIB. The B-Index was extracted from the OECD website. The indicator measuring the country's innovation capacity was obtained through the World Economic Forum website. The remaining variables (R&D expenditure variables and GVA), the PPP index and the GDP deflators (country-year indicator) were obtained through the EUROSTAT website. Table 1 below gives a detailed description of the variables.

Table 1. Variable description

Variables	Name	Description or Examples
$\mathbf{GAV_{i,t}}$	Gross added value	▪ Country output minus intermediate consumption ▪ Measures country production
$\mathbf{BerdByBus_{i,t}}$	R&D expenditure by the private sector and funded by business sector	▪ Includes R&D labour costs and R&D capital expenditure by business sector ▪ Funding could come from the firm's own internal sources, other enterprises in the same group or other unaffiliated enterprises ▪ Internal sources include retained earnings, equity and debt financing (e.g. venture capital and bank loans)
$\mathbf{BerdByGov_{i,t}}$	R&D expenditure by the business sector and funded by government	▪ Grants or subsidies ▪ Procurement contracts from government institutions
$\mathbf{GovRd_{i,t}}$	R&D expenditure by Government	▪ Basic or applied research and experimental development within ministries or armed forces ▪ Provision of technology services, such as technology transfer, storage of, and access to knowledge and scientific collections and the provision of major scientific infrastructure and facilities

Continued on the next page…

Table 1. Variable description (Continuation)

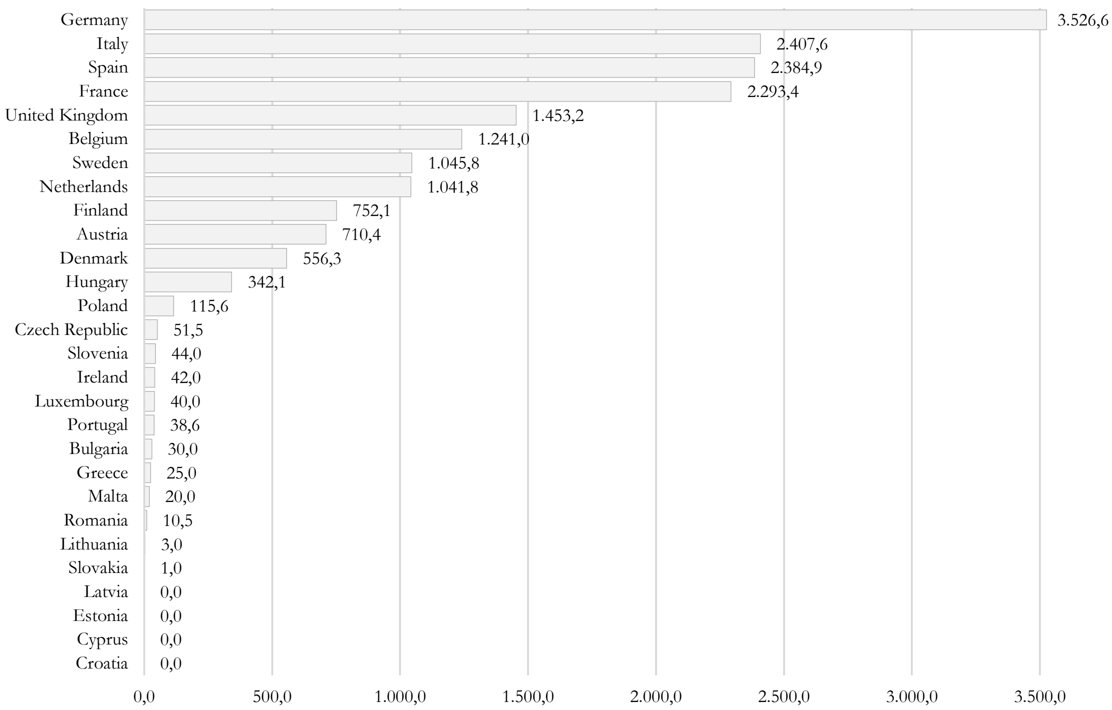
$HigRd_{i,t}$	**R&D expenditure in the higher education sector**	▪ **R&D activities under direct control of tertiary education institutions, university hospitals and clinics**
$BIndex_{i,t}$	B-Index	▪ Composite index linked with tax benefits concerning R&D expenditure (proxy for R&D tax incentive)
$Risk\ Finance_{i,t}$	Risk Finance	▪ Includes the amount of debt-financing provided by EIB to borrowers under *RSFF* (2007-2013) and *InnovFin* (2014-2016)
$Innov_{i,t}$	Capacity for innovation	▪ Sub-index of the Global Competitiveness Index ▪ Answer to question *In your country, to what extent do companies have the capacity to innovate?* ▪ The respondents need to provide a score between 1 and 7, where 1 means not at all and 7 to a great extent]

Source: Authors' own elaboration based on **OECD** (2015) – R&D policy tools – and EUROSTAT glossary for the GAV.

3.3. Descriptive statistics of the data

The total amount of financing provided under the risk sharing scheme (*RSFF* and *InnovFin*) between 2007 and 2016 was €18,176.4 million (Figure 1). Entities located in Germany, Italy, Spain and France received around 58% of the total, whereas those in Croatia, Cyprus, Estonia and Latvia did not sign up for any financing through these instruments. Hungary is the country where the amount received is the most representative, taking into account the size of the countries (% GDP), followed by Finland, Belgium and Spain (Figure 2).

