Innovation Activity under Nexus Requirements*

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Abstract

I investigate corporate innovation under changing tax incentives. Exploiting granular data on innovation activity and the introduction of nexus requirements to patent boxes across Europe, I find that curbing beneficial tax treatment of innovation *output* can reduce innovation *activity*.

ANALYSES RELY ON SCIENTIFIC USE-FILES (SUF) OF EUROSTAT CIS DATA: PRELIMINARY RESULTS! DO NOT CITE OR DISTRIBUTE!

Keywords: International Business Taxation, Nexus Requirement, Patent Box, Innovation
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*This study is based on data from Eurostat, the Community Innovation Survey (CIS) of 2010-2018 (Project ID 2023/83-CIS). The responsibility of all conclusions drawn from the data lies entirely with the author.

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Summary

Incentivizing firm innovation is a central objective of economic policy. One commonly adopted instrument in Europe is the patent box (also referred to as an "IP box"), which grants preferential tax treatment to income derived from intellectual property (IP). However, because IP is also central to profit shifting, governments have implemented measures to counteract "harmful" tax avoidance, including restrictions to patent box regimes. This raises an important question: how does tightening access to preferential tax regimes through anti–tax avoidance rules affect firms' innovation? In this paper, I show that that curbing preferential tax treatment of innovation output reduces innovation activity.

I analyze innovation responses to the OECD's "Agreement on Modified Nexus Approach for IP Regimes", under which countries agreed in late 2014 to modify patent boxes to the extent that they solely give preferential tax treatment to income that exploits IP when inventive activity is in line with the *modified nexus approach*. In essence, nexus compliance requires co-location of the inventive activity (input) and the exploited IP (output). A key challenge in analyzing corporate innovation under changing tax incentives lies in "accurately measuring and capturing innovative investment" (Lester, 2021). To address this challenge, I employ granular Eurostat data from the Community Innovation Survey (CIS) that covers a "wide range of activities that enterprises undertake in order to implement innovation processes, to develop new products and services, and to deliver them to the market" (Eurostat, 2021).

The CIS is biannually performed by the member states of the European Union, and is generally populated with stratified samples of all enterprises with 10 or more employees (see Regulation (EU) No 995/2012 and Regulation (EU) 2019/2152). It defines innovation to the firm as the introduction of new or significantly improved products, services, or processes and thus captures corporate innovation comprehensively. (For a discussion of the advantages and disadvantages of the CIS measures see Breuer et al. (2025).) To empirically identify the effects of nexus requirements for IP boxes on corporate innovation, I estimate difference-in-

differences regressions. The outcome of interest is the indicator variable *Innovating Firm* that equals one when firms introduce innnovation as defined above. (Summary statistics are not tabulated here to avoid de-anonymization of observations in CIS.) Information on countries with nexus compliant patent boxes come from reports by the code of conduct group for business taxation at the European Union[1] (i.e., indicator variable *Nexus*). Since nexus requirements became broadly applicable from 2016 on, *Post* equals one for CIS 2016 and 2018. I regress *Innovating Firm* on *Nexus* × *Post*, control variables, and country and CIS (i.e., year) and industry fixed effects.

Table 1: Innovation under Nexus Requirements

	Innovating Firm	
	(1)	(2)
Nexus × Post	-0.0357***	-0.0345***
	(0.0089)	(0.0088)
Employment Growth (z)		0.0014
		(0.0009)
Turnover (z)		0.0273***
		(0.0100)
Turnover Growth (z)		0.0049***
		(0.0010)
Group		0.1199***
		(0.0082)
Country fixed effects	✓	✓
CIS fixed effects	✓	✓
NACE fixed effects	✓	✓
Observations	447,213	447,213
Adjusted R^2	0.13291	0.14934

