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Abstract

This paper investigates how financial frictions shape the joint dynamics of firms' innovation and export behavior. Using firm-level survey data for Italian manufacturing companies, we document a mutually reinforcing relationship between innovation and exporting: innovation increases both the probability of exporting and the intensity of foreign sales, while export participation raises subsequent innovative effort. Credit rationing constrains both activities, limiting firms' ability to invest in R&D and to expand in foreign markets. Its effects, however, are asymmetric: financial constraints systematically depress innovation, but they hinder exporting only among non-innovative firms. Innovation thus partly insulates firms from the adverse impact of tight credit on internationalization. Overall, the results underscore the role of financial frictions in shaping firms' strategic choices and suggest that policies fostering innovation may indirectly promote export participation in credit-constrained environments.

JEL codes: F14; O31.
Keywords: Innovation, Exporting, Financial Constraints.

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1 Introduction

Innovation and trade are central drivers of firm growth and competitiveness. Both, however, depend critically on access to external finance, which ultimately determines whether firms can turn ideas into marketable products and exploit foreign demand. Despite their importance, prior research has mostly examined the effects of credit constraints on innovation and exporting separately, leaving limited evidence on how financial frictions shape their interaction and the complementarities between them. A clear understanding of these linkages is essential for explaining how innovation and exporting reinforce one another as engines of firm performance.

These interactions arise because innovation and exporting require substantial upfront investments and yield interdependent returns. Innovation allows firms to tailor products to foreign consumers and to develop the capabilities needed for international expansion, while exposure to foreign markets can, in turn, stimulate innovative effort through learning, technology adoption, and competitive pressures. Both activities entail significant sunk costs that must be financed in advance, making financial frictions a potentially binding obstacle to firms' ability to sustain them. Such frictions affect not only whether firms choose to innovate or export, but also how each activity amplifies or dampens the other. Moreover, engaging in one strategy can ease the financial burden associated with pursuing the second. Innovation can raise efficiency and generate intangible assets that strengthen firms' credibility and collateral value, thereby easing dependence on external finance. On the other hand, exporting may help relax financing pressures on innovation by improving liquidity and stabilizing cash flows. Despite extensive evidence on each mechanism in isolation, our understanding of their interaction under binding credit constraints remains limited. How these dynamics unfold is central to explaining firms' performance, competitiveness, and integration into global markets.

This paper investigates the mutual relationship between exporting and innovation, highlighting the role of credit constraints in shaping both activities and the links between them. Rather than simply asking whether finance matters, we examine how the intensity and direction of its influence vary across firms with different innovative and export profiles. By jointly analyzing these channels, we provide a comprehensive account of how financial frictions affect firms' strategic choices and their ability to translate innovation and internationalization into sustained growth.

Our analysis draws on rich firm-level data from the MET survey of the Italian manufacturing sector, covering the period 2013–2019. Italy provides an ideal context for this study. The sample period follows the sovereign debt crisis, a phase marked by pronounced shocks to bank credit supply and heightened relevance of financing conditions for firms' strategic decisions. Moreover, the Italian economy is dominated by privately held small and medium-sized enterprises that depend almost entirely on bank lending for external finance. Because these firms have limited access to capital markets, credit supply shocks cannot easily be offset through al-

ternative funding channels. At the same time, Italy hosts a large number of innovation-active and export-oriented firms, offering a particularly suitable setting to examine how financial frictions shape the interplay between innovation and participation in international markets.

In the empirical analysis, we focus specifically on bank-driven credit rationing as a key channel through which financial frictions influence firms' activities. A central feature of the MET data is the availability of a direct, survey-based measure of bank credit constraints, derived from firms' reported loan application outcomes, allowing for a more accurate identification of financially constrained firms than standard balance-sheet indicators (Balduzzi et al., 2024). The survey also provides detailed information on both the extensive and intensive margins of exporting and R&D investment, allowing us to assess not only whether firms engage in these activities but also the scale of their involvement. In addition, it includes information on each firm's lender banks, which we exploit in an instrumental-variable framework to address potential endogeneity in credit access.

Before turning to the empirical analysis, we develop a stylized theoretical framework that formalizes how firms' innovation and export decisions interact under financial constraints. The model highlights how limited access to external finance simultaneously restricts entry into both innovation and export activities and thus dampens the reinforcing effects between them. In particular, tighter credit conditions reduce the set of firms for which exporting and innovation are profitable. The interaction between the two margins is, however, asymmetric: innovation directly raises productivity and lowers the effective cost of exporting, whereas exporting strengthens innovation incentives only indirectly through expanded market size.

Building on these insights, the empirical strategy jointly models firms' exporting, innovation, and credit-access outcomes to capture their simultaneous nature and mutual interdependence. For the extensive margins, we estimate a trivariate probit model via simulated maximum likelihood (Roodman, 2011; Greene, 2000), which identifies the joint probability of exporting, innovating, and facing credit constraints. For the intensive margins, we employ Poisson Pseudo–Maximum Likelihood (PPML) estimations with multiple fixed effects (Correia et al., 2019, 2020) in a two-stage control-function approach. For identification, we take advantage of firm-specific instrumental variables for export participation, innovation activity, and access to finance, and include an extensive set of firm-level controls to account for observable differences in firms' characteristics and behavior. These specifications mitigate concerns about simultaneity, endogeneity, and reverse causality, while accounting for unobserved firm heterogeneity and other confounding factors.

Our results confirm strong two-way complementarities between exporting and R&D activities. Innovation significantly increases firms' likelihood and intensity of exporting, while participation in foreign markets fosters innovative efforts—showing that these strategies operate as mutually reinforcing drivers of firm growth. Credit rationing, by contrast, acts as a pervasive constraint: it lowers both the probability of engaging in these activities and the

depth of firms' involvement. Its impact, however, is markedly asymmetric. Credit constraints uniformly depress innovation, regardless of a firm's export status, but hinder exporting only among non-innovating firms. As a result, innovation substantially mitigates the adverse effect of financial frictions on export participation, whereas exporting appears to only marginally soften their impact on R&D.

This pattern aligns with the predictions of our theoretical framework, in which innovation directly raises productivity and lowers the effective cost of exporting, while exporting strengthens innovation incentives only indirectly through market expansion. Our heterogeneity results further show that the impact of credit frictions varies systematically with firms' characteristics: the adverse effects are strongest for small, less productive, and less liquid firms, and for those operating in sectors highly dependent on external finance—precisely the firms least able to self-finance innovation or absorb the fixed costs of exporting. By contrast, larger, more productive, and more liquid firms are naturally better insulated from financial constraints, which explains why the negative effects are substantially muted for them.

Our findings speak to several strands of the literature that emphasize the importance of financial frictions in shaping firms' global and technological engagement. A first line of research identifies credit constraints as a major barrier to firms' participation in international markets, documenting that better access to finance raises the likelihood of export entry and expansion (see, e.g., Berman and Héricourt, 2010; Minetti and Zhu, 2011; Manova, 2013; Muûls, 2015; Chaney, 2016; Pietrovito and Pozzolo, 2021). In particular, financial resources are needed to cover the substantial fixed and variable costs of internationalization. These costs include building distribution networks abroad, adapting products to foreign demand, complying with regulatory standards, and enforcing international contracts (**?**).

A second strand of research examines how financial constraints shape firms' innovation decisions. This literature consistently shows that access to finance is a key determinant of R&D activity and technological upgrading. Firms that rely more heavily on external capital are more likely to innovate when credit is available (Ayyagari et al., 2011), while internal financial resources are crucial for sustaining long-term R&D investment and absorbing its inherent risks (Himmelberg and Petersen, 1994; Hall and Lerner, 2010). Financial frictions can therefore delay, scale down, or entirely prevent innovation projects, particularly when informational asymmetries make R&D outcomes difficult to collateralize or monitor. Consistent with this evidence, Gorodnichenko and Schnitzer (2013) show that credit frictions weaken the innovative capacity of domestically owned firms, underscoring how limited access to finance constrains technological upgrading and competitiveness.

A third strand of the literature investigates the interaction between exporting and innovation. Existing evidence shows that the two activities are closely linked and mutually reinforcing: exporters are more likely to invest in R&D, while research investments increase the probability of entering and remaining in export markets (Harris and Moffat, 2011). Early

work highlights the role of technology and human capital in shaping export composition (Hughes, 1986), whereas more recent studies emphasize the importance of internal and non-traditional financing sources in supporting both innovation and internationalization (Yang et al., 2020). Other contributions examine these dimensions jointly—connecting financial constraints, productivity, innovation, and exporting—and underscore their simultaneity and mutual dependence (Altomonte et al., 2016; Rossi et al., 2021). Aw et al. (2011) and Braymen et al. (2011) further show that exporting and innovation together enhance firms' future productivity, reinforcing the view that these strategies function as complementary engines of firm growth and competitiveness (see also Sharma, 2018; Melitz and Redding, 2023).

Our work is most closely related to Gorodnichenko and Schnitzer (2010), who study how financial frictions simultaneously affect firms' export and innovation decisions. In their framework, firms must allocate limited financial resources between funding R&D and covering the fixed costs of accessing foreign markets; this trade-off amplifies the adverse effects of financial constraints on firms' ability to innovate and to converge toward the technological frontier. We provide a complementary perspective by embedding innovation within a broader strategic environment that also encompasses firms' access to international markets. In particular, we examine how financial frictions affect exports not only directly, but also indirectly through their impact on innovation, thereby providing new evidence on how credit constraints shape the complementarity between technological upgrading and internationalization. By integrating these mechanisms within a unified empirical framework, our study connects the literatures on trade finance, firm dynamics, and innovation. In doing so, we show how financial frictions can undermine the mutually reinforcing relationship between innovation and internationalization, especially for firms with weaker financial structures.

Overall, our findings confirm the model's prediction that innovation mitigates the distortive effects of credit constraints on firms' internationalization decisions, suggesting that policies aimed at relaxing financial frictions—particularly for smaller, less productive, or liquidity-constrained firms—can generate disproportionately large gains in innovation capacity and international competitiveness. By fostering the joint expansion of innovative and exporting activities, financial development policies, targeted credit guarantees, and innovation-linked lending instruments can reinforce the virtuous cycle between productivity growth and internationalization.

The remainder of the paper is organized as follows. Section 2 presents the theoretical framework that motivates our analysis. Section 3 describes the data and key variables. Section 4 outlines the empirical strategy, and Section 5 discusses the baseline results. Section 6 explores heterogeneities across firms' strategic profiles and characteristics, and analyzes the effects on the intensive margins. Section 7 concludes.

2 Theoretical Framework

To guide our empirical analysis, we develop a stylized theoretical model building on the framework of Manova (2013). The model describes how a profit-maximizing firm decides whether to innovate and/or export when faced with credit constraints. Both innovation and exporting involve fixed, sunk costs that must be paid upfront. Innovation reduces unit variable costs, while exporting expands market access. The firm's ability to finance these fixed costs is limited by imperfections in the credit market, represented as a positive wedge between the cost of external and internal finance. Firms rely on internal funds to cover the fixed costs of innovation and exporting; when these are insufficient, they resort to bank borrowing, which carries a financing premium (as in Kaplan and Zingales, 1997).

Under these assumptions, we analyze how engaging in both R&D and exporting affects firm profitability. We begin by characterizing the conditions under which innovation is chosen and examining how this region expands or contracts as key model parameters vary. The analysis shows that exporting broadens the range of conditions in which innovation is optimal. As a result, exporting firms choose to innovate under a wider set of circumstances than firms serving only the domestic market, increasing their likelihood of engaging in R&D. Conversely, tighter credit constraints narrow the region in which innovation is optimal, reducing the probability that firms undertake R&D activities.

Next, we conduct a similar analysis for exporting, examining how the region of the parameter space in which export participation is optimal shifts as key parameters vary. The results show that innovative firms export under a wider set of conditions than non-innovative firms, increasing their likelihood of entering foreign markets. Tighter credit constraints, in turn, narrow the range of conditions that make exporting optimal, reducing the probability that firms participate in international trade.