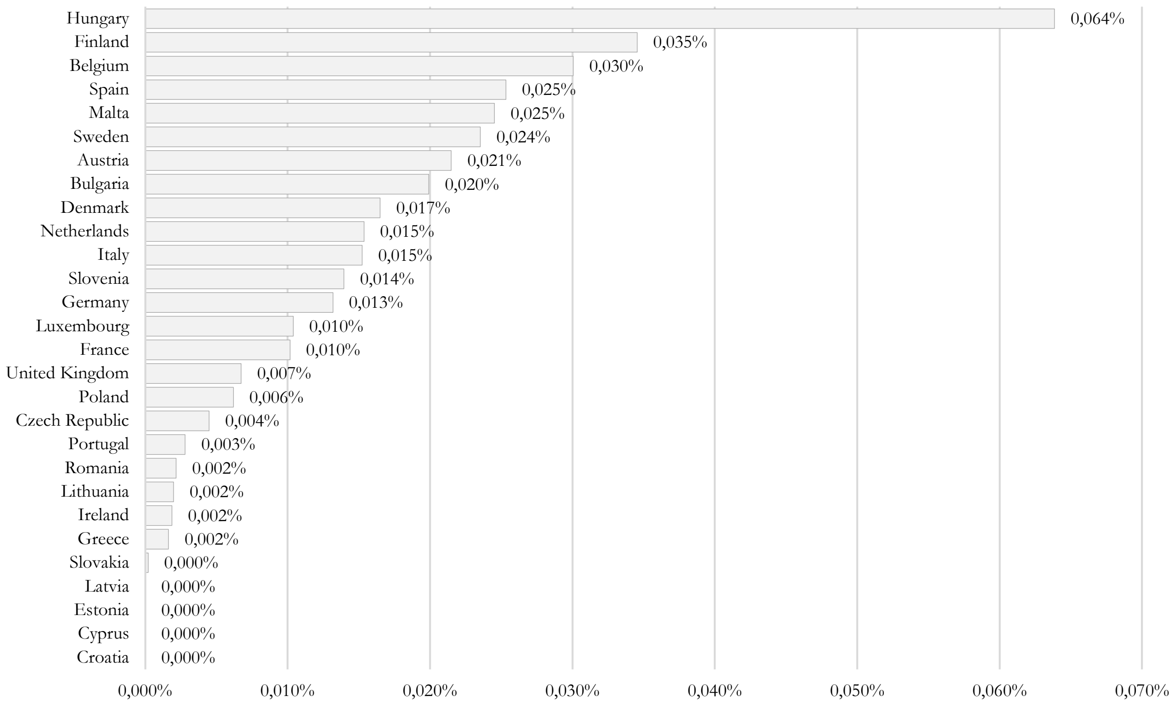
Figure 1. Total amount of Risk Finance (million €), 2007 – 2016, by country



Source: Authors' own elaboration based on data from EIB.

Note: Risk Finance indicators include RSFF data for the period 2007-2013 and InnovFin data for 2014-2016.

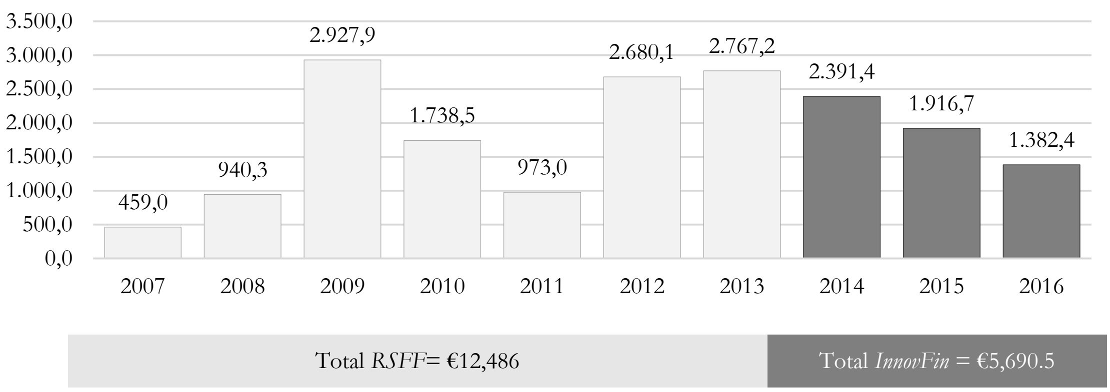
Figure 2. Risk Finance (% GDP), mean 2007 – 2016, by country



Source: Authors' own elaboration based on data from EIB and EUROSTAT.

Concerning the amount allocated per year, between 2007 and 2016, we can see in Figure 3 that its distribution does not follow a linear trend. The average amount attributed per year under RSFF (2007 - 2013) was €1,783.7 million, and for InnovFin (2014-2016) it was approximately the same – €1,896.8 million.

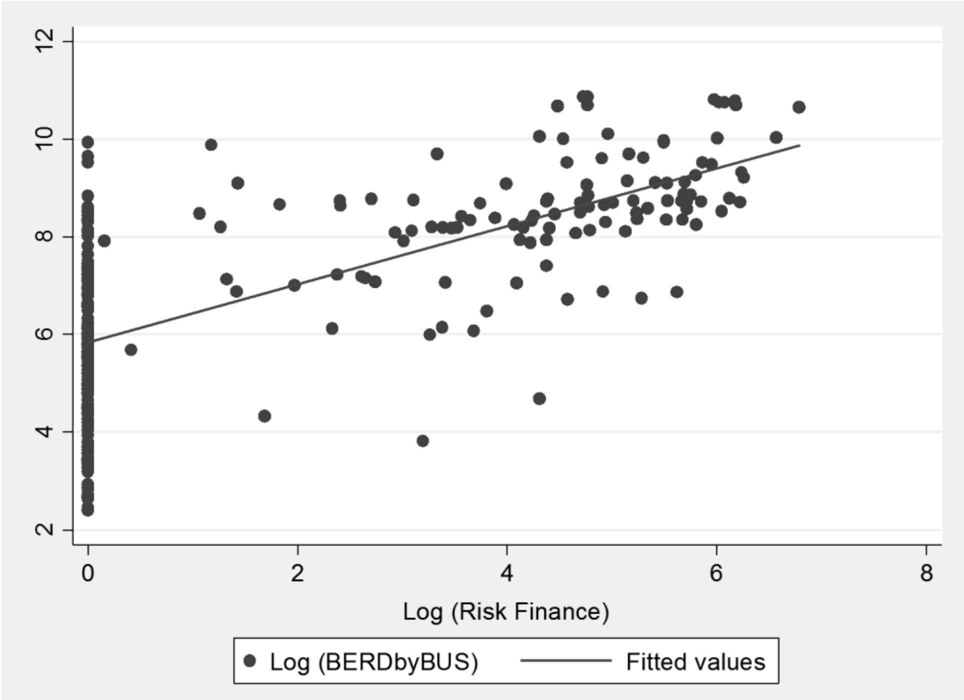
Figure 3. Total amount of Risk Finance (million €), 2007 – 2016, by year



Source: Authors' own elaboration based on data from EIB.