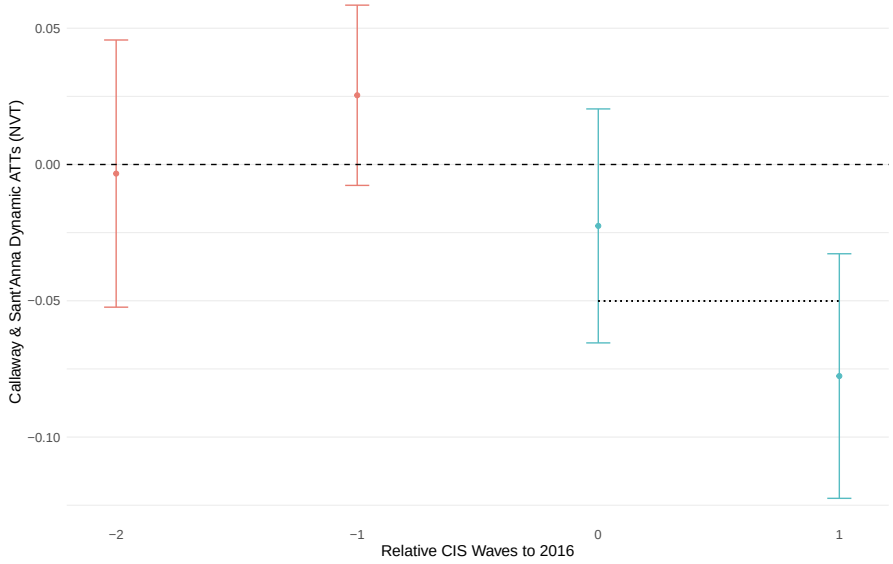
Notes: This table reports OLS estimates from regressions with *Innovating Firm* as dependent variable, which is an indicator variable equal to one for firms that introduce new or significantly improved products, services, or processes. Nexus is an indicator variable for countries that introduce a nexus conform patent box. Post equals one for CIS waves from 2016 on. Standard errors in parentheses are clustered at the Country × NACE level. Stars denote significance at the *** 1%, ** 5%, * 10% levels; (z) denotes standardization at mean zero and standard deviation one.

The ATTs displayed in Table 1 suggest that tightening access to the preferential tax

[1]This working group was established to identify potentially harmful tax measures. Their reports are available here.

regime is estimated to reduce the probability that a firm innovates by about 3.5 percentage points, and the effect is statistically strong.[2] Hence, curbing profit shifting may unintentionally dampen genuine innovation activity, underscoring the need to balance enforcement with incentives for R&D.

Figure 1: Dynamic Effects



This figure depicts results from an event study applying the technique by Callaway and Sant'Anna (2020) for DiD. The dependent variable is *Innovating Firm*, which is an indicator variable equal to one for firms that introduce new or significantly improved products, services, or processes. Points mark the estimates, the error bars cover the 95% confidence intervals, and the dotted line marks the aggregated ATT estimate.

To analyze dynamic effects, I apply the technique by Callaway and Sant'Anna (2020) for DiD and depict three takeaways in Figure 1. Firstly, the aggregated ATT using this technique also suggests a negative impact of nexus requirements on innovation activity. Secondly, I find no evidence of a violated parallel-trend assumption in the pre-period. Finally, the effect becomes more negative from 2016 to 2018, consistent with transitory effects in the policy's impact.

Next, I collapse the data to the Country × NACE × CIS level following Breuer et al.

[2]When employing a logit model as alternative, I identify marginal effects that are consistent with the tabulated OLS estimates in Table 1. When weighing the regressions with sample weights provided by Eurostat, estimates remain negative and statistically significant.

(2025). In column (1) of Table 2, I repeat the main analysis, using the simple average of *Innovating Firm* per cell as the outcome, and find results consistent with those in Table 1. In column (2), I consider *counts* of innovators at the country–industry–year level, estimate a Poisson model, and observe a negative and significant coefficient. This pattern is consistent with the policy reducing innovation on the extensive margin, i.e., decreasing the number of firms that engage in innovation at all. Since CIS data also contain information on the share of innovation spending relative to total turnover for innovating firms, I estimate a DiD regression with the cell-level average *Inn. Spend Avg.* as the outcome in (3). I find significant reductions in firms' innovation spending, an outcome that closely reflects innovation input, implying that resources devoted to innovation decrease under nexus requirements.