In our theoretical setup, the firm maximizes profits subject to several key elements: (i) fixed cost components associated with participation in export and innovation activities; (ii) unit variable costs that decline as the firm undertakes R&D; and (iii) financial constraints arising from imperfections in credit markets. The model generates a set of predictions on how these fixed costs and the innovation-induced reduction in unit costs influence the likelihood of engaging in each activity, and on how credit frictions shape firms' joint decisions to export and to innovate.

Following Melitz (2003), we assume that consumers have preferences defined over a differentiated set of goods, and each representative firm maximizes profits:

$$\pi = pq + ep^*q^* - \gamma ca(q + \tau q^*) - G - F - (F + G - L)\varphi, \tag{1}$$

subject to domestic and foreign demand functions:

$$q(p) = \frac{p^{-\epsilon} Y}{P^{1-\epsilon}}, \tag{2}$$

$$q^*(p^*) = \frac{(p^*)^{-\epsilon^*} Y^*}{(P^*)^{1-\epsilon^*}}. \tag{3}$$

Here, q and q^* denote the quantities of a given variety sold in the domestic and foreign markets, while p and p^* represent their respective prices, with e denoting the exchange rate. The term c is the cost of the input bundle required to produce one unit of output, and a is the inverse of labor productivity. Fixed costs F and G are incurred upfront for exporting and undertaking R&D, respectively. The firm's internal finance is denoted by L, and $\varphi > 1$ represents the premium paid on external finance. Undertaking R&D reduces a firm's unit variable and marginal costs, captured by the parameter γ, with $\gamma < 1$ when the firm engages in R&D and $\gamma = 1$ otherwise. The iceberg-type export cost is represented by $\tau > 1$. The parameters $\epsilon > 1$ and $\epsilon^* > 1$ denote the elasticities of substitution between varieties in the utility functions of the representative domestic and foreign consumers, respectively. Finally, Y and Y^* denote total expenditure in the domestic and foreign economies, and P and P^* are the corresponding aggregate price indices.

Substituting the demand functions (2) and (3) into equation (1) and maximizing with respect to p yields the optimal domestic price and quantity:

$$p = \frac{\epsilon}{\epsilon - 1} \gamma c a, \tag{4}$$

$$q = \left[\frac{\epsilon}{\epsilon - 1} \gamma c a \right]^{-\epsilon} \frac{Y}{P^{1-\epsilon}}. \tag{5}$$

Maximizing with respect to p^* gives the corresponding optimal foreign price and quantity:

$$p^* = \frac{1}{e} \frac{\epsilon^*}{\epsilon^* - 1} \gamma c a \tau, \tag{6}$$

$$q^* = \left[\frac{1}{e} \frac{\epsilon^*}{\epsilon^* - 1} \gamma c a \tau \right]^{-\epsilon^*} \frac{Y^*}{(P^*)^{1-\epsilon^*}}. \tag{7}$$

Substituting equations (4)–(7) into (1) and simplifying, we obtain the firm's profit function:

$$\Pi(\gamma, F, G, \varphi) = \frac{1}{\epsilon} \left(\frac{\epsilon}{\epsilon - 1} \gamma c a \right)^{1-\epsilon} \frac{Y}{P^{1-\epsilon}} + e \frac{1}{\epsilon^*} \left(\frac{\epsilon^*}{\epsilon^* - 1} \gamma c a \tau \frac{1}{e} \right)^{1-\epsilon^*} \frac{Y^*}{(P^*)^{1-\epsilon^*}} - (1+\varphi)(G+F) + \varphi L. \tag{8}$$

The corresponding profit function for a firm that does not undertake R&D is denoted by $\Pi(F, \varphi) \mid_{noR\&D}$. This expression is identical to equation (8), except that the unit cost reduc-

tion parameter is set to $\gamma = 1$, and the fixed R&D cost G is set to zero.

We can therefore compare the two profit functions and examine how the subset of the parameter space for which $\Pi(\gamma, F, G, \varphi) \lesseqgtr \Pi(F, \varphi) \mid_{noR\&D}$ expands or contracts as specific parameters vary. This comparison reveals how changes in model parameters affect the likelihood that a firm engages in R&D. Through simple manipulation, the relationship $\Pi(\gamma, F, G, \varphi) \lesseqgtr \Pi(F, \varphi) \mid_{noR\&D}$ can be reformulated as:

$$\left[\frac{\epsilon}{\epsilon - 1} ca\right]^{1-\epsilon} \frac{Y}{P^{1-\epsilon}} \frac{1}{\epsilon} (\gamma^{1-\epsilon} - 1) + \left[\frac{\epsilon^*}{\epsilon^* - 1} \frac{ca\tau}{e}\right]^{1-\epsilon^*} \frac{Y^*}{(P^*)^{1-\epsilon^*}} \frac{e}{\epsilon^*} (\gamma^{1-\epsilon^*} - 1) \lesseqgtr (1 + \varphi)G. \quad (9)$$

An examination of the left- and right-hand sides of equation (9) yields the following predictions:

1. A higher value of the parameter γ (i.e., closer to one)—which implies a smaller benefit from R&D in terms of unit cost reduction—as well as higher fixed R&D costs, G, reduce the subset of the parameter space for which $\Pi(\gamma, F, G, \varphi) > \Pi(F, \varphi) \mid_{noR\&D}$. In other words, both factors lower the probability that the firm undertakes R&D activities.
2. For nonexporting firms, the second term on the left-hand side of equation (9) equals zero rather than a positive value. Consequently, the subset of the parameter space for which $\Pi(\gamma, F, G, \varphi) > \Pi(F, \varphi) \mid_{noR\&D}$ shrinks, reducing the likelihood that a firm innovates.
3. A higher value of φ—reflecting a larger wedge between external and internal financing costs and thus tighter credit constraints—shrinks the subset of the parameter space in which undertaking R&D is profitable, thereby reducing the likelihood that the firm innovates.

We next analyze the firm's decision to participate in export markets by comparing profits under exporting and non-exporting. The former corresponds to equation (8), while the profit function of a nonexporting firm is given by:

$$\Pi(\gamma, G, \varphi) \mid_{noExp} = \frac{1}{\epsilon} \left(\frac{\epsilon}{\epsilon - 1} \gamma ca\right)^{1-\epsilon} \frac{Y}{P^{1-\epsilon}} - (1 + \varphi)G + \varphi L. \quad (10)$$

By combining equations (8) and (10), the condition under which exporting is profitable can be expressed as:

$$\frac{e}{\epsilon^*} \left[\frac{\epsilon^*}{\epsilon^* - 1} \frac{ca\gamma\tau}{e}\right]^{1-\epsilon^*} \frac{Y^*}{(P^*)^{1-\epsilon^*}} \lesseqgtr (1 + \varphi)F. \quad (11)$$

Inspection of both sides of equation (11) yields the following predictions:

1. A higher value of γ—that is, a smaller reduction in unit variable costs from innovation as γ approaches unity—not only lowers the probability of undertaking R&D, as we have

seen before, but also shrinks the subset of the parameter space for which $\Pi(\gamma, F, G, \varphi) > \Pi(\gamma, G, \varphi) \mid_{noExp}$, thereby reducing the likelihood that the firm export.

2. More binding financial constraints—i.e., a higher value of φ—not only lowers the probability of innovating (as seen before), but also reduce the subset of the parameter space in which exporting is profitable, thereby lowering the probability of export participation.[1]

To complete the analysis, we assume for simplicity that $\epsilon = \epsilon^*$ and derive the threshold level of productivity, $\frac{1}{a^*}$, at which profits are zero, $\Pi(a^*, \gamma, F, G, \varphi) = 0$:

$$\frac{1}{a^*} = [(1+\varphi)(G+F) - \varphi L]^{\frac{1}{\epsilon-1}} c\gamma \frac{\epsilon}{\epsilon-1} \epsilon^{\frac{1}{\epsilon-1}} \left[\frac{Y}{P^{1-\epsilon}} + \frac{Y^*}{(P^*)^{1-\epsilon}} \tau^{1-\epsilon} e^{\epsilon} \right]^{\frac{1}{1-\epsilon}}, \tag{12}$$

The expression yields the following comparative statics for the productivity threshold, $\frac{1}{a^*}$:

$$\frac{d(1/a^*)}{d\varphi} > 0, \quad \frac{d(1/a^*)}{dF} > 0, \quad \frac{d(1/a^*)}{dG} > 0, \quad \frac{d(1/a^*)}{d\gamma} > 0, \tag{13}$$

which summarizes how changes in key parameters affect the productivity threshold $1/a^*$ required for profitable participation in innovation or export activities. A higher external financing premium φ increases the effective cost of external funds, tightening credit constraints and restricting entry to the most productive firms. Similarly, larger fixed costs of exporting (F) or innovating (G) raise the minimum productivity needed for these activities to be worthwhile. Finally, a higher γ—implying a smaller efficiency gain from R&D—further narrows the range of firms able to profitably engage in innovation or exporting.

Summing up. The model generates a set of predictions that guide the empirical analysis in Section 5. First, because both exporting and innovation involve fixed and sunk costs that must be financed upfront, credit frictions—captured by the external financing premium φ—raise the effective cost of undertaking these activities. As shown by the productivity threshold condition in equation (12), tighter credit constraints increase the minimum productivity level $1/a^*$ required for entry, thereby reducing the share of firms for which exporting or innovation is profitable (equation 13).

Second, the model highlights a mutual but asymmetric complementarity between exporting and innovation. As evident from equation (9), innovation reduces unit production costs through a lower γ, expanding the profitability range of exporting. Conversely, equation (11) shows that exporting, by widening a firm's market base and earnings, increases the likelihood that innovation becomes profitable. The asymmetry arises because the cost-reducing effect of innovation directly enhances export profitability, whereas the reverse channel operates only through expected revenue. Consequently, credit frictions disproportionately hinder firms that

[1] The same prediction holds for higher export-specific fixed costs F or higher iceberg trade costs τ.

have not yet entered either activity—while innovative firms, benefiting from higher productivity, efficiency, and internal liquidity, are better able to withstand financial constraints.

Third, the strength of these mechanisms depends on the firm's financing capacity. Firms with greater internal resources (L) or a smaller financing wedge (φ) can more easily fund the fixed costs of exporting (F) and innovating (G), whereas smaller or liquidity-constrained firms face tighter restrictions. At the industry level, sectors characterized by higher external financial dependence—that is, where investment must be financed largely through external capital—are predicted to be more exposed to credit frictions, amplifying the impact of financing constraints on both export and innovation decisions.

Finally, the comparative statics summarized in equation (13) show that tighter financial frictions, higher entry costs, or less effective innovation technologies push upward the productivity threshold for profitable participation, thereby shrinking the set of firms able to engage in innovation and exporting. While these results refer to the extensive margin—the decision to enter foreign markets or undertake R&D—the same mechanisms suggest that credit constraints can also limit the scale of activity once entry occurs, by restricting firms' ability to finance the variable costs of exporting and R&D, tightening working-capital availability, and curbing their capacity to sustain ongoing investment.

Taken together, these mechanisms yield four central predictions: (i) credit constraints reduce both the probability and intensity of exporting and innovation; (ii) innovation and exporting are mutually reinforcing but asymmetrically so; (iii) innovative firms are better able to mitigate the adverse effects of credit constraints, whereas the cushioning role of exporting is comparatively weaker; and (iv) financial frictions tend to be more binding for firms with weaker financial or operational strength—for instance, those that are smaller, less productive, or less liquid, as well as those operating in sectors more dependent on external finance. These theoretical implications provide the foundation for the heterogeneity analyses that follow, which explore how the effects of credit constraints vary across firms' strategic profiles and financial structures.