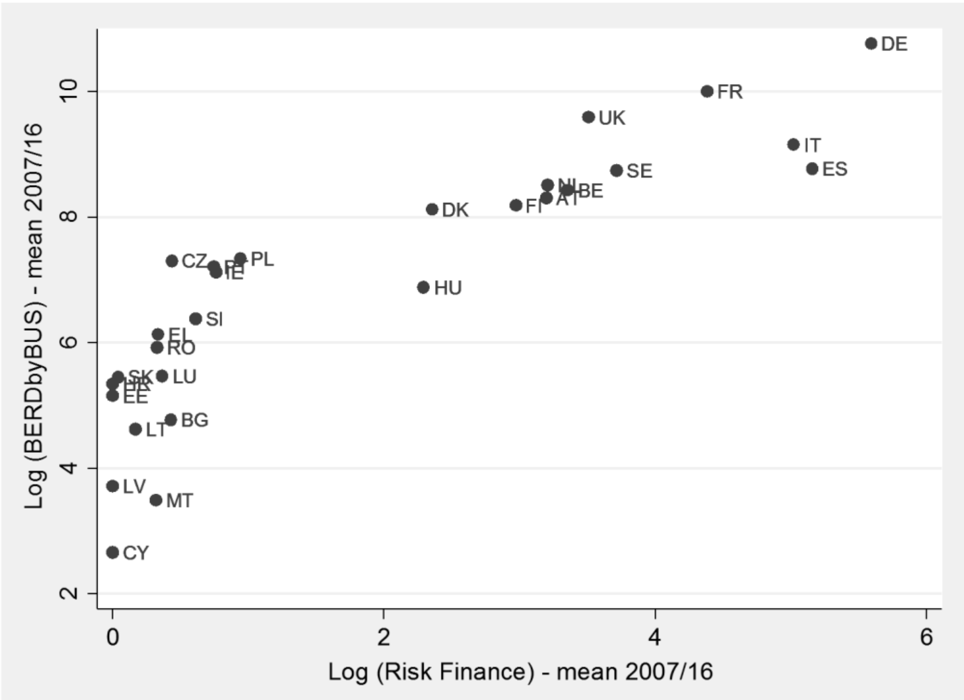
As regards the relationship between Business R&D expenditure funded by the private sector (BerdByBus) and Risk Finance, we observe in Figure 4 and Figure 5 a positive and linear correlation between both variables.

Figure 4. Two-way Scatterplots BerdByBus and Risk Finance, 2007 – 2016



Source: Authors' own elaboration based on data from EIB and EUROSTAT.

Figure 5. Two-way Scatterplots BerdByBus and Risk Finance, mean 2007 – 2016 by country



Source: Authors' own elaboration based on data from EIB and EUROSTAT.

4. Results and discussion

4.1. Baseline regressions

Table 2 displays the results of FE regression for equations (2) and (3). Column (1) refers to model estimation without controlling for endogeneity of Risk Finance, whereas column (2) reports the results using the CF approach. Starting by interpreting the results in Column (1), where Risk Finance is considered an exogenous variable, we can see that the effect of Risk Finance on BerdByBus is almost null and non-significant. Nevertheless, when testing for the endogeneity of Risk Finance, the results in Column (2) show that the coefficient of CF residuals (ρ) is statistically significant, which means that we can reject the hypothesis that Risk Finance is exogenous. The negative value of ρ indicates that the existing bias due to endogeneity lowers the effect of Risk Finance on BerdByBus and the coefficient value (0.19) refers to the size of the bias.

Table 2. Results of the FE model without and with CF

Variables	**Y = Log(BerdByBus)**	
	(1)	**(2)**
Log(Risk Finance) in T	-0.00005	0.189***
	(0.00820)	(0.0555)
Coeff. residuals of CF ($\boldsymbol{\rho}$)	-	-0.190***
		(0.0554)
CONTROL VARIABLES		
△Log(GVA) in T	0.376	0.376
	(0.441)	(0.441)
Log(BerdByGov) in T-1	0.178**	0.178**
	(0.0655)	(0.0655)
Log(GovRd) in T-1	0.0326	0.0326
	(0.0818)	(0.0818)
Log(HeRd) in T-1	-0.108	-0.108
	(0.217)	(0.217)
Log(B-Index) in T-1	0.510	0.510
	(0.338)	(0.338)
Year dummy and country fixed effect	YES	YES
Constant	6.634***	6.509***
	(1.375)	(1.368)
Observations (n° id)	280 (28)	280 (28)
R-squared	0.222	0.222
VALIDATION TEST		
Wald test - H0: All coefficient = 0	0.0000	0.0000
Ramsey test - H0: model has no omitted variables	0.0586	0.0588
Specification link test - H0: model is correctly specified	0.8960	0.8960

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

Since Risk Finance is confirmed to be endogenous, only the results of Column (2) report consistent estimators. To validate this model, we perform some additional tests. The results of the Wald test for joint significance and of the specification link test reveal that the model is correctly specified and fits the data well. The Ramsey test shows that the model has no omitted variables, which confirms the macroeconomic framework of **Guellec and van Pottelsberghe** (2000) and **Cincera et al.** (2009), where BerdByBus could only be explained by country output growth and R&D policy tools.[16] The multicollinearity diagnostic (Appendix B), performed using the Variance Inflation Factor (VIF), shows that our independent variables are not correlated with each other, leading to precise estimation.

The results of Column (2) show a positive effect of Risk Finance on BerdByBus. Since the model has a double-log functional form, the coefficient values refer to the elasticity. Therefore, interpretation of the Risk Finance coefficient reveals that a 1% increase of Risk Finance increases BerdByBus by 0.19%. The complementary analysis using alternative dependent variables also confirms the positive effect of the new debt-financing instrument on country innovation capacity (Table C2 – Appendix C), BerdByBus per capita (Table C3 – Appendix C) and BerdByBus minus Risk Finance (Table C4 – Appendix C).

As regards the effect of control variables, BerdByGov, which is associated with grants and subsidies, reports a positive and significant effect on BerdByBus. The B-Index also has a positive effect but at 15% significance level. Output growth only has a significant positive effect when time dummies are not included – see results of Column (2) in Table C6 in Appendix C – which could suggest that time dummies are able to capture all the effect of the economic cycle, making output growth non-significant when estimated together.[17] The GovRd and HeRd have respectively a positive and negative coefficient but both are non-significant. Although not the purpose of the present paper, on the basis of the complementary analysis (Table C7 in Appendix C), a positive and significant effect is found for both variables HeRd and GovRd, when country fixed effect and BerdByGov are not included in the model specification. This could suggest that in the EU other factors associated with countries' characteristics are more able to influence BerdByBus than GovRd and HeRd.

To assess the sensitivity of the result obtained in Table 2, we lagged Risk Finance one or two periods of time. The results in Column (3) and (4) of Table C6 in Appendix C respectively, confirm the positive and significant effect of the new EU debt-financing instrument on R&D expenditure funded by the private sector. Furthermore, the size of the new coefficients (0.156 and 0.121) is also close to that found when the variable is not lagged (0.19). To translate these elasticities into euro terms, we estimated the marginal rate of return. This corresponds to the

[16] We replicate the same regression estimation but without including Risk Finance (see results in column (1) of Table C6 in Appendix C), and the Ramsey test result also confirms this hypothesis.

