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DOI: 10.35765/HP.2690

Horyzonty Polityki
2026, Vol. 17, N° 58
OPEN ACCESS

Public Support, Innovation and Productivity in Polish Manufacturing: Evidence from an Extended CDM Model

Abstract

RESEARCH OBJECTIVE: This paper examines whether public financial support strengthens the R&D-innovation-productivity nexus in Polish manufacturing firms.

THE RESEARCH PROBLEMS AND METHODS: Building on Crépon-Duguet-Mairesse framework (1998) (hereafter CDM model) and its extension by Busom & Vélez-Ospina (2017), we estimate a multi-stage model that incorporates public support as a determinant of innovation investment. The analysis uses survey data from 1049 Polish manufacturing firms covering the period 2015–2017, combined with financial information from the Orbis database.

THE PROCESS OF ARGUMENTATION: The paper conceptualize public support as a factor potentially affecting each stage of the innovation process: investment in innovation activities, the probability of introducing innovation, and subsequent labour productivity – the empirical model tests whether public funding reinforces these sequential links.

RESEARCH RESULTS: Public support significantly increases innovation expenditure intensity but does not affect the decision to engage in innovation. Innovation inputs stimulate product, process, and marketing innovation; however, none of these innovation outputs translates into higher labour productivity.

CONCLUSIONS, INNOVATIONS, AND RECOMMENDATIONS: The findings indicate the presence of input and output additionality, but no

Suggested cittation: Zabłocka-Abi Yaghi, A. (2026). Public Support, Innovation and Productivity in Polish Manufacturing: Evidence from an Extended CDM Model. *Horizons of Politics*, *17*(58), 385–401. DOI: 10.35765/HP.2690.

evidence of productivity additionality. This suggests a structural limitation in translating innovation into performance gains. The study contributes firm-level evidence from Poland and highlights the need for policy instruments that strengthen the productivity effects of innovation.

Keywords:
CDM model, public support, R&D, innovation, labor productivity, Poland

INTRODUCTION

Innovation is widely recognised as a key driver of long-term economic growth. In the Schumpeterian "Mark II" tradition, innovation emerges within established firms shaped by competitive and institutional conditions (Freeman et al., 1982). In catching-up economies, however, the relationship between innovation efforts and productivity may differ from what is observed in advanced countries.

Microeconometric evidence based on the CDM model (Crepon, Duguet, & Mairesse, 1998) confirms a positive link between R&D, innovation output, and productivity in high-income economies. Yet findings for Central and Eastern European Countries (CEECs) remain mixed, suggesting that the transmission from innovation to productivity may be structurally weaker in post-transition contexts.

Public financial support has become a central instrument of EU innovation policy, particularly in cohesion economies. Cross-country studies point to substantial heterogeneity in its effectiveness, while firm-level evidence from Poland remains scarce. This leaves open the question of whether public support strengthens the R&D-innovation-productivity mechanism in the Polish economy.

This paper addresses this gap by estimating an extended CDM model for 1049 Polish manufacturing firms. Building on Crépon, Duguet and Mairesse (1998) and incorporating public financial support as a determinant of innovation investment, we examine whether public funding reinforces the innovation-productivity nexus in a catching-up economy. The results indicate that public support increases innovation expenditure intensity, but does not significantly affect the likelihood of introducing innovation, nor does innovation input translate into higher labour productivity.

By providing micro-level evidence from Poland, the study contributes to the literature on innovation and productivity in post-transition economies. It offers an insight into the functioning of public innovation support within the CDM framework.

THE RESEARCH PROBLEMS AND METHODS

The growing availability of firm-level microdata has enabled structural analyses of the innovation-productivity nexus. Earlier studies embedded R&D within a standard production function, treating it as a direct input to output. However, such approaches overlooked the sequential nature of the innovation process.

The CDM framework addresses this limitation by modelling innovation as a three-stage process linking innovation inputs, outputs, and productivity. The first stage captures firms' engagement in innovation and their investment intensity; the second estimates a knowledge production function; the third evaluates the impact of innovation output on productivity.

While empirical applications for high-income economies generally confirm a positive innovation-productivity relationship, evidence for Central and Eastern European countries (CEECs) remains mixed. Masso and Vahter (2008), Hashi and Stojčić (2013) and Ramadani et al. (2019) report positive links between innovation inputs and performance, whereas Tevdovski et al. (2017), Disoska et al. (2020), Toshevska-Trpchevska et al. (2019), and Zabłocka-Abi Yaghi and Tomaszewski (2024) find weak or insignificant productivity effects. These discrepancies suggest that the transmission of innovation to productivity may depend on structural and institutional conditions.