3 Data

Our empirical analysis draws on Italian firm-level data from the MET survey, a dataset specifically designed to investigate the behavior of firms along key dimensions such as innovation, internationalization, and access to finance (see, for instance, Brancati, 2025; Brancati et al., 2025; Balduzzi et al., 2024). The MET survey is particularly well suited for our purposes, as it collects harmonized, high-quality information on firms' activities and financial constraints that are central to our analysis.

The MET sample is representative along three dimensions: firm size (four classes), ge-

ographic location (20 NUTS-2 regions), and sector of activity.[2] Importantly, the sample includes firms of all sizes, including micro-enterprises with fewer than ten employees.[3] This is a key advantage in the Italian context, where small and micro firms represent over 95% of the business population and play a central role in employment, value added, and export.

We focus on the 2013, 2015, 2017, and 2019 waves of the MET survey, each comprising roughly 24,000 observations. These waves coincide with the aftermath of the European sovereign debt crisis, a period that generated substantial cross-sectional variation in firms' access to credit and financial constraints. The survey data are matched with balance-sheet information from the AIDA Bureau van Dijk database, enabling the construction of a rich firm-level dataset that includes both structural characteristics and performance indicators.[4]

Main Measures. The MET survey provides detailed information on firms' innovation and export activities. We define the extensive margin of export as a binary variable equal to one if the firm exports to foreign markets, and zero otherwise. Similarly, the extensive margin of innovation is defined as a binary indicator equal to one if the firm reports positive R&D expenditures. The intensive margins are measured, respectively, by the share of total sales generated from exports and by R&D expenditure as a share of sales. In robustness analyses, we further employ dummy variables identifying product and process innovations as alternative proxies for innovativeness, to ensure that our findings are not driven by the specific definition of innovation expenditure.

Following Balduzzi et al. (2024), we measure credit constraints using a direct, survey-based indicator derived from firms' self-reported loan application outcomes. Firms are asked whether they applied for credit in the previous year and to indicate the outcome among the following categories: (i) loan granted under favorable conditions; (ii) loan granted under slightly less favorable conditions; (iii) loan granted for a substantially lower amount than requested or under very unfavorable conditions; (iv) loan denied. Firms that did not apply for credit are asked whether this was due to a lack of need (v) or the expectation of rejection (vi).

We classify as credit constrained all firms reporting outcomes (iii), (iv), or (vi), and define a binary variable, *Credit rationing*, equal to one for constrained firms. This definition captures both firms that face outright credit rejection and those that refrain from applying due to

[2]The sample covers firms operating in manufacturing (60%) and production-related services (40%), grouped into 12 reaggregated sectors based on the NACE Rev.2 classification. The manufacturing sector includes: Food, Textile, Furniture, Printing and Publishing, Chemical, Machinery, Transportation, Engineering, Electric, and Mineral industries. The production-related services comprise two broad sectors: (i) distributive trades, transportation, and storage services; and (ii) information and communication services, as well as administrative and support service activities.

[3]See Brancati (2025) for a detailed comparison between the MET sample and the full population of Italian firms.

[4]Since balance-sheet data are unavailable for unincorporated firms, the final estimation sample is smaller than the original MET survey population.

anticipated denial.[5]

A key advantage of this survey-based measure is that it directly captures firms' effective access to external finance, rather than inferring financial constraints from accounting-based proxies such as size, age, or liquidity. As noted by Campello et al. (2010), these indicators may imperfectly reflect firms' actual financing conditions and can conflate genuine credit frictions with other factors affecting financial statements. In contrast, the MET survey identifies constraints based on firms' actual borrowing experiences, providing a more accurate assessment of credit rationing and its effects on firm behavior. Importantly, it also includes detailed information on each firm's lender banks, which we exploit to construct our instrumental variable for *Credit rationing*. The focus on bank credit is particularly relevant in a context like Italy, where small, privately held firms rely almost exclusively on bank lending—so that being credit constrained effectively implies exclusion from external finance altogether.

The dataset is further complemented by a comprehensive set of firm-level controls. In all regressions, we include firm age (log years since founding), size (log of total assets, which also proxies for pledgeable collateral), profitability (return on assets), and labor productivity (log value added per employee). These controls account for differences in firm performance, financial structure, and market positioning that may influence both access to credit and the propensity to innovate or export.[6]

Summary Statistics. Roughly 45% of the firms in our estimating sample are exporters, with foreign sales accounting on average for 17% of total turnover. Around one-third (31%) report positive R&D expenditures, with an average R&D intensity of 2.6% of sales, while approximately 9% are classified as credit constrained according to our definition. The median firm is 24 years old, employs about 24 workers and records a return on assets of roughly 5%, reflecting the prevalence of small yet mature firms in the Italian productive system. The summary statistics reported in Table 1 confirm the substantial heterogeneity in firms' engagement in exporting, innovation, and financial conditions.

Table 2 complements this evidence by comparing firms' characteristics across innovation status, export participation, and credit rationing. The patterns are clear and economically significant. Firms engaging in R&D are almost twice as likely to export as non-innovators (69% vs 34%) and display a substantially higher export intensity (29% vs 11% of turnover). Likewise, exporters show greater innovative activity and R&D effort, providing preliminary evidence of mutual reinforcement between innovation and internationalization. By contrast,

[5] In robustness exercises, we adopt a narrower definition of credit constraints (*Bank credit rationing*) that excludes discouraged borrowers—focusing solely on firms that applied for a loan and were either rejected or granted less credit than requested. Our results remain qualitatively unchanged.

[6] In testing the robustness of our results, we also employ additional controls capturing firms' financial structure and governance characteristics, including leverage, liquidity, length of the relationship with the lender bank, family ownership, group affiliation, and the share of managers with prior experience or university degrees (see Section 5).

credit-constrained firms lag systematically behind: they are less likely to innovate or export, and those that do so exhibit lower intensity levels. Constrained firms are also smaller, less productive, and less profitable, underscoring the role of financial frictions as a key determinant of firm performance and strategic choices. These descriptive patterns motivate our empirical strategy in the next section, where we formally examine the joint relationship between exporting, innovation, and credit constraints.

Table 1: Descriptive statistics (I)

	Mean	Min	Median	Max	SD
Export	0.450	0.000	0.000	1.000	0.497
% Export	0.168	0.000	0.000	1.000	0.272
R&D	0.312	0.000	0.000	1.000	0.463
% R&D	0.026	0.000	0.000	1.000	0.082
Credit rationing	0.088	0.000	0.000	1.000	0.284
Age	27.586	1.000	24.000	170.000	19.558
Labor productivity	65.170	0.001	49.740	59,300	355.953
Total assets	21.700	0.047	2.678	62,200	346.000
ROA	0.068	-0.254	0.048	8.492	0.107
Real exchange-rate shock	0.001	-0.095	-0.003	0.117	0.021
Foreign-demand shock	0.016	-2.751	0.015	0.503	0.087
Sectoral R&D expenditure	0.943	0.000	0.543	5.213	1.074

Notes: This table reports descriptive statistics for the main measures employed in the analysis. Variable definitions are provided in Appendix Table A1.

Table 2: Descriptive statistics (II)

	Average		Sign.	Average		Sign.	Average		Sign.
	R&D=0	R&D=1	t-test	Export=0	Export=1	t-test	Rationing=0	Rationing=1	t-test
Export	0.343	0.686	***				0.456	0.390	***
% Export	0.112	0.290	***				0.171	0.136	***
R&D				0.178	0.475	***	0.318	0.243	***
% R&D				0.019	0.036	***	0.026	0.022	***
Credit rationing	0.097	0.069	***	0.098	0.076	***			***
Age	26.774	29.378	***	24.977	30.775	***	27.679	26.623	***
Labor productivity	63.901	67.970	**	62.661	68.236	**	66.236	54.135	***
Total assets	13.200	40.500	***	17.000	27.500	***	22.300	15.300	***
ROA	0.066	0.073	***	0.067	0.070	**	0.071	0.037	***

Notes: This table reports conditional distributions by firms' R&D, export, and credit-rationing status. The t-test reports results from two-sample mean comparison tests based on Welch's t-statistic. Additional statistics by group are reported in Table A2. **, *** indicate statistical significance at the 5%, and 1%, respectively.

4 Empirical Strategy

The theoretical framework outlined in Section 2 predicts that firms' exporting, innovation, and financing decisions are jointly determined and closely interdependent strategic choices.

Estimating the effect of financial constraints on exporting or R&D in isolation would therefore yield biased results, even when endogeneity is controlled for, since each of these decisions influences the others. To address this simultaneity problem, we adopt an estimation framework in which the probabilities of exporting, engaging in R&D, and being credit constrained are jointly estimated. This approach captures the complex interactions among financial frictions, innovation, and internationalization, allowing us to assess both their direct and indirect effects on firms' strategic choices.

Identification in this framework relies on a set of exclusion restrictions that provide the exogenous variation necessary to disentangle the simultaneous relationships among exporting, innovation, and credit constraints. Given the numerical complexity of jointly estimating all parameters, we implement separate procedures for the extensive and intensive margins of firms' activities. For the extensive margins—export participation, engagement in R&D, and the probability of being credit constrained—we estimate a trivariate probit model following Roodman (2011) and Greene (2000). This approach allows the simultaneous estimation of three binary equations through simulated maximum likelihood, using the GHK smooth recursive simulator to approximate the multivariate normal integrals.[7]

Instruments. To address potential endogeneity in export decisions, we adopt an instrumental variable strategy based on industry-level shocks to external conditions. Specifically, the probability that a firm exports is instrumented using two time-varying, sector-specific variables: a measure of exchange rate variability (*Real exchange-rate shock*) and an indicator of foreign demand (*Foreign-demand shock*). Both instruments capture shocks to international competitiveness and market opportunities that affect firms' propensity to export but are plausibly exogenous to firm-level innovation or financing decisions. This is especially so in the Italian context, where the vast majority of firms are micro or small enterprises with limited influence over exchange rate dynamics or global demand conditions.

To construct the industry-specific measures of exchange rates shocks, we use annual bilateral exchange rates obtained from the Bank of Italy. For each trading partner we compute the annual percentage change. These bilateral variations are then merged with sector–partner trade weights and aggregated—using lagged trade shares as weights—to obtain sector-specific, trade-weighted indicators of exchange rate changes. The resulting variables provide plausibly exogenous instruments capturing the exposure of each sector to exchange rate fluctuations.[8]

The foreign demand variable is constructed as follows: (i) for each sector s, we collect data on total imports of sector s's products by all destination countries, excluding imports from Italy; (ii) we compute the time variation in the *log* of these import flows; and (iii) we

[7] The GHK simulator generates simulated probabilities for the joint likelihood, which are then maximized using standard optimization routines. See Terracol (2002) for algorithmic details.

[8] Annual average bilateral exchange rates are sourced from: https://tassidicambio.bancaditalia.it/terzevalute-wf-ui-web/averageRates.

weight these changes by Italy's lagged export shares of sector s's products to each country. This construction provides a granular measure of external demand shocks that affect Italian firms' export opportunities, while the use of lagged trade weights helps mitigate potential endogeneity arising from the contemporaneous correlation between firms' export performance and current trade patterns.[9]

To instrument firms' innovation decisions, we use *Sectoral R&D expenditure*, measured as the total R&D spending undertaken by Italian firms in each two-digit NACE Rev.2 industry and year, sourced from Eurostat's R&D statistics.[10] This variable captures sector-level technological intensity and the broader innovation environment in which firms operate. Variation in *Sectoral R&D expenditure* across industries and over time identifies changes in innovation opportunities that shape firms' incentives to invest in R&D, while being plausibly unrelated to firm-specific export or financing decisions. Because sector fixed effects are included in all estimations, identification relies on within-sector temporal fluctuations, net of persistent technological differences across industries. In this way, the instrument captures shifts in the sectoral innovation environment that influence firms' R&D behavior, while being unlikely to directly affect firm-specific export performance or credit conditions.