[17] We also test for the existence of multicollinearity issues between output growth and time dummies. The results reported in Table B1 in Appendix B do not seem to suggest that the variables are correlated.

product of the elasticity and the ratio of the dependent variable (BerdByBus) and independent variable (Risk Finance), where the values of these variables are expressed by their average amount. The results of the average marginal effect of Risk Finance on BerdByBus are described in Table 3 and show that one euro of Risk Finance induces additional private R&D expenditure (BerdByBus) between 8.4€ and 14€.[18] The range found is higher than the multiplier effect expected by policy makers of 1-to-3, but the regression estimation is made at the macro-level, which can capture not only the direct but also the indirect effect of the EU policy instrument. For instance, private R&D decision in a firm could stimulate innovation among its competitors and also encourage its suppliers to innovate in order to provide new raw material. Furthermore, if a firm is funded by EIB, this could be a sign of firm credibility, leading to easier access to funding and to additional R&D expenditure.

Table 3. Average marginal effect of Risk Finance in different time periods

	T	T - 1	T – 2
N° observations	280	252	224
(A) Beta Risk Finance =	0.1895	0.1558	0.1216
(B) Mean BerdByBus =	4,822.99 €	4,804.36 €	4,682.13 €
(C) Mean Risk Finance =	65.45 €	67.53 €	67.62 €
(D) Marginal Effect = (A)*[(B)/(C)]	13.96 €	11.09 €	8.42 €

Source: Authors' own elaboration.

Note: Mean value for dependent and main explanatory variables was extracted from Table A1 in Appendix A.

Additionally, if we compare the rate of return of BerdByGov- 2.17€[19] - we can see that its effect is lower than that of Risk Finance (8.4€ - 14€). One possible explanation could be linked with the type of financing provided (grants/subsidies *versus* loans). Indeed, firms could have more motivation to achieve the planned goals and even to perform better, if they need to reimburse the financing received. Furthermore, the selection process to finance corporate RDI investment under *RSFF* or *InnovFin* is also different, since the firm needs to be creditworthy to be selected. Therefore, pre-selection, among those that are already financially the best performers, is carried out.

4.2. Synergies among R&D policy tools

To assess some differences in BerdByBus behavior depending on the amount of government funding for private R&D expenditure and on the level of R&D tax incentives, we re-estimated equation (3) by groups. Table C9 in Appendix C reproduces the results of this additional analysis, where column (1) and (3) refer to country-year data above the average value of

[18] This range is close to that found when the dependent variable is BerdByBus minus Risk Finance(8.3€ - 11.9€), as reported in Table C5 – Appendix C.

[19] This value was estimated by the product of the coefficient of BerdByGov (0.178) and the ratio between the average amount of BerdByBus (€4,822) and BerdByGov in T-1 (€396).

BerdByGov or of B-Index and the remaining columns those below the average. All the regression estimations show a positive and significant effect of Risk Finance on BerdByBus, but the coefficients show different magnitudes. Since their values refer to elasticities from different samples (and with different characteristics), in order to compare differences in term of impact we need to estimate the marginal rate of return and to perform a Z-test to test the significance of this difference. The results in Table 4 show that the leverage effect of Risk Finance on BerdByBus is statistically lower when BerdByGov is above the average (4.8€ versus 14.3€). A possible explanation for this finding could be that in countries where a higher amount of BerdByGov is available, firms are less likely to ask for bank-debt-financing. Concerning the effect of Risk Finance on BerdByBus when the R&D tax incentive is above average, the rate of return shows a higher effect than when the B-Index is below the average (16.8€ versus 7.6€). However, this difference seems to be non-significant.

Table 4. Average marginal effect of Risk Finance, by groups

	BerdByGov>$\bar{x}$	BerdByGov<$\bar{x}$	B-Index >$\bar{x}$	B-Index <$\bar{x}$
(A) Beta Risk Finance =	0.0599	0.2482	0.1892	0.1427
(B) Mean BerdByBus =	15,945.42 €	1,307.88 €	5,492.67 €	3,794.11 €
(C) Mean Risk Finance =	198.68 €	22.72 €	61.73 €	71.12 €
(D) Marginal Effect = (A)*[(B)/(C)]	4.80 €	14.29 €	16.83 €	7.61 €
Z-test – H0: difference between coefficients = 0	0.010		0.698	

Source: Authors' own elaboration.
Note: Results of z-test refer to p-value. The z-test is estimated on the basis of the same methodology used by **Clogg et al.** (1995): $Z = \beta_1 - \beta_2/\sqrt{(Std.Error\ \beta_1)^2 + (Std.Error\ \beta_2)^2}$.

4.3. Assessing inverse causality

As a complementary analysis, we perform a Granger causality test (**Granger 1969**) to assess the inverse relationship, i.e. to test the hypothesis if BerdByBus explains Risk Finance. The BerdByBus variable is assumed to Granger-cause the Risk Finance variable if, given the past values of Risk Finance, the past values of BerdByBus are suitable for predicting Risk Finance. To test Granger causality, a frequent method is to regress y (i.e. Risk Finance) on its own lagged values and on the lagged values of x (i.e. BerdByBus) and then to test the null hypothesis that the estimated coefficients for x (i.e. BerdByBus) are jointly equal to zero. Rejecting the null hypothesis means that x (i.e. Risk Finance) Granger-causes. Table C9 in Appendix C shows that BerdByBus does not explain Risk Finance.

5. Conclusion

The present paper provides one of the first impact assessments of a new EU debt-financing instrument designed to enhance private R&D expenditure. Through sharing the risk of potential losses, between the European Commission and the EIB, the EIB was able to provide directly or indirectly additional loans to borrowers to support investment in excellent, but high risk RDI projects (**EC 2011**).

Based on a macro-economic analysis, covering the 28 EU Member States in the period 2007-2016, the study reports a positive and significant effect of the new EU policy financing instrument on Private R&D expenditure and its rate of return seems to be higher than that of grants or subsidies. A possible justification for these significant differences could be linked with the type of funding provided by Risk Finance (loan and not grant) and the EIB's selection process to finance a borrower.

Furthermore, we also observe that the financing provided through *RSFF* and *InnovFin* is highly concentrated in some countries.[20] Indeed, Germany, Italy, Spain and France account for 58% of the total financing committed. Entities located in Croatia, Cyprus, Estonia and Latvia have not signed any debt-financing contract through *RSFF* or *InnovFin*. A possible explanation for this finding could be that firms located in this last group of countries have access to other structural funds under the form of grants and are consequently less likely to request a loan, when grants are more available. Indeed, this interpretation is also in line with the results of the complementarity analysis described in section 4.2, which reveal that the leverage effect of Risk Finance on BerdByBus is statistically lower when BerdByGov is above the average.

Policy recommendations are that more financing through *InnovFin* should be provided, because this kind of financing support is effective in leveraging private R&D activities and its effect also appears to be greater than that of other direct government funding. Furthermore, it seems that greater dissemination of *InnovFin* products is needed, especially in countries that benefited least from this new debt-financing instrument.