As argued by Slavo Radosevic (2022), post-socialist restructuring of firms and strong integration into multinational production networks often limited the endogenous development of R&D capabilities in CEECs. Consequently, many studies adapted the original CDM specification by using broader innovation expenditure measures and survey-based indicators of product, process, marketing, or organizational innovation, rather than patent applications.

Recent research further highlights contextual moderators. Fedyunina and Radosevic (2022) stress the importance of technology-upgrading paths in middle-income economies, while Poszytek et al. (2023) and Guzmán Cofré et al. (2023) emphasize the roles of collaboration, digital competences, and firm heterogeneity.

Cross-country evidence on public support adds another layer. Lewandowska et al. (2022) document heterogeneous additional effects across EU Member States, with limited productivity additionality in several CEECs. Foreman-Peck and Zhou (2022) show that structural constraints may limit the productivity impact of the EU subsidies in cohesion economies.

Despite this growing literature, firm-level evidence from Poland within a structural CDM framework remaines scarce. Our study therefore, estimates an extended CDM model for Polish manufacturing firms. Following Busom and Vélez-Ospina (2017), public financial support is incorporated as a determinant of innovation investment. The analysis combines survey data for 2015–2017 with financial information from Orbis to assess whether public support reinforces the sequential innovation-productivity mechanism.

RESEARCH METHODOLOGY

Our analysis is based on a 2018 survey of 1049 Polish manufacturing firms, selected from the InfoCredit (Orbis) database to ensure sectoral and regional representativeness. Due to low response rates via Computer-Assisted Web Interviewing (CAWI), direct engagement with managers was employed to secure full responses. Survey data were supplemented with financial information from Orbis.

We adopt the extended CDM framework proposed by Busom and Vélez-Ospina (2017), which incorporates firms' access to public funding as a selection mechanism affecting innovation investment. Our model examines five interrelated stages:

1. Access to public support for innovation;
2. Decision to invest in R&D&I;
3. R&D&I investment intensity;
4. Innovation output;
5. Labor productivity as a function of innovation output.

The first equation represents firms' access to the public support for business innovation:

$$S_i = \begin{cases} 1 \quad if\ S_i^* = \sum x_{0i}\ \beta_0 + \varepsilon_i > c \\ 0 \quad if\ S_i^* = \sum x_{0i}\ \beta_0 + \varepsilon_i \leq c \end{cases}$$

Where:
S_i is a binary variable indicating whether a firm has received public support for R&D&I.
x_{0i} are explanatory variables,
β_0 are coefficients for specific explanatory variables,
ε_i is the error term.

This equation assesses firms' eligibility for public support, considering factors such as exporter status, company size (SME), abandoned or ongoing innovations, and the Herfindahl-Hirschman Index (HHI). We employ a probit model to estimate this equation using the entire sample of enterprises.

The following two equations represent firms' engagement in R&D&I: the decision to invest in R&D&I (D_{rd}) and the intensity of R&D&I expenditures (Inn_{input}).

$$D_{RDi} = \begin{cases} 1 \quad if\ D_{RD\ 0,i}^* = fS_i + \sum x_{1i}\ \beta_1 + \varepsilon_{1i} > \tau \\ 0 \quad if\ D_{RD\ 0,i}^* = fS_i \sum x_{1i}\ \beta_1 + \varepsilon 1_i \leq \tau \end{cases}$$

$$Inn_{input\ i} = \begin{cases} Inn_{input\ i}^* = fS_i + \sum x_{2i}\ \beta_2 + \varepsilon_{2i}\ if D_{RDi} = 1 \\ \qquad = 0 \quad if\ D_{RDi} = 0 \end{cases}$$

These equations are simultaneously estimated using the Heckman model. The dependent variable D_{RDi} indicates whether firms invest in innovative activities, and the continuous variable Inn_{input} quantifies their R&D&I expenditures. Independent variables include exporter status, cooperation in innovative activities, patent applications, foreign ownership, market activities, CEO age group, and the predicted probability of receiving public R&D and I support (S_i). The equation modelling the extent of firms' investment in innovation is linked to the estimated probability of public support (S_i), exporter status, employee skill level, capital group affiliation, engagement in cooperative innovative activities, and the regular introduction of innovations.

This approach enables a comprehensive examination of the determinants of firms' decisions to invest in R&D and the magnitude of these investments, accounting for both firm-specific characteristics and the potential impact of public support.