The probability of being credit rationed is instrumented using the predicted value from a specification capturing credit supply conditions, denoted as *Bank lending tightness*. This variable is obtained from the interaction between year dummies and binary indicators for firms' lender banks, which generates a set of time-varying, bank-specific fixed effects. These interacted effects capture changes in lending conditions that differentially affect firms depending on their lenders' financial situations. The specification flexibly accounts for shocks to banks' funding costs, capital adequacy, or risk exposure, without imposing assumptions about the specific source of financial tightening. The resulting *Bank lending tightness* measure is relevant because shifts in banks' credit supply directly influence the likelihood that client firms face credit rationing, while it remains plausibly exogenous to firms' export and innovation decisions, as it reflects supply-side fluctuations in bank behavior rather than firm-level demand for finance. In this way, the instrument isolates variation in access to external finance stemming from lenders' conditions, not from firms' own characteristics or strategic choices. To mitigate potential selection issues arising from non-random firm–bank matching, robustness checks include an extensive set of controls for firms' fundamentals—such as profitability, productivity, leverage, liquidity, and size—reducing concerns that stronger firms assortatively match with less risk-averse banks. We also control for proxies of relationship lending, in particular the length of the lending relationship, which captures the informational capital accumulated between a bank and its clients and helps ensure that unobserved differences in

[9] Using contemporaneous export weights could introduce simultaneity bias, as current trade shares may themselves be influenced by firms' export decisions in the same period. Lagged weights avoid this by relying on predetermined trade structures.

[10] See https://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm.

bank–firm ties do not confound our estimates.

Main Specifications. Given these exclusion restrictions and the simultaneity among exporting, innovation, and credit constraints suggested by the theory, we estimate a trivariate probit model that jointly models the three binary decisions. This approach explicitly allows for correlated unobservables across equations and provides estimates of cross-equation error correlations, which serve as a direct test of interdependence among the three margins. For computational tractability, we estimate two complementary specifications of the model rather than the full trivariate system with all endogenous equations estimated simultaneously. This strategy preserves the joint nature of the framework while maintaining numerical stability and clear identification through exclusion restrictions.

In the first specification, the firm's export decision depends on its innovation status and credit conditions, while R&D engagement is treated as exogenous to both exporting and credit rationing; the system is thus defined as:

$$Export^*_{i,t} = \beta^E_0 + \beta^E_1 R\&D_{i,t} + \beta^E_2 CR_{i,t} + \beta^E_X X_{i,t} + \delta^E_t + \theta^E_r + \varphi^E_s + u^E_{i,t}, \tag{14a}$$

$$R\&D^*_{i,t} = \beta^R_0 + \beta^R_X X_{i,t} + \beta^R_Z Z^R_{i,t} + \delta^R_t + \theta^R_r + \varphi^R_s + u^R_{i,t}, \tag{14b}$$

$$CR^*_{i,t} = \beta^C_0 + \beta^C_X X_{i,t} + \beta^C_Z Z^C_{i,t} + \delta^C_t + \theta^C_r + \varphi^C_s + u^C_{i,t}. \tag{14c}$$

where $R\&D^*$, $Export^*$, and CR^* denote latent propensities to innovate, export, or face credit rationing, such that $Export_{i,t} = 1$ if $Export^*_{i,t} > 0$ (0 otherwise), $R\&D_{i,t} = 1$ if $R\&D^*_{i,t} > 0$, and $CR_{i,t} = 1$ if $CR^*_{i,t} > 0$.

In the second specification, the direction of dependence is reversed: innovation is modeled as endogenous to exporting and credit constraints, while exporting is treated as exogenous:

$$R\&D^*_{i,t} = \beta^R_0 + \beta^R_1 Export_{i,t} + \beta^R_2 CR_{i,t} + \beta^R_X X_{i,t} + \delta^R_t + \theta^R_r + \varphi^R_s + u^R_{i,t}, \tag{15a}$$

$$Export^*_{i,t} = \beta^E_0 + \beta^E_X X_{i,t} + \beta^E_Z Z^E_{i,t} + \delta^E_t + \theta^E_r + \varphi^E_s + u^E_{i,t}, \tag{15b}$$

$$CR^*_{i,t} = \beta^C_0 + \beta^C_X X_{i,t} + \beta^C_Z Z^C_{i,t} + \delta^C_t + \theta^C_r + \varphi^C_s + u^C_{i,t}. \tag{15c}$$

where $R\&D_{i,t} = 1$ if $R\&D^*_{i,t} > 0$, $Export_{i,t} = 1$ if $Export^*_{i,t} > 0$, and $CR_{i,t} = 1$ if $CR^*_{i,t} > 0$. The error terms $u^j_{i,t}$ $(j = E, R, C)$ follow a multivariate normal distribution, allowing for cross-equation correlations that capture unobserved linkages between firms' strategic choices. $X_{i,t}$ denotes the baseline set of firm-level controls (age, total assets, ROA, and labor productivity), while $Z^j_{i,t}$ represent the instruments discussed above. Finally, δ^j_t, θ^j_r, and φ^j_s capture time, region, and sector fixed effects. Standard errors are clustered at the firm level to account for within-firm serial correlation.

When analyzing the intensive margins, we estimate two complementary equations to exam-

ine the joint interaction between export and innovation intensities. In the first specification, export intensity (*% Export*) is modeled as a function of firms' R&D expenditure (as a share of total sales) and credit constraints. In the second, the direction of dependence is reversed: R&D intensity (*% R&D*) is explained by export intensity and financial constraints.

To address potential endogeneity in this framework, we employ a two-stage control-function approach within a Poisson Pseudo–Maximum Likelihood (PPML) estimator. The estimation strategy mirrors the logic of the trivariate probit model used for the extensive margins, allowing for consistent identification of the effects of credit constraints, innovation, and exporting when these variables are jointly determined. In the first stage, each potentially endogenous regressor—credit rationing and, depending on the specification, either the share of R&D expenditures or the export share—is regressed on the same external instrument set ($Z_{i,t}^{\cdot}$) used in the extensive-margin analysis, along with all firm-level controls ($X_{i,t}$) and fixed effects ($\Psi_{s(i),r(i),t}^{\cdot}$).[11] The first stages read as follows:

$$\%\, Export_{i,t} = \pi_0^E + \pi_Z^E Z_{i,t}^E + \pi_X^E X_{i,t} + \Psi_{s(i),r(i),t}^E + v_{i,t}^E, \tag{16a}$$

$$\%\, R\&D_{i,t} = \pi_0^R + \pi_Z^R Z_{i,t}^R + \pi_X^R X_{i,t} + \Psi_{s(i),r(i),t}^R + v_{i,t}^R, \tag{16b}$$

$$CR_{i,t} = \pi_0^C + \pi_Z^C Z_{i,t}^C + \pi_X^C X_{i,t} + \Psi_{s(i),r(i),t}^C + v_{i,t}^C. \tag{16c}$$

The error terms $v_{i,t}^{\cdot}$ capture the endogenous component of each regressor that is not explained by the instruments and observables; their estimated counterparts, $\hat{v}_{i,t}^{\cdot}$, are then included in the second-stage PPML equations—together with the original endogenous variables and the controls—to correct for endogeneity. The models read as follows:

$$\%\, Export_{i,t} = \beta_0^{E'} + \beta_1^{E'} \%\, R\&D_{i,t} + \beta_2^{E'} CR_{i,t} + \lambda_R^{E'} \hat{v}_{i,t}^R + \lambda_C^{E'} \hat{v}_{i,t}^C + \beta_X^{E'} X_{i,t} + \Psi_{s(i),r(i),t}^{E'} + u_{i,t}^{E'}, \tag{17a}$$

$$\%\, R\&D_{i,t} = \beta_0^{R'} + \beta_1^{R'} \%\, Export_{i,t} + \beta_2^{R'} CR_{i,t} + \lambda_E^{R'} \hat{v}_{i,t}^E + \lambda_C^{R'} \hat{v}_{i,t}^C + \beta_X^{R'} X_{i,t} + \Psi_{s(i),r(i),t}^{R'} + u_{i,t}^{R'}. \tag{17b}$$

Standard errors are then bootstrapped to account for the two-stage nature of the estimation and ensure valid inference in the presence of generated regressors. This control-function correction ensures consistent estimates under standard assumptions about the orthogonality of instruments and structural errors, while the PPML estimator accommodates the multiplicative functional form, heteroskedasticity, and the presence of zero outcomes (Wooldridge, 2015;

[11] For notational simplicity, we group these fixed effects under a single composite term —$\Psi_{s(i),r(i),t}^{\cdot}$— collecting additive sector (s), region (r), and year (t) fixed effects.

Correia et al., 2020).

Identification Concerns. The joint estimation of firms' exporting, innovation, and financing decisions may raise several identification challenges. A key concern is the presence of unobserved shocks or common factors that simultaneously influence these outcomes within sectors over time. For example, industry-specific demand fluctuations or technological changes could jointly affect firms' innovation efforts, export participation, and access to credit, potentially generating spurious correlations if not adequately controlled for. To address this issue, we re-estimate the model with a richer fixed-effects structure, which absorbs time-varying shocks shared by firms within the same industry.[12]

A further concern relates to unobserved firm-specific heterogeneity and the persistence of exporting, innovation, or financial conditions, which may bias the estimated relationships. In principle, firm fixed effects would absorb time-invariant characteristics—such as managerial ability, risk attitudes, or structural competitiveness—that jointly influence these outcomes. However, incorporating firm fixed effects into a nonlinear multivariate framework is not feasible, as it would hinder convergence and undermine identification based on cross-sectional variation in the instrumental variables. To mitigate these issues, we adopt several complementary strategies. First, potential biases from unobserved time-varying shocks are alleviated by including an extensive set of fixed effects at the region, sector, and time level, in addition to firm-specific, time-varying controls. Second, unobserved time-invariant heterogeneity is addressed, in robustness checks, through a Mundlak–Chamberlain adjustment (Mundlak, 1978; Chamberlain, 1982), which augments each equation with firm-specific time averages of all time-varying covariates. This specification allows these covariates to be correlated with the firm-specific error component, effectively accounting for unobserved heterogeneity in a manner consistent with random-effects estimation.

A closely related challenge arises from the persistence of firms' strategic choices. Past engagement in exporting or innovation may influence current decisions through sunk costs, learning effects, or path dependence, potentially biasing cross-sectional identification. To address this issue, we replicate the analysis on the subsample of switchers—firms that change their export or innovation status over the sample period—thus exploiting within-firm variation and mitigating bias arising from time-invariant propensities to engage in specific activities.

A further issue is that our instrument for credit rationing may capture, to some extent, variation in firms' financial strength or risk profile rather than purely exogenous shifts in credit

[12]Clearly, to achieve identification in our IV setting, sectoral instruments must exhibit variation within the fixed-effect structure adopted in estimation. For this reason, when estimating industry×time fixed effects, we employ a less granular industry definition than the two-digit NACE Rev.2 classification used to construct the instruments. Specifically, we rely on the 12 reaggregated sectors corresponding to the sectoral dimension of representativeness in the MET survey's sampling scheme. This classification preserves sufficient within-cell variation over time while capturing broad structural differences across industries.

supply. If bank–firm relationships exhibit assortative matching—whereby financially stronger firms tend to borrow from less risk-averse banks—the instrument could reflect differences in borrower quality instead of supply-side credit shocks. To address this, we control for a rich set of firm-level indicators of creditworthiness—including profitability, leverage, liquidity, productivity, and the ability to pledge collateral—which absorb variation related to firms' financial health and borrowing capacity. As noted, we also control for a proxy of relationship lending, measured by the length of the firm's relationship with its banks, to ensure that persistent informational advantages or stronger relational ties are not confounded with our measure of credit supply. In an additional robustness exercise, we also account for ownership structure and managerial experience to capture differences in access to bank credit and other persistent heterogeneities linked to managerial organization.[13]

Finally, we assess the robustness of our results to alternative measurement choices. First, we replace the R&D indicator with a broader measure of innovation encompassing both product and process innovations, ensuring that our conclusions are not driven by a specific definition of innovative activity. Second, we adopt a stricter definition of credit rationing that excludes discouraged borrowers and focuses solely on firms whose loan applications were explicitly rejected by banks, thereby isolating genuine cases of credit supply constraints.