References

Aerts, K. & Thorwarth, S. (2008) Additionality effects of public R&D funding: "R" versus "D". FBE Research Report MSI_0811, K. U. Leuven - Faculty of Business and Economics.

Afcha, S. & López, G. L. (2014) Public funding of R&D and its effect on the composition of business R&D expenditure. BRQ Business Research Quarterly, 17(1), 22–30. doi:10.1016/j.cede.2013.01.001

Aghion, P., Bond, S., Klemm, A. & Marinescu, I. (2004) Technology and Financial Structure: Are Innovative Firms Different? Journal of the European Economic Association, 2(2-3), 277–288.

Aghion, P.,Fally, T. & Scarpetta, S. (2007) Credit Constraints as a Barrier to the Entry and Post-Entry Growth of Firms. Economic Policy, 22(52), 731–779.

[20] This weakness was also highlighted in the report of **Avice et al.** (2013) about the *RSFF* (2007 – 2013).

Arellano, M. & Bond, S. (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies, 58, 277–297.

Arrow, K. (1962) Economic Welfare and the Allocation of Resources for Invention. In Universities-National Bureau Committee for Economic Research, Committee on Economic Growth of the Social Science Research Council (Ed), The Rate and Direction of Inventive Activity: Economic and Social Factors (pp. 609 – 626). New Jersey: Princeton University Press.

Avice, E., Stevens, W., Mann, E., Figueiredo, J-F. & Maimets, T. (2013) Second interim evaluation of the RSFF, Final report Independent Expert Group (IEG).

Bah, R. & Dumontier, P. (2001) R&D Intensity and Corporate Financial Policy: Some International Evidence. Journal of Business Finance and Accounting, 28(5-6), 671-692.

Baum, C.F. (2006). An introduction to Modern Econometrics Using Stata. Massachusetts: Stata Press.

Bellucci, A., Favaretto, I., Giombini, G. (2014) Does Innovation Affect Credit Access? New Empirical Evidence from Italian Small Business Lending. IAW Discussion Papers, 104.

Blazy, R. & Weill, L. (2013) Why do banks ask for collateral in SME lending? Applied Financial Economics 23(13), 1109-1122. http://dx.doi.org/10.1080/09603107.2013.795272

Busom, I. (2000) An Empirical Evaluation of the Effects of R&D Subsidies. Economics of Innovation and New Technology, 9, 111-148. doi:10.1080/10438590000000006

Cassar, G. (2004) The financing of business start-ups. Journal of Business Venturing, 19, 261–283, doi:10.1016/S0883-9026(03)00029-6

Cincera, M. (2003) Financing constraints, fixed capital and R&D investment decisions of Belgian firms. Ined. Butzen and Fuss (Ed.) Firms' Investment and Finance Decisions: Theory and Empirical Methodology (pp.129-147).Cheltenham: Edwar Elgar.

Cincera, M. & Santos, A. (2015) Innovation and Access to Finance – A Review of the Literature. Working Paper iCite, 2015 – 016.

Cincera, M. & Ravet, J. (2010) Financing constraints and R&D investments of large corporations in Europe and the USA. Science and Public Policy, 37(6), 455-466.

Cincera, M.,Czarnitzki, D. & Thorwarth, S. (2009) Efficiency of public spending in support of R&D activities. Economic Papers n.° 376, European Economy, Directorate-General for Economic and Financial Affairs Publications, European Commission, Brussels.

Clogg, C. C., Petkova, E., & Haritou, A. (1995) Statistical methods for comparing regression coefficients between models. American Journal of Sociology, 100(5), 1261-1293.

Damodaran, A. (2006) Applied Corporate Finance – A User's Manual, 2nd Edition. John Wiley & Sons, Inc.

EC (2006) Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions – Implementing the Community Lisbon Programme: Financing SME Growth – Adding European Value. COM(2006) 349 final.

EC (2011). Risk-Sharing Finance Facility (RSFF) - Investing in European research and innovation. Research EU Focus, n.° 10, Publications Office of the European Union, Luxembourg. Available at: ftp://ftp.cordis.europa.eu/pub/news/research-eu/docs/focus-10_en.pdf (accessed on 11 December 2015).

EC (2015) State of the Innovation Union 2015. Directorate-General for Research and Innovation European Commission.

EC (2016) Ex-Post Evaluation of the Seventh Framework Programme, Commission Staff Working Document accompanying the document Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the

Committee of the Regions On the Response to the High Level Expert Group on the Ex-Post Evaluation of the Seventh Framework Programme. SWD(2016) 2 final

EESC (2007) Opinion of the European Economic and Social Committee on 'Innovation: impact on industrial change and the role of EIB' (2007/C 256/17).Official Journal of the European Union C256:88-93, 27.10.2007.

Erden, L. & Holcombe, R. G. (2005) The effects of public investment on private investment in developing economies. Public Finance Review, 33(5), 575-602. https://doi.org/10.1177/1091142105277627

Falk, R. (2007) Measuring the effects of public support schemes on firms' innovation activities Survey evidence from Austria. Research Policy, 36(5), 665-679. doi:10.1016/j.respol.2007.01.005

Galindo, M. A. & Méndez, M. T. (2014) Entrepreneurship, economic growth, and innovation: Are feedback effects at work?. Journal of business research, 67(5), 825-829.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37, 424–438.

Groth, G. C. & Khan, H (2010) Investment Adjustment Costs: An Empirical Assessment. Journal of Money, Credit and Banking, 42(8), 1469-1494.

Guellec, D. & van Pottelsberghe de la Potterie, B. (2000) The Impact of Public R&D Expenditure on Business R&D.OECD Science, Technology and Industry Working Papers, 2000/04. http://dx.doi.org/10.1787/670385851815

Hall, B. (2009) The financing of innovative firms. *EIB Papers*, 14(2). Available at: http://eml.berkeley.edu/~bhhall/papers/BHH09_EIB_Papers_14_Nr_2.pdf.Accessed 18 January 2019.

Hall, B. & Lerner, J. (2010) The Financing of R&D and Innovation. In Bronwyn H. Hall and Nathan Rosenberg (Ed.), Handbook of the Economics of Innovation, Vol. 1 (pp. 609-639). Elsevier.

Hasan, I. & Tucci, C. (2010) The innovation–economic growth nexus: Global evidence. Research policy, 39(10), 1264-1276.

Hölzl, W. & Peneder, M. (2013) Financing innovation. InElias G. Carayannis (Ed.), Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship (pp. 734-738). New York: Spinger.doi: 10.1007/978-1-4614-3858-8_487

Hottenrott, H. & Peters, B. (2012) Innovative Capability and Financing Constraints for Innovation - More Money, More Innovation?. ZEW Discussion Paper No. 09-081.