In the subsequent stage, we estimate a probit equation to capture a firm's propensity to introduce innovations.

$$Inn_{output\ i} = \begin{cases} 1 & if\ Inn^*_{outputi} = \alpha_1 Inn^*_{input} + \sum x_{3i}\ \beta_3 + \varepsilon_{3i} > 0 \\ 0 & if\ Inn^*_{output\ i} = \alpha_1\ Inn^*_{input} + \sum x_{3i}\ \beta_3 + \varepsilon_{3i} \leq 0 \end{cases}$$

We analyse four types of innovation: product, process, organisational, and marketing, by estimating probit models for each. Each model incorporates the predicted innovation input value from the previous stage. The independent variables included in each estimation vary to capture the specific factors influencing firms' introduction of each type of innovation.

Finally, we estimate labour productivity, assuming its dependence on the estimated likelihood of innovation introduction and other firm characteristics denoted by x_4:

$$y_i = \alpha_0 + \alpha_1 Inn^*_{ouput\ i} + \beta_4 x_{4i} + \varepsilon_{4i}$$

We conduct four separate OLS estimations, each focusing on Inn_{output}^* representing the predicted value of one of four types of innovations. The other variables include firm age (in logs), exporter status, location in Warsaw, and physical capital (tangible fixed assets in logs).

All variables used in the model, along with their respective explanations and statistics, are presented in the tables 1–3.

Table 1. Explanation of variables

Variable	Souces	Description
HHI	Orbis	A market concentration in 2017 (Herfindahl-Hirschman Index)
Age (ln)	Orbis	A company's age in 2017
EMPSKILL (ln)	survey	Percentage of employees with a tertiary degree in 2017
Innovation expenditu-re (ln)	survey	Total spending (2015–2017) on in-house and external R&D, machinery, equipment, software & buildings, knowledge acquisition, and other innovation-related activities (design, training, marketing, and other)
Physical capital (ln)	Orbis	Physical capital in 2017
Labor productivity (ln)	Orbis	Labor productivity – sales per worker in 2017
R&D State Aid	survey	1 if the company received public R&D&I support (local/regio-nal, national, or EU) from 2015 to 2017, otherwise 0
Export	survey	1 if the company had export sales in 2015, otherwise 0
SME	survey	1 if the company is classified in 2017 as a small or medium-si-zed enterprise according to the EU definition, and is included in the Orbis database (i.e. registered with KRS), otherwise 0. The sample therefore excludes many micro-enterprises witho-ut KRS reporting obligations.
Patent applications	survey	1 if the company applied for a patent between 2015 and 2017, otherwise 0
City WAW	survey	1 if the company's headquarters is in Warsaw, otherwise 0
Product innovation	survey	1 if the company introduced a product innovation (2015–2017), otherwise 0
Process innovation	survey	1 if the company introduced a process innovation (2015–2017), otherwise 0
Organisational innovation	survey	1 if the company introduced an organisational innovation (2015–2017), otherwise 0
Marketing innovation	survey	1 if the company introduced a marketing innovation (2015–2017), otherwise 0
Cooperation	survey	1 if the company engaged in innovative cooperation (2015–2017), otherwise 0
Group	survey	1 if the company is part of a larger capital group, otherwise 0
Foreign	survey	1 if the company has a foreign investor, otherwise 0
Regular R&D	survey	1 if the company has permanently changed its product range, production processes, or organisation, otherwise 0
National market	survey	1 if the company sold goods/services in national markets (2015–2017), otherwise 0
European market	survey	1 if the company sold goods/services in European markets (2015–2017), otherwise 0
All other countries	survey	1 if the company sold goods/services in other than European markets (2015–2017), otherwise 0
Abandoned or ongo-ing innovations	survey	1 if the company abandoned, suspended, or has ongoing inno-vation activities (2015–2017), otherwise 0
CEO age group	survey	Categorical variable for CEO's age group (one of five categories)

Table 2. Descriptive statistics of continuous variables

Variable	Obs	Mean	Std. Dev.	Min	Max
HHI	1,049	165.5965	160.1623	0	3023.88
Age (ln)	1,049	2.600927	.8933262	0	5.298317
EMPSKILL (ln)	623	3.025584	1.061761	.6931472	4.60517
Innovation expenditure (ln)	383	11.87096	1.674142	7.600903	14.7318
Physical capital (ln)	955	7.683509	2.56612	2.995732	13.71247
Labor productivity (ln)	721	5.814172	.9649186	1.609438	10.3338