Taken together, these exercises mitigate the main identification challenges arising from unobserved shocks, firm-level heterogeneity, persistence, instrument validity, and measurement error. The full set of robustness checks is consistently applied to both the extensive- and intensive-margin specifications.

5 Baseline Results

We begin the empirical analysis by examining the joint relationship between firms' exporting, innovation, and access to external finance. Because these strategic choices are closely intertwined, we use an instrumental-variable approach to isolate exogenous variation in each decision margin. Before turning to the estimation results, we first assess the relevance and strength of the instruments introduced in Section 4.

The first-stage-type regressions, reported in Appendix Table A3, indicate that the instruments perform as expected. These regressions present marginal effects from probit models linking each endogenous variable to its corresponding external instrument. The *Real*

[13]For instance, family-owned firms may face tighter financing constraints due to weaker external governance, limited collateral diversification, or a higher aversion to external ownership, while group-affiliated firms typically benefit from internal capital markets and reputational spillovers that ease borrowing constraints. Likewise, firms managed by individuals with prior managerial experience or advanced educational backgrounds may exhibit stronger financial planning, reporting standards, and credibility with lenders, thereby reducing perceived credit risk and improving access to external finance. Controlling for these factors ensures that the estimated effects of credit rationing are not conflated with differences in ownership structure or managerial quality.

exchange-rate shock and *Foreign-demand shock* are significantly associated with the probability of exporting, with the anticipated signs: a real appreciation of the euro reduces export participation, while stronger foreign demand raises it. Similarly, *Sectoral R&D expenditure* is positively correlated with firms' innovation activity, and *Bank lending tightness* captures meaningful variation in access to external finance. The corresponding Kleibergen–Paap F-statistics—computed from analogous linear specifications (not reported)—substantially exceed conventional thresholds, confirming the strength and relevance of the instruments.

We next turn to the estimation, focusing first on the extensive margins of exporting and innovation, before analyzing the heterogeneity and intensive-margin effects predicted by the model. Table 3 reports the results of the trivariate probit estimations described in equations (14a–14b–14c) and (15a–15b–15c).[14] Columns (1)–(2)–(3) present results for the first system, where the probability of exporting is modeled as a function of firms' innovation activity and credit rationing, both instrumented as described in Section 4. The estimates indicate that innovative firms are significantly more likely to export, whereas credit-constrained firms face a lower probability of doing so. Quantitatively, engaging in R&D increases the likelihood of exporting by about 42 percentage points—roughly a 90% rise relative to the unconditional export probability of 45% (in Table 1). Conversely, credit rationing reduces the probability of exporting by around 8 percentage points (–18%), confirming that financial frictions substantially hinder firms' participation in foreign markets. The corresponding first-stage regressions, reported in the lower panel, show that the instruments are strong and relevant, consistent with the results in Appendix Table A3. In the analogous linear specifications (not reported), the Kleibergen–Paap F-statistic is approximately 500—well above conventional thresholds—further attesting to the power of the identification strategy.

Columns (4)–(5)–(6) of Table 3 report the results from the second system, where the probability of engaging in R&D is modeled as a function of exporting and credit rationing, using the same identification strategy. Export participation increases the likelihood of undertaking R&D by about 25 percentage points—a 80% rise relative to the unconditional probability of innovation (31%). Credit constraints, by contrast, reduce the probability of R&D engagement by roughly 15 percentage points (–50%), indicating that financial frictions are even more detrimental to innovation than to exporting. In all cases, the linear counterparts of our IV specifications yield consistent results, confirming the strength and reliability of the instruments. Moreover, the corresponding Hansen J-test does not reject the null of instrument validity (p-value of 0.241), providing further support for the soundness of the identification strategy.

Taken together, these findings underscore a strong complementarity between exporting and innovation: internationalization fosters innovation, and innovation, in turn, boosts export

[14] For brevity and ease of interpretation, we report marginal effects only for the main variables of interest. The full set of coefficient estimates is presented in Appendix Table A4.

participation. In both dimensions, credit rationing emerges as a critical friction that limits firms' ability to sustain and expand these mutually reinforcing growth strategies.

Robustness. To assess the robustness of our baseline findings, we re-estimate the models under a range of alternative specifications and variable definitions addressing the main identification challenges discussed in Section 4. We begin by introducing a richer fixed-effects structure with sector–year interactions to absorb time-varying demand, technology, or policy shocks common to firms within each industry (Table A5). To account for firm-level heterogeneity and persistence, we implement a Mundlak–Chamberlain adjustment that augments each equation with firm-specific time averages of all time-varying covariates (Table A6), and we replicate the analysis on the subsample of switchers—firms that change export or R&D status during the sample period—to exploit within-firm variation (Table A7). We also address potential concerns about the validity of the credit-rationing instrument by controlling for detailed firm-level indicators of creditworthiness (profitability, leverage, liquidity, productivity, pledgeable collateral, and a proxy for relationship lending; Table A8) and further incorporating ownership and managerial characteristics (Table A9). Finally, we test the sensitivity of our results to alternative measurement definitions by replacing the R&D indicator with a broader innovation measure (product or process innovation) and by adopting a stricter definition of credit rationing based solely on explicit loan rejections (Tables A10–A11). In all cases, results prove extremely robust, consistently addressing the main identification challenges and providing coherent evidence in support of an exogenous component in credit rationing rather than differences driven by borrower fundamentals.

6 Heterogeneity and Intensive Margins

The theoretical framework developed in Section 2 provides a clear rationale for exploring heterogeneity in the relationship between exporting, innovation, and financial constraints. In the model, both exporting and innovation involve fixed and sunk costs that must be financed upfront, while credit frictions—captured by a wedge between the cost of external and internal finance—raise the effective cost of undertaking these activities. These frictions shift upward the productivity threshold at which firms find it profitable to export or innovate, implying that credit constraints are more binding for smaller, less productive, or financially dependent firms.

The model also predicts that the complementarity between exporting and innovation is inherently asymmetric. Innovation directly enhances productivity and reduces production costs, thereby expanding firms' ability to compete in foreign markets. Exporting, by contrast, strengthens innovation incentives only indirectly, through larger market size and higher revenues. This asymmetry has clear implications for how financial frictions operate: credit

Table 3: Extensive Margins — Baseline

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
Credit rationing	-0.078***			-0.152***		
	(0.026)			(0.031)		
R&D	0.416***					
	(0.007)					
Export				0.251***		
				(0.070)		
	Instruments					
Sectoral R&D expenditure		0.063***				
		(0.002)				
Real exchange-rate shock					-1.996***	
					(0.283)	
Foreign-demand shock					0.054**	
					(0.021)	
Bank lending tightness			0.604***			0.604***
			(0.041)			(0.041)
Time & Sector & Region FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table reports the marginal effects derived from trivariate probit estimates that jointly model three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented. The impact of the instruments is reported in the bottom panel. The reported marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Full coefficient estimates are provided in Table A4. Variable definitions are reported in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

constraints are expected to be more binding for firms that do not innovate, as they lack the efficiency gains, internal liquidity, and reputational advantages that help cushion the impact of limited credit access. Differences between exporters and non-exporters, instead, should be less pronounced, since the export channel primarily influences innovation through increased demand rather than financial capacity.

While the model focuses on entry decisions, its logic naturally extends to the scale of firms' engagement once they innovate or export. Credit constraints can restrict working capital and the financing of variable costs, thereby limiting export intensity and R&D investment even after entry. This suggests that financial frictions may not only determine whether firms participate in these activities but also how deeply they can sustain them.

Guided by these mechanisms, the empirical analysis proceeds along three main dimensions of heterogeneity. First, Section 6.1 examines strategic heterogeneity, analyzing whether credit constraints exert differential effects across firms' activity profiles—between exporters and non-exporters, and between innovators and non-innovators. Second, Section 6.2 focuses on financial heterogeneity, allowing for differences in firm size, productivity, liquidity, and sectoral external financial dependence as key structural dimensions shaping how tightly financing frictions bind. Finally, Section 6.3 turns to the intensive margins of exporting and innovation to assess how credit constraints influence not only firms' participation but also the intensity of their engagement in these activities. Together, these analyses provide a comprehensive test of the model's predictions and reveal where—and for whom—financial frictions most strongly shape the joint dynamics of innovation and internationalization.

6.1 Heterogeneity by Strategic Profile

Table 4 tests for heterogeneous effects of financing constraints across firms' strategic profiles. It compares the impact of credit rationing on exporting between innovative and non-innovative firms, and on R&D investment between exporters and non-exporters. Given the split-sample design, the analysis employs bivariate probit models that jointly estimate the relevant outcome pairs, ensuring coherence with the baseline trivariate specification. The results reveal a marked asymmetry: credit constraints significantly depress export participation among non-innovative firms but have no statistically significant effect for those that engage in innovation. In the subsample of non-innovators (column 1), credit rationing reduces the probability of exporting by about 9 percentage points, which—given a conditional export probability of 34% (see Table 2)—corresponds to a 27% decline in the likelihood of exporting. By contrast, for innovative firms (column 2) the coefficient is statistically insignificant, and although its point estimate is similar to that for non-innovators, the implied effect amounts to only 9%, indicating a much weaker economic impact of credit constraints among R&D performers. These results indicate that innovation shields firms from the negative impact of credit constraints on exporting,

possibly through gains in productivity, reputation, and access to alternative funding sources.

Using the same empirical setup, columns (3) and (4) of Table 4 reverse the perspective and examine whether credit constraints influence the likelihood of undertaking innovation differently for exporters and non-exporters. Unlike the previous result, where innovation effectively neutralized the impact of credit rationing on export participation, exporting only partially mitigates the adverse effects of financial frictions on innovation. The evidence points to a more uniform pattern: credit rationing significantly reduces firms' R&D engagement across both groups. The estimated marginal effects are similar in magnitude—around a 14.5–15 percentage-point decline in the probability of innovation—but the relative impact is much stronger for non-exporters. Given the conditional probabilities of R&D activity, this corresponds to an 87% decrease among non-exporting firms and a 31% reduction among exporters, both economically sizable though clearly smaller for the latter. This asymmetry aligns closely with the model's predictions, according to which both innovation and exporting help ease financing frictions, but innovation provides the stronger buffer against credit constraints. Hence, while exporting attenuates the impact of credit constraints, it does not eliminate it, confirming that access to external finance remains a critical bottleneck for innovation itself.

Table 4: Extensive Margins — Heterogeneity by Strategic Profile

	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.091**	-0.061	-0.150***	-0.145**
	(0.036)	(0.053)	(0.050)	(0.059)
Sample:	R&D=0	R&D=1	Export=0	Export=1
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	36,059	16,290	28,804	23,545

Notes: This table reports the marginal effects derived from a bivariate probit model that jointly estimates two binary outcomes: *Export* (columns 1–2) or *R&D* (columns 3–4), and *Credit rationing* (coefficients not reported). The bivariate specification is adopted because the sample is split according to firms' R&D or export status, which prevents the joint estimation of the full trivariate system. The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Each endogenous variable is instrumented as in Table 3. Columns (1)–(2) refer to firms that do not or do perform R&D, respectively, while columns (3)–(4) distinguish between firms that do not or do export. Marginal effects are evaluated at observed sample values. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. Standard errors, clustered at the firm level, are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

These heterogeneous patterns remain robust across a wide range of alternative specifications, including models with a richer fixed-effects structure (Table A12), the Mundlak–Chamberlain adjustment (Table A13), and specifications that additionally control for firms' creditworthiness (Table A14). As an additional exercise, we re-estimate the models using an alternative sample split based on firms' intensity of engagement. Specifically, we

classify exporters and innovators, according to whether their export or R&D intensity lies above the 33rd percentile among firms with positive values (Table A15). This approach excludes marginal exporters and firms allocating only negligible resources to R&D, ensuring that the comparison is based on substantial and sustained engagement in these activities. The results are qualitatively consistent, confirming that the asymmetric impact of credit rationing across firm types is robust to defining exporters and innovators by the intensity rather than the incidence of these activities.