Hyytinen, A. & Toivanen, O. (2005) Do financial constraints hold back innovation and growth? Evidence on the role of public policy. Research Policy, 34 (9), 1385-1403.doi:10.1016/j.respol.2005.06.004

Jorgenson, D. W. (1963) Capital theory and investment behavior. American Economic Review, 53(2), 247–259.

Kim, D. H.; Lin, S. C. & Chen, T.C. (2016) Financial structure, firm size and industry growth. International Review of Economics and Finance, 41, 23-39. doi:10.1016/j.iref.2015.10.002

Kock M (2010) The Risk-Sharing Finance Facility (RSFF) – An innovative financing instrument to support investments in R&D and Innovation including Low Carbon Technologies, presentation at CEPS meeting "The SET Plan: From concept to practice", Brussels, 19 November 2010.https://www.ceps.eu/sites/default/files/Koch.pdf. Accessed 17 January 2019.

Lee, N., Sameen, H. & Cowling, M. (2015) Access to finance for innovative SMEs since the financial crisis. Research Policy, 44(2), 370-380.doi:10.1016/j.respol.2014.09.008

Malo J.D. (2009) Risk-Sharing Finance Facility (RSFF) – Innovative financing for more investment in Research, Development and Innovation. Presentation at the NMP Programme Committee Brussels, 9 July 2009. http://www.eurosfaire.prd.fr/7pc/documents/1253113382_jean_david_malo___module_10.pdf. Accessed 17 January 2019.

Mazzucato, M. (2013) Financing innovation: creative destruction vs. destructive creation. Industrial and Corporate Change, 22(4), 851-867. doi:10.1093/icc/dtt025

OECD (2014) Financing SMEs and Entrepreneurs 2014: An OECD Scoreboard.Paris: OECD Publishing. DOI: 10.1787/fin_sme_ent-2014-en

OECD (2015) Frascati Manual 2015 - Guidelines for Collecting and Reporting Data on Research and Experimental Development, The Measurement of Scientific, Technological and Innovation Activities. Paris: OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264239012-en

Radas, S., Anić, I. D., Tafro, A. & Wagner, V. (2015) The effects of public support schemes on small and medium enterprises. Technovation, 38, 15-30. doi:10.1016/j.technovation.2014.08.002

Rahaman, M. M. (2011) Access to financing and firm growth. Journal of Banking & Finance, 35(3), 709-723.doi:10.1016/j.jbankfin.2010.09.005

Santos, A. & Cincera, M. (2017). Access to finance as a pressing problem: Evidence from innovative European firms. iCite Working Paper 2017– 022.

Shah, A. (1994) The Economics of Research and Development: How Research and Development Capital Affects Production and Markets and Is Affected by Tax Incentives.Policy Research Working Paper n.° 1325, The World Bank.

Silva, E. S. (2017) Tipologia dos riscos – Uma introdução, Portugal: Vida Económica.

Toma, S.V.,Chiriţă, M. & Şarpe, D. (2012) Risk and Uncertainty. Procedia Economics and Finance, 3, 975-980.https://doi.org/10.1016/S2212-5671(12)00260-2.

Tsoukas, S. (2011) Firm survival and financial development: Evidence from a panel of emerging Asian economies. Journal of Banking & Finance, 35(7), 1736-1752. doi:10.1016/j.jbankfin.2010.12.008

Un, C.A. & Montoro-Sanchez, A. (2010) Public funding for product, process and organizational innovation in service industries. The Service Industries Journal, 30(1), 133-147. doi: 10.1080/02642060802252035

Wooldridge (2015) Control Function Methods in Applied Econometrics. Journal of Human Resources, 50(2), 420-445.

Appendix

Appendix A. Descriptive Statistics

Table A.1. Mean, Standard Deviation, Minimum and Maximum

Variables	Mean	Std. Dev.	Min	Max
Log(BerdByBus)	6.91	2.05	2.39	10.88
BerdByBus (€)	4,822.99	9,558.21	10.88	53,004.49
Log(Risk Finance)	1.80	2.34	0.00	6.78
Risk Finance (€)	65.45	131.54	0.00	883.22
△Log(GVA)	0.00	0.05	-0.23	0.34
GVA (€)	455,430	643,206	8,052	2,661,600
Log(BerdByGov)	4.32	2.29	-2.32	7.95
BerdByGov (€)	391.98	632.02	0.10	2,835.99
Log(GovRd)	5.81	1.76	-0.20	9.40
GovRd (€)	1,205.33	2,282.04	0.82	12,100.15
Log(HeRd)	6.49	1.76	2.72	9.67
HeRd (€)	2,190.57	3,230.10	15.23	15,877.05
Log(B-Index)	-0.15	0.18	-0.67	0.03
B-Index	0.88	0.14	0.51	1.03

Source: Authors' own elaboration.
Note: N° of observations = 280. Monetary values are expressed in Millions euros, PPP and constant price (base year 2016).

Appendix B. Testing Muti-Collinearity

Table B1. Collinearity Diagnostics: Results of VIF test

Variables	**VIF**	**Sqrd VIF**	**Tolerance**	**R-Squared**
Log(Risk Finance) in T	1.92	1.39	0.5197	0.4803
△Log(GVA) in T	2.11	1.45	0.4743	0.5257
Log(BerdByGov) in T-1	6.64	2.58	0.1505	0.8495
Log(GovRd) in T-1	5.43	2.33	0.1843	0.8157
Log(HeRd) in T-1	6.45	2.54	0.1549	0.8451
Log(B-Index) in T-1	1.06	1.03	0.9463	0.0537
Year = 2008	2.22	1.49	0.4509	0.5491
Year = 2009	2.92	1.71	0.3423	0.6577
Year = 2010	1.88	1.37	0.5328	0.4672
Year = 2011	1.95	1.40	0.5120	0.4880
Year = 2012	2.04	1.43	0.4896	0.5104
Year = 2013	2.01	1.42	0.4986	0.5014
Year = 2014	1.90	1.38	0.5273	0.4727
Year = 2015	1.89	1.37	0.5294	0.4706
Year = 2016	1.95	1.40	0.5126	0.4874
Mean VIF	2.82			

Source: Authors' own elaboration.
Note: Number of observations = 280. VIF corresponds to the variance inflation factor and values higher than 10 reveal evidence of collinearity (**Baum, 2006**). Since the results in Table B.1 show that the maximum VIF is less than 7, no evidence of collinearity is found.