Table 3. Descriptive statistics of dichotomous variables

Variable	Obs	0	1
R&D State Aid	1,049	941	108
Export	1,049	591	458
SME	1,049	80	969
Patent applications	1,049	994	55
City WAW	1,049	954	95
Product innovation	1,049	519	530
Process innovation	1,049	689	360
Organisational innovation	1,049	841	208
Marketing innovation	1,049	759	290
Cooperation	1,049	857	192
Group	1,049	883	166
Foreign	1,049	946	103
Regular R&D	1,049	995	54
National market	1,049	46	1003
European market	1,049	361	688
All other countries	1,049	798	251
Abandoned or ongoing innovations	1,049	802	247
CEO age group: 1 – up to 40 2 – between 41–45 3 – between 46–50 4 – between 51–60 5 – more than 61	1,049: 75 225 367 191 191		

Descriptive statistics indicate substantial variation in innovation activities and firm characteristics. Continuous variables exhibit wide dispersion, reflecting heterogeneity in firm capabilities and market conditions. The chosen methodology allows us to account for firm heterogeneity, selection effects, and the specific structural characteristics of Polish manufacturing, while tracing the sequential influence of public support on innovation inputs, innovation outputs, and productivity.

RESEARCH RESULTS

The empirical evidence confirms a sequential but incomplete additionality mechanism in Polish manufacturing firms (see Table 4). Exporter status, firm size, and ongoing or abandoned innovation activities increase the likelihood of receiving public R&D&I support. The economic magnitude of these effects indicates that funding is concentrated among firms already structurally advantaged in scale and market access. Compared with other CDM-based studies in catching-up economies (Busom & Vélez-Ospina, 2017; Masso & Vahter, 2008; Tevdovski et al., 2017), this allocation pattern is not unusual; however, in Poland, the concentration is particularly strong, suggesting limited redistribution toward financially constrained firms.

Table 4. Results of the public financial support equation

R&D State Aid		
	Coefficient (s.e.)	**Marginal Effects**
Export	0.454*** (0.12)	0.073***
SME	−0.747*** (0.17)	−0.170**
HHI	0.001* (0.00)	0.0001*
Abandoned or ongoing innovations	0.447*** (0.12)	0.081**
Constant	−1.116*** (0.19)	
Number of observations	1,049	
LR chi2 (4)	77.552	
Prob > chi2	0.0000	
Log likelihood	−308.99704	
Pseudo R2	0.1115	

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001.

The second stage of the model (see Table 5) confirms that public support does not increase the probability of engaging in innovation activities but significantly raises the intensity of R&D&I expenditure. This reinforces the interpretation that policy instruments scale up existing innovation efforts rather than activate new innovators. Compared with the evidence from other CEECs and emerging economies (Masso & Vahter, 2008; Tevdovski et al., 2017; Busom & Vélez-Ospina, 2017), where broader activation effects are sometimes observed, the Polish case reflects the reinforcement of established innovation trajectories rather than the expansion of the innovation base.

Market orientation plays a differentiated role. Exporters are more likely to engage in R&D&I, consistent with the competition-driven innovation hypothesis documented by Kahn et al. (2022) and Crespi & Zuniga (2012). Activity in non-European markets further strengthens this propensity, while orientation toward European markets is negatively associated with innovation decisions – a result also noted, though insignificantly, by Hashi & Stojčić (2013). In contrast, domestic market orientation positively correlates with R&D&I engagement (in line with Hashi & Stojčić (2013), Disoska et al. (2020), and Tevdovski et al. (2017)), suggesting that competitive pressures in the national market remain a relevant drive of innovation in Polish manufacturing.

Cooperation increases the likelihood of undertaking innovation but does not raise R&D&I expenditure intensity. This pattern, frequently observed in CEECs and other emerging economies (Tevdovski et al., 2017; Masso & Vahter, 2008; Crespi & Zuniga, 2012), is typically attributed to weak innovation networks (Crespi & Zuniga, 2012) and limited depth of collaboration (Tevdovski et al., 2017), particularly between firms and research institutions (Masso & Vahter, 2008). Managerial characteristics also matter: firms led by older CEOs display a higher propensity to innovate than those led by younger CEOs, potentially reflecting accumulated experience and risk assessment capacity (You et al., 2020; Worthy et al., 2011). Interestingly, submitting patent applications reduces the probability of engaging in further innovation, suggesting that formal knowledge appropriation substitutes for subsequent R&D efforts.