6.2 Additional Heterogeneities

To further investigate the mechanisms underlying our baseline results, we explore heterogeneity along four key dimensions: firm size, productivity, liquidity, and external financial dependence of the operating sector. These dimensions capture complementary aspects of how financial frictions shape firms' strategic behavior and are closely aligned with the mechanisms emphasized in our theoretical framework. Firm size and productivity reflect internal firm capabilities—affecting access to credit, efficiency, and the ability to absorb fixed costs associated with innovation and export activities—while liquidity captures firms' short-term financial flexibility and reliance on internal resources. At the sectoral level, external financial dependence measures the structural need for outside funding to sustain investment and growth, reflecting the technological and financial characteristics of the industry in which firms operate. Examining these four sources of heterogeneity—three at the firm level and one at the sectoral level—allows us to disentangle how both micro- and industry-level financial factors affect the relationship between credit constraints, innovation, and export participation. To this end, we re-estimate the trivariate probit model using a sample-splitting approach, comparing the marginal effects of credit rationing across groups of firms that differ along each of these four dimensions. For clarity, we discuss economic relevance by taking the estimates reported in Table 5 and rescaling the marginal effects using the corresponding conditional probabilities of exporting or performing R&D within each group (Table A2), thereby obtaining implied multipliers that quantify the magnitude of the effects.

We begin by examining whether the effects of credit constraints on exporting and innovation vary systematically with firm size.[15] Panel A of Table 5 shows that credit rationing exerts a stronger negative effect on small firms' exporting and innovation decisions, consistent with their more limited access to external finance. In contrast, for medium–large firms, the estimated impact of credit constraints is weaker—likely reflecting their greater financial resilience, easier access to bank credit, and broader internal funding capacity.[16] The magni-

[15] While the trivariate probit jointly models exporting, innovation, and credit rationing, we report only the marginal effects of credit constraints by group. This choice follows the theoretical framework, which predicts heterogeneity primarily in the strength of financial frictions rather than in the direct export–innovation linkage. We also do so for expositional clarity, given the many dimensions considered in Table 5.

[16] Small firms are defined as those with fewer than 50 employees and either annual turnover or total assets

tude of these effects is economically meaningful. Credit constraints reduce the probability of exporting by about 19% among small firms, compared to 12% for medium–large firms. The corresponding decline in the likelihood of performing R&D is of comparable magnitude—57% for small firms vs 50% for medium–large firms—showing that financial frictions consistently weigh more heavily on smaller firms, even if the differences in magnitude are moderate.

Panel B of Table 5 examines whether the effects of credit constraints differ across firms with varying productivity levels. Firms are divided according to whether their labor productivity lies below or above the sample median. The results reveal a clear pattern: credit rationing significantly hampers both exporting and innovation among low-productivity firms, whereas the effects are statistically insignificant for their more productive counterparts. This finding aligns with the model's prediction that financial frictions bind more tightly for less efficient firms, which typically face lower profitability margins and reduced internal liquidity. Quantitatively, credit constraints reduce the probability of exporting by about 33% relative to the baseline probability for low-productivity firms. For R&D, the estimated marginal effect is of comparable magnitude—essentially eliminating the baseline likelihood of engaging in innovation. Together, these results indicate that productivity acts as an important buffer against credit constraints, with only the least efficient firms experiencing substantial restrictions on their ability to export and innovate.

Panel C of Table 5 examines heterogeneity by firms' liquidity position, distinguishing between firms with low and high liquidity based on the sample median of liquid assets over total assets. The results show that credit rationing has a pronounced negative effect on export participation only for firms with low liquidity, reducing their probability of exporting by about 24%. For firms with higher liquidity, the effect is statistically insignificant, suggesting that stronger cash buffers help mitigate exposure to external financing shocks. Regarding R&D activity, credit constraints significantly reduce innovation engagement for both liquidity groups, though the impact is considerably stronger among firms with limited liquidity—47% compared with 32% for their more liquid counterparts. These findings indicate that internal liquidity serves as an important cushion against credit supply restrictions, consistent with the model's self-financing channel, whereby firms' own liquid resources relax effective financial constraints on innovation and export activities.

Panel D of Table 5 examines heterogeneity by external financial dependence (EFD), measured in the spirit of Rajan and Zingales (1998). EFD is defined as the share of investment expenditures not financed through internal cash flow, computed at the firm level and aggregated by sector to capture persistent technological and structural features that shape financing needs across industries. Higher EFD values indicate sectors that rely more heavily on external capital markets or bank financing to sustain investment activity. The results show that credit rationing significantly reduces export participation only for firms operating in sectors

not exceeding 10 million euros. See https://single-market-economy.ec.europa.eu/smes/sme-definition_en.

Table 5: Extensive Margins — Additional Heterogeneities

	Panel A: Firm Size			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.070*	-0.074**	-0.138***	-0.241***
	(0.036)	(0.031)	(0.044)	(0.081)
Sample:	Small	Medium–Large	Small	Medium–Large
N obs.	38,332	14,017	38,332	14,017
	Panel B: Firm Productivity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.109***	-0.063	-0.252***	-0.080
	(0.035)	(0.042)	(0.040)	(0.050)
Sample:	Low Productivity	High Productivity	Low Productivity	High Productivity
N obs.	25900	26449	25900	26449
	Panel C: Firm Liquidity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.103***	-0.046	-0.140***	-0.098*
	(0.029)	(0.052)	(0.038)	(0.051)
Sample:	Low Liquidity	High Liquidity	Low Liquidity	High Liquidity
N obs.	25714	26635	25714	26635
	Panel D: External Financial Dependence (EFD)			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.044	-0.108***	-0.092***	-0.180***
	(0.044)	(0.035)	(0.033)	(0.043)
Sample:	Low EFD	High EFD	Low EFD	High EFD
N obs.	25900	26449	25900	26449
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y

Notes: This table reports the marginal effects of *Credit rationing* estimated across different subsamples of firms to test the model prediction that financing frictions exert heterogeneous effects depending on firms' structural characteristics. The estimates are derived from trivariate probit models jointly modelling three binary outcomes—*Export*, *R&D*, and *Credit rationing*—allowing for correlation in unobserved factors through unrestricted error-term correlations. Each endogenous variable is instrumented as in Table 3. Panels A–D present results for alternative firm groupings. In Panel A, firms are split by size (*Small* vs *Medium–Large*) following the Eurostat definition: fewer than 50 employees and either annual sales or total assets below €10 million. Panel B classifies firms as *Low*- or *High*-productivity based on whether labor productivity lies below or above the sample median. Panel C separates firms by liquidity (*Low* or *High*), according to the median ratio of liquid assets to total assets. Panel D distinguishes firms operating in sectors with *Low* or *High* external financial dependence (EFD), computed following Rajan and Zingales (1998) as the sector-level average of firms' external financing needs, defined by the ratio of investment to operating cash flow. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *R&D* (in columns 1-2), *Export* (in columns 3-4), *Age*, *Labor productivity*, *Total assets*, and *ROA*. Conditional averages by size, productivity, liquidity, and EFD used to derive the implied multipliers discussed in the main text are reported in Table A2. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

with high EFD, lowering their probability of exporting by about 31%. For firms in low-EFD sectors, the effect is smaller and statistically insignificant, suggesting that the negative effect of financial frictions on exporting is most pronounced in industries structurally dependent on external funding. In the case of R&D activity, credit constraints exert a negative and significant effect for both groups, but the magnitude is markedly stronger for firms in high-EFD sectors—around 72% compared with 26% for those in low-EFD sectors. This pattern underscores that structural reliance on external finance amplifies firms' vulnerability to credit supply shocks, as sectors where internal cash flow plays a limited role are less able to buffer investment and innovation against funding constraints.

These heterogeneous patterns are largely robust to the full set of sensitivity analyses performed in Section 6.2, including specifications with a richer fixed-effects structure, the Mundlak–Chamberlain correction, and additional controls for firms' creditworthiness (see Tables A16–A18).[17]

Taken together, the results reveal a consistent pattern: credit constraints are most detrimental for firms that are smaller, less productive, and less liquid, as well as for those in sectors structurally reliant on external finance. Across most groups, financing frictions appear to bind more tightly for innovation than for exporting, as R&D activity is systematically hindered by credit rationing regardless of firms' characteristics. These findings align with the mechanisms highlighted in the theoretical model, whereby firms with stronger internal resources or greater access to finance are better able to sustain innovation and internationalization when credit supply tightens. Our results show that both firm-level financial capacity and industry-level reliance on external finance critically shape how strongly credit constraints limit firms' strategic growth activities.

6.3 Intensive Margins

To conclude, we extend the empirical framework to the intensive margins by re-estimating the full trivariate system for exporting, innovation, and credit rationing. The analysis assesses whether financing frictions shape not only firms' decisions to participate but also the magnitude of their involvement in these activities. *% Export* is defined as the share of total turnover generated abroad, while *% R&D* corresponds to the share of turnover devoted to R&D expenditure. Given the non-negative and highly skewed distribution of these variables, we estimate Poisson pseudo–maximum likelihood (PPML) regressions. As outlined in Section 4, we address potential endogeneity using a control-function (residual inclusion) approach. In a first step, *% Export*, *% R&D*, and *Credit rationing* are each regressed on the corresponding instruments and controls, and the residuals from these first-stage equations—capturing the

[17] While point estimates sometimes differ in magnitudes across specifications, the implied multipliers—obtained by rescaling marginal effects by the relevant conditional probabilities—consistently confirm the conclusions discussed in the text.

endogenous components—are then included in the second-stage specifications. The estimated coefficients are reported as average marginal effects, measuring how changes in financial constraints or complementary activities affect the intensity of firms' exporting and innovation efforts, conditional on the estimated residuals.

The results, reported in Table 6, show that financial constraints substantially hinder firms' ability to scale up both exporting and innovation. Credit rationing is associated with lower *% Export* and *% R&D*, revealing that limited access to finance constrains the expansion of these activities. The estimated effects are economically significant: credit constraints have a strong impact on export intensity, with a marginal effect of 0.226, corresponding to roughly 61% of the conditional mean among exporting firms (0.373), and a smaller but still significant effect on R&D intensity, with a coefficient of 0.043, that is about 45% of the conditional mean among innovators (0.096). These magnitudes imply that financial frictions substantially limit firms' ability to deepen their engagement in international and innovative activities once they have entered these domains. Moreover, export and innovation intensities reinforce each other, consistent with the model's prediction of asymmetric complementarity—whereby innovation, by improving efficiency and internal liquidity, more strongly supports export performance than the reverse channel operating through market expansion.

Table 6: Intensive Margins

	(1)	(2)
	% Export	% R&D
Credit rationing	-0.226***	-0.043**
	(0.055)	(0.017)
% R&D	1.939***	
	(0.098)	
% Export		0.358***
		(0.041)
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—together with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to purge endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

These results are robust across a wide range of alternative specifications, mirroring the

exercises performed for the extensive margins (Section 5). The estimates are virtually unchanged when adopting a richer fixed-effects structure, applying the Mundlak–Chamberlain adjustment, conditioning on firm switchers, or controlling for creditworthiness, ownership, and managerial characteristics. Likewise, using an alternative measure of credit rationing based solely on explicit loan rejections yields consistent results, confirming that our conclusions are not driven by model specification or measurement choices (Tables A19–A24).