Appendix C. Robustness test

Table C1. Results fixed-effects IV regression (2SLS)

Variables	**Y = Log(BerdByBus)**	
	(1)	**(2)**
Log(Risk Finance) in T	0.148 (0.517)	0.205 (0.435)
CONTROL VARIABLES (CV)		
△Log(GVA) in T	- -	0.389 (0.688)
Log(BerdByGov) in T-1	- -	0.186* (0.0988)
Log(GovRd) in T-1	- -	-0.00909 (0.187)
Log(HeRd) in T-1	- -	-0.0836 (0.188)
Log(B-Index) in T-1	- -	0.830 (0.986)
Year dummy	YES	YES
Country fixed effect	YES	YES
Constant	6.757*** (1.078)	6.542*** (1.425)
Observations (n° id)	252 (28)	251 (28)
R-squared	0.4926	0.6776
Wald test - *H0: All coefficient = 0*	0.0000	0.0000
Sargan-Hansen test - *H0: overidentifying restrictions are valid*	0.0000	0.0000
Instruments	Log(Risk Finance) in T-1 and dummy years	Log(Risk Finance) in T-1, CV and dummy years

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

Table C2. Results of FE regression with an alternative measure for innovation

Variables	Y = Log(Innovation capacity)	
	(1)	(2)
Log(Risk Finance) in T	-0.000704	0.0887***
	(0.00284)	(0.0186)
Coeff. residuals of CF	-	-0.0894***
	-	(0.0197)
Control variables	YES	YES
Year dummy and country fixed effect	YES	YES
Constant	YES	YES
Observations	280	280
Number of id	28	28
R-squared	0.608	0.608
Wald test - H0: All coefficient = 0	0.000	0.000

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Result of Wald test refers to p-value.

Table C3. Results fixed-effects regression with per capita variable

Variables	Y = Log(BerdByBus per capita)	
	(1)	(2)
Log(Risk Finance per capita) in T	0.266***	-
	(0.0774)	-
Log(Risk Finance per capita) in T-1	-	0.272***
	-	(0.0866)
Coeff. CF residuals (rho)	-0.260***	-0.263***
	(0.0760)	(0.0872)
CONTROL VARIABLES		
△Log(GVA per capita) in T	0.348	0.430
	(0.339)	(0.306)
Log(BerdByGov per capita) in T-1	0.170**	0.167**
	(0.0669)	(0.0726)
Log(GovRd capita) in T-1	0.00341	-0.0240
	(0.121)	(0.121)
Log(HeRd per capita) in T-1	-0.122	-0.0554
	(0.239)	(0.221)
Log(B-Index) in T-1	0.523	0.586
	(0.320)	(0.353)
Year dummy	YES	YES
Country fixed effect	YES	YES
Constant	1.010	1.130*
	(0.626)	(0.652)
Observations	280	252
Number of id	28	28
R-squared	0.196	0.196
VALIDATION TEST		
Wald test - *H0: All coefficient = 0*	0.0000	0.0000
Ramsey test - *H0: model has no omitted variables*	0.0246	0.0559
Specification link test - *H0: model is correctly specified*	0.5690	0.3690

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

Table C4. Results fixed-effects regression with BerdByBus without Risk Finance

Variables	Log(BerdByBus minus Risk Finance)		
	(1)	(2)	(3)
Log(Risk Finance) in T	0.163***	-	-
	(0.0582)	-	-
Log(Risk Finance) in T-1	-	0.168**	-
	-	(0.0668)	-
Log(Risk Finance) in T-2	-	-	0.119**
	-	-	(0.0527)
Coeff. CF residuals (***ρ***)	-0.189***	-0.170**	-0.130**
	(0.0591)	(0.0683)	(0.0585)
CONTROL VARIABLES			
△Log(GVA) in T	0.487	0.572	0.638
	(0.503)	(0.511)	(0.556)
Log(BerdByGov) in T-1	0.179**	0.202**	0.172**
	(0.0686)	(0.0872)	(0.0821)
Log(GovRd) in T-1	-0.101	-0.178	-0.223
	(0.106)	(0.141)	(0.169)
Log(HeRd) in T-1	-0.0491	0.0220	0.114
	(0.225)	(0.205)	(0.177)
Log(B-Index) in T-1	0.512	0.700*	0.630
	(0.352)	(0.411)	(0.376)
Year dummy	YES	YES	YES
Country fixed effect	YES	YES	YES
Constant	6.927***	6.833***	6.683***
	(1.427)	(1.262)	(1.139)
Observations	280	252	224
Number of id	28	28	28
R-squared	0.221	0.226	0.227
VALIDATION TEST			
Wald test - *H0: All coefficient = 0*	0.0000	0.0000	0.0000
Ramsey test - *H0: model has no omitted variables*	0.1691	0.0135	0.0038
Specification link test - *H0: model is correctly specified*	0.7990	0.766	0.805

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

Table C5. Average marginal effect of Risk Finance based on Table C4

	T	T - 1	T - 2
(A) Beta =	0.1631	0.1682	0.1190
(B) Mean BerdByBus - Risk Finance =	4,758.03 €	4,772.56 €	4,699.53 €
(C) MeanRisk Finance =	65.45 €	67.53 €	67.62 €
(D) Marginal Effect = (A) * (B/C) =	**11.86 €**	**11.89 €**	**8.27 €**
N° observations	280	252	224

Source: Authors' own elaboration.

Table C6. Results fixed-effects regression (complementary analysis)

Variables	Y = Log(BerdByBus)			
	(1)	(2)	(3)	(4)
Log(Risk Finance) in T	-	0.0942***	-	-
	-	(0.0270)	-	-
Log(Risk Finance) in T-1	-	-	0.156***	-
	-	-	(0.0498)	-
Log(Risk Finance) in T-2	-	-	-	0.122**
	-	-	-	(0.0470)
Coeff. CF residuals (**ρ**)	-	-0.0955***	-0.157***	-0.133**
		(0.0276)	(0.0511)	(0.0530)
CONTROL VARIABLES				
△Log(GVA) in T	0.376	1.143***	0.425	0.673
	(0.440)	(0.283)	(0.436)	(0.532)
Log(BerdByGov) in T-1	0.178**	0.153**	0.178**	0.168**
	(0.0651)	(0.0638)	(0.0696)	(0.0771)
Log(GovRd) in T-1	0.0326	0.0641	0.00673	-0.0634
	(0.0811)	(0.0718)	(0.0913)	(0.131)
Log(HeRd) in T-1	-0.108	-0.0275	-0.0609	0.0485
	(0.217)	(0.240)	(0.206)	(0.164)
Log(B-Index) in T-1	0.511	0.290	0.587	0.604
	(0.339)	(0.265)	(0.361)	(0.361)
Constant	6.634***	5.927***	6.432***	6.217***
	(1.374)	(1.450)	(1.263)	(1.087)
Year dummy and Country fixed effect	YES	NO	YES	YES
Observations (n° id)	280 (28)	280 (28)	252 (28)	224 (28)
R-squared	0.222	0.139	0.232	0.247
VALIDATION TEST				
Wald test - H0: All coefficient = 0	0.0000	0.0016	0.0000	0.0000
Ramsey test - H0: model has no omitted variables	0.0563	0.0930	0.1329	0.0348
Specification link test - H0: model is correctly specified	0.8960	0.9360	0.8670	0.8410