Regarding innovation intensity, belonging to a capital group and a higher share of tertiary-educated employees are associated with lower R&D&I expenditure. These findings diverge from several CEEC and emerging-market studies (Hashi & Stojčić, 2013; Ramadani et al., 2019; Busom & Vélez-Ospina, 2017), and may reflect internal resource allocation within capital groups and structural specificities of Polish manufacturing, where formal human capital does not necessarily translate into higher R&D spending.

The knowledge-production function (see Table 6) further reveals that innovation expenditure significantly increases the probability of product, process, and marketing innovations, but not organisational innovation, indicating that non-technological innovation follows a different logic than formal R&D investment. Complementarities between innovation types are strong and multidirectional: process and organisational innovation reinforce product and marketing innovation and vice versa, suggesting bundled innovation strategies rather than isolated activities (Danneels, 2002; Mothe & Thi, 2010; Rust et al., 2012).

Table 5. Results of the selection and innovation intensity equations

	Decision (selection)	**Innovation expenditure (ln)**
R&D State Aid ^{pred}	0.980 (1.36)	3.651** (2.95)
Export	0.467*** (3.42)	0.903*** (4.27)
Cooperation	0.740*** (6.05)	−0.278 (−1.24)
EMPSKILL		−0.184* (−2.37)
Group		−1.666*** (−5.76)
Regular R&D		0.580 (1.54)
Constant		12.24***(31.13)
Patent applications	−0.837*** (−3.90)	
Foreign	−0.261 (−1.78)	
National market	1.127*** (3.85)	
European market	−0.268* (−2.25)	
All other countries	0.335** (2.93)	
CEO age group:		
– group 1.	0 (.)	
– group 2.	0.334 (1.67)	
– group 3.	−0.300 (−1.53)	
– group 4.	0.670*** (3.43)	
– group 5.	0.847*** (4.28)	
Constant	−2.158*** (−6.04)	
/mills		
lambda	−0.492* (−2.00)	
Number of observations	989	
Selected	323	
Nonselected	666	

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001

Ownership structure introduces additional heterogeneity. Foreign-owned firms show a higher propensity for product and marketing innovation but a lower likelihood of process and organisational innovation, consistent with multinational firms adapting products to local markets while relying on headquarters-based technological capabilities. Exporter status negatively affects certain technological innovations, possibly reflecting the relatively low R&D intensity of exported goods (Crespi & Zuniga, 2012).

Table 6. Results of the innovation output equations

	Product innovation		Process innovation		Organisational innovation		Marketing innovation	
	Coeff. (s.e)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects	Coeff. (s.e.)	Marginal effects
Innovation expenditure predict	1.784*** (6.29)	0.688***	0.701*** (6.74)	0.270***	−0.0421 (−0.18)	−0.0094 (−0.05)	0.515*** (5.95)	0.200***
EMPSKILL	0.206** (2.69)	0.080**					0.315*** (5.41)	0.120***
Export	−2.764*** (−7.23)	−0.746***			0.635 (1.96)	0.141* (0.071)		
Foreign	0.909*** (4.91)	0.302***	−0.580** (−3.12)	−0.210**	−1.294*** (−5.13)	−0.288*** (0.052)	0.366* (2.30)	0.143*
Group	1.710*** (3.97)	0.430***	1.736*** (5.93)	0.574***	1.048* (2.30)	0.2332* (0.101)		
Process innovation	0.815*** (6.30)	0.300***			0.259 (1.79)	0.058 (0.032)	0.617*** (4.59)	0.236***
Organisational innovation	1.050*** (7.11)	0.362***	0.267 (1.71)	0.104			0.984*** (7.38)	0.380***
Product innovation			0.774*** (5.59)	0.290***	0.945*** (6.21)	0.210*** (0.031)		
Marketing innovation			0.757*** (5.35)	0.290***	1.093*** (8.04)	0.243*** (0.025)		
Cooperation			1.838*** (10.37)	0.633***			−0.447** (−2.96)	−0.163**
SME			0.498 (1.70)	0.180	−0.810* (-2.56)	−0.180** (0.069)	0.443* (1.99)	0.156*
_cons	−21.87*** (−6.23)		−10.85*** (−7.50)		−0.884 (−0.31)		−8.594*** (−7.22)	
Number of observations LR chi2 Prob > chi2 Log likelihood Pseudo R2	623 187.87 0.0000 −333.1264 0.2200		623 299.11 0.0000 −271.60120.3551		623 259.29 0.0000 −251.00800.3406		623 198.00 0.0000 −321.00390.2357	