Finally, as a counterpart to the heterogeneity analysis in Section 6.1, Table 7 examines how the impact of credit constraints varies with the intensity of firms' exporting and innovation activities. The sample is split according to firms' export and R&D intensity to capture differences in the degree of engagement rather than simple participation. The results show that financial constraints are most binding for firms at the lower end of the intensity distribution and gradually lose importance as firms expand their presence in foreign markets or innovation (see also the robustness in Tables A25–A27). Unlike the extensive margin—where credit constraints hinder exporting only among non-innovators—at the intensive margin the effect is less asymmetric: credit constraints significantly depress both export and R&D intensity across all groups. This pattern is consistent with the mechanisms implied by our theoretical framework: once firms have entered exporting or innovation and sunk the associated fixed costs, subsequent adjustments take place along the variable-cost margin, where credit constraints operate through working-capital needs and therefore dampen export and R&D intensity in a more similar way. Nevertheless, the complementarity between exporting and innovation remains asymmetric, as increases in R&D intensity continue to exert a substantially stronger effect on export intensity than the reverse channel operating through market expansion.

Overall, our results confirm that exporting and innovation are mutually reinforcing strategies, and that financial constraints remain a key bottleneck in scaling up both forms of firm dynamism. Taken together, the evidence highlights that easing credit frictions could generate substantial productivity and competitiveness gains, by enabling firms not only to enter but also to expand their presence in foreign and innovation markets.

7 Conclusions

This paper has examined the joint relationship between firms' innovation, exporting, and access to external finance. Guided by a stylized theoretical framework, we showed that these strategic choices are mutually reinforcing but characterized by asymmetric complementarities. Innovation enhances productivity and lowers marginal production costs, thereby expanding the profitability range of exporting. Export participation, in turn, increases the expected returns to innovation by broadening market opportunities and strengthening learning and reputational channels. Both activities, however, require substantial upfront investment and are thus sensitive to financial frictions that limit firms' ability to finance fixed and working-

Table 7: Intensive Margins — Heterogeneity by Strategic Profile

	(1)	(2)	(3)	(4)
	% Export	% Export	% R&D	% R&D
Credit rationing	-0.129**	-0.057	-0.051**	0.020
	(0.051)	(0.145)	(0.021)	(0.031)
% R&D	4.063***	1.847***		
	(0.152)	(0.261)		
% Export			0.459***	0.324***
			(0.052)	(0.080)
Sample:	% R&D $\leq$ p33	% R&D > p33	% Export $\leq$ p33	% Export > p33
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	41818	8173	35833	14158

Notes: This table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. Columns (1)–(2) present results for the *% Export* equation, estimated separately for firms below and above the 33rd percentile of the *% R&D expenditure* distribution (conditional on positive R&D spending). Columns (3)–(4) report results for the *% R&D* equation, estimated separately for firms below and above the 33rd percentile of the *% Export* distribution. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—together with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to purge endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

capital costs. The model predicts that these frictions weigh most heavily on firms that have not yet entered export or innovation activities, because credit constraints are more binding before firms accumulate the productivity, liquidity, and credibility gains that reduce their reliance on external finance once these activities are underway. As firms deepen their engagement in exporting and innovation, these gains gradually relax the effective tightness of credit constraints.

Empirically, we provided novel evidence consistent with these mechanisms using firm-level data that combine balance-sheet information with survey-based measures of R&D, exporting, and credit access. The results reveal strong two-way complementarities: innovation promotes international trade, exporting stimulates innovative effort, and both rely on access to external finance. Credit rationing significantly reduces not only firms' participation in these activities but also their scale, underscoring the central role of financial constraints in limiting firm dynamism. At the same time, innovation mitigates the adverse effects of credit frictions on exporting, consistent with the notion that more innovative firms benefit from higher productivity and greater internal liquidity. Conversely, while exporting also helps ease financial constraints on innovation, its mitigating effect is more limited, confirming that access to external finance remains a key bottleneck for innovative activity. These effects are not uniform across firms: financing constraints are particularly binding for smaller, less productive, and less liquid firms, as well as for those operating in sectors more dependent on external finance. This pattern supports the view that firms' capacity to self-finance and generate internal resources shields them from the real effects of credit frictions on exporting and innovation, while financially weaker firms remain more exposed.

Overall, our evidence confirms that exporting and innovation are deeply interlinked components of firm growth, while access to finance continues to constrain the extent to which firms can fully exploit these complementarities. Policies that alleviate credit frictions—particularly for smaller, less productive, or liquidity-constrained firms—may therefore yield disproportionate returns in terms of innovation capacity and international competitiveness. By facilitating the joint expansion of innovative and exporting activities, financial development policies, targeted credit guarantees, and innovation-oriented lending instruments could reinforce the virtuous cycle between productivity growth and internationalization, amplifying the aggregate benefits of firm-level dynamism.

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When Credit Bites: Financing Constraints and the Innovation–Export Link

Online Appendix

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Table A1: Variable description

Variable name	**Definition**
Export	Dummy equal to one if the firm exports. Source: MET survey.
% Export	Share of the firm's sales generated by exports, expressed as a percentage. Source: MET survey.
R&D	Dummy equal to one if the firm has undertaken R&D activities. Source: MET survey.
% R&D	Ratio of the firm's total R&D spending to total sales, expressed as a percentage. Source: MET survey.
Credit rationing	Dummy equal to one if the firm reports being credit rationed by banks. Following Balduzzi et al. (2024), a firm is considered rationed if its loan request was denied, granted for a lower amount than requested, or if it refrained from applying for credit due to anticipated refusal. In robustness checks, we use a narrower definition (*Bank credit rationing*) that includes only firms whose loan applications were explicitly rejected by banks. Source: MET survey.
Innovation	Dummy equal to one if the firm has introduced at least one product or process innovation. Source: MET survey.
Sectoral R&D expenditure	Instrument for firm-level R&D activity. Total R&D spending undertaken by Italian firms in each two-digit NACE Rev.2 industry and year. Source: Eurostat R&D statistics.
Real exchange-rate shock	Instrument for export activity. Annual changes in bilateral exchange rates between Italy and each exporting partner country, weighted by the corresponding export shares. Sources: MET Survey (industry-level information) and Bank of Italy (bilateral exchange rates).
Foreign-demand shock	Instrument for export activity. Weighted growth rate of foreign demand for sectoral products, calculated from total imports by all destination countries (excluding Italy). Changes in the log of import flows are weighted by Italy's lagged export shares by sector and destination. Source: WITS.
Bank lending tightness	Instrument for credit rationing. Measure of credit-supply variation based on the interaction between year dummies and the identity of the firm's main lender bank, capturing time-varying, bank-specific lending conditions. Source: MET survey.
Age	Natural logarithm of the firm's age (years since establishment). Source: MET survey.
Labor productivity	Natural logarithm of value added per employee. Source: Aida Bureau van Dijk.
Total assets	Natural logarithm of total assets (in euros). Source: Aida Bureau van Dijk.
ROA	Return on assets, defined as the ratio of operating profits to total assets. Source: Aida Bureau van Dijk.
Relationship lending	Length of the relationship with the firm's lender banks. In the case of multiple banking relationships (approximately 40% of the sample), this measure is computed as the simple average across all reported bank–firm relationships. Source: MET Survey.
Leverage	Ratio of total liabilities to total assets. Source: Aida Bureau van Dijk.
Liquidity	Ratio of liquid assets to total assets. Source: Aida Bureau van Dijk.
Family firm	Dummy equal to one if the firm is family owned. Source: MET survey.

Group	Dummy equal to one if the firm belongs to a corporate group. Source: MET survey.
% Manager past experience	Share of managers with previous managerial experience in other firms. Source: MET survey.
% Manager degree	Share of managers with a university or postgraduate degree. Source: MET survey.
Small	Dummy equal to one if the firm qualifies as a small enterprise under the Eurostat definition, i.e., employing fewer than 50 workers and having either annual sales or total assets below €10 million. Sources: MET survey and Aida Bureau van Dijk.
Medium–Large	Dummy equal to one if the firm does not qualify as a small enterprise, i.e., employing 50 or more workers or having annual sales or total assets equal to or above €10 million. Sources: MET survey and Aida Bureau van Dijk.
Productivity (High/Low)	Dummy equal to one if the firm's labor productivity is above (below) the sample median. Source: Aida Bureau van Dijk.
Liquidity (High/Low)	Dummy equal to one if the firm's liquidity ratio is above (below) the sample median. Source: Aida Bureau van Dijk.
EFD (High/Low)	Sector-level measure of external financial dependence (EFD), defined as the share of investment expenditures not financed through internal cash flow. For each firm, EFD is computed as (capital expenditures − operating cash flow)/capital expenditures, where capital expenditures include both tangible and intangible investments. The sectoral EFD is obtained as the average firm-level value within each two-digit NACE Rev.2 industry. A dummy is set equal to one for sectors with EFD above the median. Constructed following Rajan and Zingales (1998). Source: Aida Bureau van Dijk.

Table A2: Conditional Averages by Size, Productivity, Liquidity, and EDF

	Average	
	Export	ReS
Small	0.376	0.243
Medium-Large	0.621	0.476
Low Productivity	0.335	0.229
High Productivity	0.535	0.371
Low Liquidity	0.428	0.298
High Liquidity	0.452	0.309
Low EFD	0.532	0.360
High EFD	0.352	0.249

Notes: This table reports conditional means of *Export* and *R&D* by group categories, used to provide an economic quantification of the marginal effects. Variable definitions are in Appendix Table A1.

Table A3: Power of the Instruments

	(1) Export	(2) R&D	(3) Credit rationing
	External Instruments		
Real exchange-rate shock	-1.609***		
	(0.264)		
Foreign-demand shock	0.053***		
	(0.020)		
Sectoral R&D expenditure		0.048***	
		(0.003)	
Bank lending tightness			0.572***
			(0.040)
	Other Regressors in First Stage		
Credit rationing	-0.010	-0.018**	
	(0.007)	(0.007)	
R&D	0.188***		-0.006*
	(0.004)		(0.003)
Export		0.178***	-0.004
		(0.004)	(0.003)
Age	0.030***	-0.017***	-0.002
	(0.003)	(0.003)	(0.002)
Labor productivity	0.016***	0.005	-0.021***
	(0.004)	(0.003)	(0.002)
Total assets	0.058***	0.050***	0.001
	(0.002)	(0.001)	(0.001)
ROA	0.043**	-0.004	-0.003
	(0.021)	(0.003)	(0.002)
Sector & Region & Time FE	Y	Y	Y
N obs.	53,863	53,863	52,349
Pseudo R2	0.239	0.156	0.067

Notes: This table reports first-stage-type results assessing the strength and relevance of the instrumental variables. The dependent variable is a binary indicator for *Export* (column 1), *R&D* (column 2), and *Credit rationing* (column 3). Reported coefficients correspond to average marginal effects from probit estimations. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Variable definitions are reported in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A4: Extensive Margins (Baseline) — Full Controls Included

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
Credit rationing	-0.078***			-0.152***		
	(0.026)			(0.031)		
R&D	0.416***					
	(0.007)					
Export				0.251***		
				(0.070)		
Age	0.027***	-0.011***	-0.002	-0.019***	0.027***	-0.002
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Labor productivity	0.010***	0.007**	-0.021***	0.001	0.015***	-0.021***
	(0.003)	(0.004)	(0.002)	(0.004)	(0.005)	(0.002)
ROA	0.030*	-0.005	-0.002	-0.005**	0.062**	-0.002
	(0.017)	(0.003)	(0.002)	(0.002)	(0.027)	(0.002)
Total assets	0.029***	0.062***	0.001	0.044***	0.072***	0.001
	(0.002)	(0.001)	(0.001)	(0.007)	(0.002)	(0.001)
	Instruments					
Sectoral R&D expenditure		0.063***				
		(0.002)				
Real exchange-rate shock					-1.996***	
					(0.283)	
Foreign-demand shock					0.054**	
					(0.021)	
Bank lending tightness			0.604***			0.604***
			(0.041)			(0.041)
Time & Sector & Region FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table replicates the analysis of Table 3, while reporting the full set of control variables included in the estimations. The table presents marginal effects derived from trivariate probit models that jointly estimate three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A5: Extensive Margins — Richer Fixed Effects Structure