Table 2: Aggregated Data

	Inn. Firm Avg.	***Inn. Firm Tot.***	***Inn. Spend Avg.***
	(1)	(2)	(3)
	OLS	Poisson	OLS
Nexus × Post	-0.0250**	-0.1298***	-0.0266*
	(0.0120)	(0.0386)	(0.0137)
Controls	✓	✓	✓
Country fixed effects	✓	✓	✓
CIS fixed effects	✓	✓	✓
NACE fixed effects	✓	✓	✓
Observations	1,199	1,199	1,166
Adjusted R^2	0.77397		0.45571

Notes: This table reports regression estimates that employ different dependent variables and estimators. Data for these analyses are collapsed at the Country × NACE × CIS level. In (1), the dependent variable is the average of *Innovating Firm* per Country × NACE × CIS. In (2), the dependent variable is the total number/sum of *Innovating Firm* = 1 observations per Country × NACE × CIS, with the estimates relying on Poisson regression. In (3), the dependent variable is the average of the ratio of innovation expenses to a firm's total turnover per Country × NACE × CIS. Nexus is an indicator variable for countries that introduce a nexus conform patent box. Post equals one for CIS waves from 2016 on. Standard errors in parentheses are clustered at the Country × NACE level. Stars denote significance at the *** 1%, ** 5%, * 10% levels; (z) denotes standardization at mean zero and standard deviation one.

Because the nexus approach limits the share of outsourced innovation expenditures that qualify for preferential treatment, the policy is expected to affect contracted-out R&D more

than in-house R&D. Using CIS data items on external and in-house inventive activities, Table 3 shows that external inventive activity declines relative to in-house activity, suggesting that the policy disproportionately reduces outsourced innovation. Taken together, these results indicate that nexus requirements not only lower the likelihood and intensity of innovation but also alter how firms organize innovation, ultimately reducing collaboration and experimentation outside the firm.

Table 3: External Innovation Activities

	Ext./InH (1)	***Ext./N*** (2)	***Ext./Inn.*** (3)
Nexus × Post	-0.0423***	-0.0154***	-0.0496***
	(0.0122)	(0.0056)	(0.0186)
Controls	✓	✓	✓
Country fixed effects	✓	✓	✓
CIS fixed effects	✓	✓	✓
NACE fixed effects	✓	✓	✓
Observations	1,152	1,162	1,162
Adjusted R^2	0.43342	0.71422	0.51791

Notes: This table reports OLS estimates. Data for these analyses are collapsed at the Country × NACE × CIS level. In (1), the dependent variable is the share of the total number/sum of firms that engage in external research and development activities (numerator) over the sum of the numerator and the total number/sum of firms that engage in in-house research and development activities (denominator). In (2), the denominator changes to the count of observations per Country × NACE × CIS. In (3), the denominator changes to the total number/sum of *Innovating Firm* = 1 observations per Country × NACE × CIS. Standard errors in parentheses are clustered at the Country × NACE level. Stars denote significance at the *** 1%, ** 5%, * 10% levels; (z) denotes standardization at mean zero and standard deviation one.

Analyzing the introduction of the nexus requirements to patent boxes primarily contributes to the insights on the real effects of these regimes. With some research critical of the effectiveness of patent boxes (Haufler and Schindler, 2023; Ciaramella, 2023; Gaessler et al., 2021), firms are found to acquire IP through acquisitions when patent boxes are introduced (Bradley et al., 2021), which might explain increases in regime-eligible innovation-output (e.g., see Bornemann et al. (2023) who document innovation increases in Belgium). Lester

(2021) asks whether "requiring nexus in this context "bad" (because it limits the investment response) or "good" (because it requires real activity in exchange for tax benefits)?" and adds that "more evidence that incorporates data from years after implementation of the new nexus requirements is necessary to better evaluate this policy design." Relying on novel, comprehensive, and large-scale data on firms' innovation across the European Union (as recently also brought forward by Breuer et al. (2025)), I show that curbing beneficial tax treatment of innovation *output* reduces innovation *activity*. This key finding expands analyses by Boie-Wegener (2024), Schwab and Todtenhaupt (2021), and Chen et al. (2023) on employment effects and patent protected knowledge. Overall, my study demonstrates that anti–tax avoidance measures can alter not just the scale, but also the organization, of innovative activity.

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