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001

The final stage of the CDM model (Table 7) indicates that there is no statistically significant relationship between innovation outputs and labour productivity in Polish manufacturing firms. Instead, productivity is primarily driven by tangible capital and metropolitan location (Warsaw), while firm age and exporter status are negatively associated with productivity. The absence of innovation's impact on productivity aligns with several CDM applications in catching-up economies (Raffo et al., 2008; Benavente, 2006; Masso & Vahter, 2008; Disoska et al., 2020; Tevdovski et al., 2017; Crespi & Zuniga, 2012), although in contrast with findings for Colombia (Busom & Vélez-Ospina, 2017). Even when short lags are introduced (firms' labour productivity in 2018 and 2019), results remain unchanged. Overall, the evidence supports input and output additionality but not productivity additionality for Polish manufacturing firms.

Table 7. Results of the productivity equations

	Labor productivity (ln)	**Labor productivity (ln)**	**Labor productivity (ln)**	**Labor productivity (ln)**
Product innovation predicted	−0.111 (−1.64)			
Process innovation predicted		−0.227 (−1.44)		
Organisational innovation predicted			−0.164 (−0.95)	
Marketing innovation predicted				−0.00860 (−0.04)
Age (ln)	−0.279*** (−5.54)	−0.226*** (−3.50)	−0.230*** (−3.54)	−0.226*** (−3.49)
Physical capital	0.127*** (8.61)	0.119*** (6.18)	0.119*** (6.17)	0.118*** (6.13)
Export	−0.239*** (−3.50)	−0.182 (−1.74)	−0.209* (−2.02)	−0.253* (−2.25)
City WAW	0.326** (2.75)	0.531** (3.28)	0.525** (3.24)	0.518** (3.18)
_cons	5.748*** (33.47)	5.664*** (24.89)	5.648*** (24.82)	5.626*** (24.51)
N	679	399	399	399
Prob > F	0.0000	0.0000	0.0000	0.0000
R-squared	0.1419	0.1416	0.1391	0.1371
Adj R-squared	0.1356	0.1307	0.1281	0.1261

t statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001

CONCLUSION AND RECOMMENDATIONS

The study provides evidence that public R&D&I support in Polish manufacturing generates input and output additionality but fails to translate into measurable productivity gains. Public funding increases the intensity of innovation expenditures. It strengthens the likelihood of technological and marketing innovation, yet it does not expand the pool of innovators nor produce statistically significant improvement in labour productivity. The additionality mechanism is therefore sequential but incomplete: policy instruments reinforce existing innovation trajectories without triggering broader structural upgrading.

The allocation pattern suggests a reinforcement logic rather than a corrective one. Support is disproportionately directed toward exporters and structurally stronger firms, while financially constrained firms remain underrepresented. As a result, public intervention appears to scale up ongoing activities rather than activate new innovation actors. From a policy perspective, this raises concerns about limited transformative impact and potential path dependency in the innovation systems.

The absence of a link between innovation and labour productivity has important implication for the policy design. Innovation in Polish manufacturing firms seems oriented more towards product adaptation, market positioning, and incremental upgrading than towards efficiency-enhancing technological transformation. This may reflect structural characteristics of the sector, including medium-technology specialization, fragmented innovation networks, and limited absorptive capacity. However, it also suggests that current instruments insufficiently incentivizing productivity-oriented innovation and organizational change.

Future policy should therefore move beyond input-based logic focused primarily on increasing R&D expenditure. Greater emphasis should be placed on activating new innovators – particularly SMEs facing financial constraints – and on strengthening managerial and organisational capabilities that enable productivity gains. Selection criteria could incorporate clearer performance expectations, including post-project monitoring of efficiency outcomes. Complementary instruments fostering deeper and more systemic collaboration between firms and research institutions may also be necessary to overcome weak knowledge diffusion mechanisms.

At the same time, the findings should be interpreted with methodological caution. The cross-sectional nature of the model limits the ability to fully capture time lags between R&D expenditure, innovation output and productivity effects. A longitudinal extension of the analysis constitutes a natural next step and would allow for a more precise assessment of dynamic productivity additionality. Nevertheless, even within these limitations, the results suggest that without addressing structural bottlenecks and absorptive capacity constraints, public R&D support in catching-up economies risks reinforcing existing hierarchies rather than fostering genuine productivity-based transformation.

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