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

Table C7. Results Pooled OLS – Baseline model (without Risk Finance)

Variables	Y = Log(BerdByBus)	
	(1)	(2)
△Log(GVA) in T	2.009*	3.408***
	(1.094)	(1.189)
Log(BerdByGov) in T-1	0.392***	-
	(0.108)	-
Log(GovRd) in T-1	0.0270	0.252*
	(0.132)	(0.133)
Log(HeRd) in T-1	0.612***	0.876***
	(0.149)	(0.131)
Log(B-Index) in T-1	0.421	0.477
	(0.488)	(0.534)
Year dummy	YES	YES
Country fixed effect	NO	NO
Constant	1.153	-0.227
	(0.681)	(0.574)
Observations	280	280
R-squared	0.922	0.892
VALIDATION TEST		
Wald test - H0: All coefficient = 0	0.0000	0.0000
Ramsey test - H0: model has no omitted variables	0.0000	0.0000

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Result of Wald test refers to p-value.

Table C8. Results of FE regression, by groups

Variables	Y = Log(BerdByBus)			
	BerdByGov>$\bar{x}$	BerdByGov<$\bar{x}$	B-Index >$\bar{x}$	B-Index <$\bar{x}$
	(1)	(2)	(3)	(4)
Log(Risk Finance) in T	0.0599**	0.248***	0.189*	0.143*
	(0.0178)	(0.0702)	(0.0928)	(0.0755)
Coeff. residuals of CF	-0.0509**	-0.253***	-0.191*	-0.143*
	(0.0196)	(0.0704)	(0.0946)	(0.0764)
Control variables	YES	YES	YES	YES
Year dummy and country fixed effect	YES	YES	YES	YES
Constant	YES	YES	YES	YES
Observations	68	212	169	111
Number of id	8	22	20	15
R-squared	0.737	0.246	0.237	0.285
Wald test - H0: All coefficient = 0	0.0000	0.0000	0.0000	0.0000

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Result of Wald test refers to p-value.

Table C9. Results of fixed-effects regression: Testing inverse causality

Variables	Y = Log(Risk Finance)
Log(Risk Finance) in T-1	-0.0404
	(0.0655)
Log(BerdByBus) in T-1	0.196
	(0.285)
△Log(GVA) in T	-0.639
	(2.092)
Log(BerdByGov) in T-1	-0.208
	(0.402)
Log(GovRd) in T-1	0.506
	(0.503)
Log(HeRd) in T-1	-0.153
	(0.701)
Log(B-Index) in T-1	-3.317*
	(1.801)
Year dummy	YES
Country fixed effect	YES
Constant	-1.193
	(3.942)
Observations	252
Number of id	28
R-squared	0.086
Wald test - H0: All coefficient = 0	0.0000

Source: Authors' own elaboration.

Note: Robust and clustered standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1. Results of validation test refer to p-value.

WORKING PAPERS 2013

001 - Exploring europe's r&d deficit relative to the us: differences in the rates of return to r&d of young leading r&d firms - Michele Cincera and Reinhilde Veugelers

002 - Governance typology of universities' technology transfer processes - A. Schoen, B. van Pottelsberghe de la Potterie, J. Henkel.

003 - Academic Patenting in Belgium: Methodology and Evidence – M. Mejer.

004 - The impact of knowledge diversity on inventive performance at European universities – M. Mejer

005 - Cross-Functional Knowledge Integration, Patenting and Firm's Performance – M. Ceccagnoli, N. van Zeebroeck and R. Venturini.

006 - Corporate Science, Innovation and Firm Value, M. Simeth and M. Cincera

WORKING PAPERS 2014

007 - Determinants of Research Production at top US Universities – Q. David.

008 - R&D financing constraints of young and old innovation leaders in the EU and the US – M. Cincera, J. Ravet and R. Veugelers

009 - Globalization of Innovation Production; A Patent-Based Industry Analysis – J. Danguy

010 - Who collaborates with whom: the role of technological distance in international innovation – J. Danguy

WORKING PAPERS 2015

011 - Languages, Fees and the International Scope of Patenting – D. Harhoff , K. Hoisl, B. van Pottelsberghe de la Potterie , C. Vandeput

012 - How much does speed matter in the fixed to mobile broadband substitution in Europe? – M. Cincera, L. Dewulf, A. Estache

013 - VC financing and market growth – Interdependencies between technology-push and market-pull investments in the US solar industry – F. Schock, J. Mutl, F. Täube, P. von Flotow

014 - Optimal Openness Level and Economic Performance of Firms: Evidence from Belgian CIS Data – M. Cincera, P. De Clercq, T. Gillet

015 - Circular Causality of R&D and Export in EU countries – D. Çetin, M. Cincera.

016 - Innovation and Access to Finance – A Review of the Literature – M. Cincera, A. Santos.

WORKING PAPERS 2016

017 - Effectiveness of Government intervention in the SME sector: Evidence from the Brussels-Capital Region – G. E. Fombasso, M. Cincera.

018 - A review of corporate R&D intensity decomposition – P. Moncada-Pastemò-Castello.

019 - The laws of action and reaction: on determinants of patent disputes in European chemical and drug industries – R. Kapoor, N. van Zeebroeck.

020 - How do the normativity of headquarters and the knowledge autonomy of subsidiaries co-evolve? – M. Hansmans, G. Liu.

WORKING PAPERS 2017

021 - The case for offensive strategies in response to digital disruption – J. Bughin, N. van Zeebroeck.

022 - Access to finance as a pressing problem: Evidence from innovative European firms – A. Santos, M. Cincera.

023 - Platform play among incumbent firms: the wrong focus? – N. van Zeebroeck, J. Bughin.

024 - Social Movements – M. Hensmans, K. van Bommel.

025 - Decoding Patent Examination Services – L. Gimeno-Fabra, B. van Pottelsberghe de la Potterie.

026 - Countries Attractiveness: an Analysis of EU Firms's Decisions to (De) Localize R&D Activities – M. Cincera, A. Santos.

WORKING PAPERS 2018

027 - The impact of EUREKA projects on the economic performance of R&D SMEs – M. Cincera, G. Fombasso.

028 - Forecasting short-term transaction fees on a smart contracts platform – C. Hoffreumon, N. van Zeebroeck.

029 - Sharing the risk of innovative investment: Assessing the effect of new European financing instrument - M. Cincera, A. Santos.

030 - Academic scientists: The golden opportunity for high-tech companies – L. Dewulf, M. Cincera.