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
Credit rationing	-0.087***			-0.161***		
	(0.031)			(0.031)		
R&D	0.411***					
	(0.008)					
Export				0.237***		
				(0.071)		
	Instruments					
Sectoral R&D expenditure		0.064***				
		(0.003)				
Real exchange-rate shock					-2.341***	
					(0.328)	
Foreign-demand shock					0.039*	
					(0.022)	
Bank lending tightness			0.609***			0.609***
			(0.041)			(0.041)
Sector × Time FE	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table replicates the analysis of Table 3, while allowing for a richer fixed-effects structure. Specifically, sector–year interacted effects replace separate sector and time dummies, capturing unobserved industry-specific shocks that vary over time—such as changes in demand, technology, or policy—that may simultaneously influence firms' export, innovation, and financing decisions. The table presents marginal effects derived from trivariate probit estimates that jointly model three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A6: Extensive Margins — Mundlak-Chamberlain Adjustment

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
Credit rationing	-0.072**			-0.169***		
	(0.028)			(0.034)		
R&D	0.301***					
	(0.011)					
Export				0.091		
				(0.106)		
	Instruments					
Sectoral R&D expenditure		0.062***				
		(0.002)				
Bank lending tightness			0.580***			0.601***
			(0.040)			(0.041)
Real exchange-rate shock					-1.958***	
					(0.305)	
Foreign-demand shock					0.054**	
					(0.021)	
Mundlak adjustment	Y	Y	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
Observations	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table replicates the analysis of Table 3, while accounting for unobserved firm-level heterogeneity. The Mundlak–Chamberlain correction (Mundlak, 1978; Chamberlain, 1982) is implemented by augmenting each equation with the firm-specific time averages of all time-varying regressors, thereby controlling for potential correlation between these covariates and time-invariant unobserved factors. The table presents marginal effects derived from trivariate probit estimates jointly modeling three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A7: Extensive Margins – Analysis on Switchers

	(1) Export	(2) R&D
Credit rationing	-0.072	-0.144***
	(0.072)	(0.032)
R&D	0.263***	
	(0.025)	
Export		0.243***
		(0.079)
Sample	Export_{t-1}=0	$\text{R\&D}_{t-1}$=0
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	12,008	50,028

Notes: This table replicates the analysis of Table 3, restricting the sample to firms that had not exported or undertaken R&D activities prior to period t. The estimated coefficients therefore capture the probability of *starting* export and R&D activities, respectively. This approach helps address potential persistence and path dependence in firms' strategic choices, ensuring that results reflect the determinants of entry into exporting and innovation rather than the continuation of pre-existing behaviors. The table reports marginal effects derived from trivariate probit estimates that jointly model three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Column (1) presents results for export decisions (Equation 14a), while column (2) reports results for R&D activities (Equation 15a). Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A8: Extensive Margins — Controlling for Proxies of Firm Creditworthiness

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a–14b–14c			Equations 15a–15b–15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
R&D	0.412***					
	(0.007)					
Export				0.221**		
				(0.112)		
Credit rationing	-0.061**			-0.144***		
	(0.025)			(0.032)		
Age	0.029***	-0.010***	-0.003	-0.018***	0.030***	-0.002
	(0.002)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)
Labor productivity	0.011***	0.008**	-0.021***	0.003	0.018***	-0.021***
	(0.003)	(0.004)	(0.002)	(0.004)	(0.005)	(0.002)
ROA	0.008	-0.005*	-0.002	-0.005**	0.030	-0.002
	(0.015)	(0.003)	(0.002)	(0.003)	(0.026)	(0.002)
Total assets	0.032***	0.064***	-0.001	0.047***	0.076***	-0.001
	(0.002)	(0.001)	(0.001)	(0.012)	(0.002)	(0.001)
Leverage	-0.099***	-0.054***	0.035***	-0.010	-0.162***	0.035***
	(0.010)	(0.010)	(0.007)	(0.024)	(0.013)	(0.007)
Liquidity	-0.000*	-0.001**	-0.001*	-0.001**	-0.001***	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Relationship lending	0.107***	0.054***	-0.035***	0.010	0.168***	-0.035***
	(0.009)	(0.010)	(0.007)	(0.024)	(0.011)	(0.007)
	Instruments					
Sectoral R&D expenditure		0.062***				
		(0.002)				
Bank lending tightness			0.580***			0.600***
			(0.041)			(0.041)
Real exchange-rate shock					-1.913***	
					(0.308)	
Foreign-demand shock					0.048**	
					(0.021)	
Sector & Region & Time FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,327	52,327	52,327	52,327	52,327	52,327

Notes: This table replicates the analysis of Table 3, while additionally controlling for proxies of firms' creditworthiness to mitigate concerns that the credit-supply instrument may capture borrower quality rather than exogenous financial shocks. These proxies include *Leverage*, *Liquidity*, *ROA*, and the *Relationship lending*. By conditioning on these balance-sheet variables and proxies of soft information accumulated by the lender bank (length of the relationship), we reduce the risk that our results reflect assortative matching between more creditworthy firms and less risk-averse banks, rather than genuine supply-side constraints. The table presents marginal effects derived from trivariate probit estimates jointly modeling three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A9: Extensive Margins — Controlling for Proprietorship and Managerial Characteristics

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Credit rationing	R&D	Export	Credit rationing
R&D	0.396***					
	(0.008)					
Export				0.271***		
				(0.046)		
Credit rationing	-0.145***			-0.162***		
	(0.040)			(0.044)		
Family firm	0.042***	0.043***	0.004	0.024***	0.075***	0.003
	(0.005)	(0.006)	(0.003)	(0.007)	(0.006)	(0.003)
Group	0.011*	-0.011	-0.006	-0.014*	0.009	-0.007
	(0.007)	(0.008)	(0.005)	(0.008)	(0.008)	(0.005)
% Manager past experience	0.000***	-0.000***	-0.000***	-0.000***	0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
% Manager degree	0.000***	0.001***	0.000	0.001***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	Instruments					
Sectoral R&D expenditure		0.078***				
		(0.003)				
Bank lending tightness			0.574***			0.587***
			(0.044)			(0.044)
Real exchange-rate shock					-3.179***	
					(0.519)	
Foreign-demand shock					0.017	
					(0.023)	
Sector & Region & Time FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	27,629	27,629	27,629	27,629	27,629	27,629

Notes: This table replicates the analysis of Table 3, while additionally controlling for firms' proprietorship structure and managerial characteristics to address potential heterogeneity in access to finance and strategic decision-making. The additional variables include *Family firm*, *Group*, *% Manager past experience*, and *% Manager degree*. *Family firm* is a dummy indicating whether the firm is family-owned; *Group* is a dummy equal to one if the firm belongs to a corporate group; *% Manager past experience* measures the share of managers with previous managerial experience in other firms; and *% Manager degree* captures the share of managers holding a university or postgraduate degree. Together, these variables account for ownership structure, organizational complexity, and managerial quality, which may influence firms' access to external finance, innovation, and export performance. Controlling for these dimensions helps to mitigate concerns that the estimated effects reflect persistent firm-specific characteristics rather than exogenous credit-supply shocks. The table presents marginal effects derived from trivariate probit estimates jointly modeling three binary outcomes: *Export*, *R&D*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Other untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A10: Extensive Margins — Alternative Measure of Innovation

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	Innovation	Credit rationing	Innovation	Export	Credit rationing
Credit rationing	-0.081***			-0.143***		
	(0.024)			(0.033)		
Innovation	0.400***					
	(0.006)					
Export				0.184***		
				(0.045)		
	Instruments					
Sectoral R&D expenditure		0.062***				
		(0.003)				
Real exchange-rate shock					-1.936***	
					(0.272)	
Foreign-demand shock					0.055**	
					(0.021)	
Bank lending tightness			0.596***			0.596***
			(0.041)			(0.041)
Sector & Region & Time FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table replicates the analysis of Table 3, while employing an alternative measure of innovation. Instead of *R&D*, we use *Innovation*, a dummy equal to one if the firm has introduced at least one product or process innovation. The table presents marginal effects derived from trivariate probit estimates that jointly model three binary outcomes: *Export*, *Innovation*, and *Credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *Innovation* in column (2), *Export* in column (5), and *Credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A11: Extensive Margins — Alternative Measure of Credit Rationing

Specification:	(1)	(2)	(3)	(4)	(5)	(6)
	Equations 14a-14b-14c			Equations 15a-15b-15c		
	Export	R&D	Bank credit rationing	R&D	Export	Bank credit rationing
Bank credit rationing	-0.045*			-0.119***		
	(0.023)			(0.034)		
R&D	0.417***					
	(0.007)					
Export				0.251***		
				(0.070)		
	Instruments					
Sectoral R&D expenditure		0.063***				
		(0.002)				
Real exchange-rate shock					-1.994***	
					(0.283)	
Foreign-demand shock					0.054**	
					(0.021)	
Bank lending tightness			0.409***			0.409***
			(0.037)			(0.037)
Sector & Region & Time FE	Y	Y	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y	Y	Y
N obs.	52,349	52,349	52,349	52,349	52,349	52,349

Notes: This table replicates the analysis of Table 3, while employing an alternative definition of credit rationing (*Bank credit rationing*). In this specification, the variable captures only cases of explicit loan rejection by banks, thereby excluding discouraged borrowers—firms that refrained from applying for credit due to anticipated denial. The table presents marginal effects derived from trivariate probit estimates that jointly model three binary outcomes: *Export*, *R&D*, and *Bank credit rationing*. The specification allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Columns (1)–(3) correspond to Equations 14a–14b–14c, while columns (4)–(6) refer to Equations 15a–15b–15c. *R&D* in column (2), *Export* in column (5), and *Bank credit rationing* in columns (3) and (6) are instrumented, with the impact of the instruments reported in the bottom panel. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A12: Extensive Margins — Heterogeneity by Strategic Profile
Richer Fixed Effects Structure

	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.103**	-0.082	-0.162***	-0.155**
	(0.043)	(0.061)	(0.051)	(0.060)
Sample:	R&D=0	R&D=1	Export=0	Export=1
Sector × Time FE	Y	Y	Y	Y
Region FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	36,059	16,290	28,804	23,545

Notes: This table replicates the analysis of Table 4, while adopting a richer fixed-effects structure. Specifically, sector–year interacted effects replace separate sector and time dummies, capturing unobserved industry-specific shocks that vary over time—such as fluctuations in demand, technological change, or policy interventions—that may jointly influence firms' export, innovation, and financing decisions. The table reports the marginal effects derived from a bivariate probit model that jointly estimates two binary outcomes: *Export* (columns 1–2) or *R&D* (columns 3–4), and *Credit rationing* (coefficients not reported). The bivariate specification is adopted because the sample is split according to firms' R&D or export status, which prevents the joint estimation of the full trivariate system. The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Marginal effects are evaluated at observed sample values. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. Standard errors, clustered at the firm level, are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A13: Extensive Margins — Heterogeneity by Strategic Profile
Mundlak–Chamberlain Adjustment

	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.081**	-0.051	-0.171***	-0.162**
	(0.039)	(0.057)	(0.052)	(0.064)
Sample:	R&D=0	R&D=1	Export=0	Export=1
Mundlak adjustment	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	36,059	16,290	28,804	23,545

Notes: This table replicates the analysis of Table 4, while accounting for unobserved firm-level heterogeneity. The Mundlak–Chamberlain correction (Mundlak, 1978; Chamberlain, 1982) is implemented by augmenting each equation with the firm-specific time averages of all time-varying regressors, thereby controlling for potential correlation between these covariates and time-invariant unobserved characteristics. The table reports the marginal effects derived from a bivariate probit model that jointly estimates two binary outcomes: *Export* (columns 1–2) or *R&D* (columns 3–4), and *Credit rationing* (coefficients not reported). The bivariate specification is adopted because the sample is split according to firms' R&D or export status, which precludes the joint estimation of the full trivariate system. The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Marginal effects are evaluated at observed sample values. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. Standard errors, clustered at the firm level, are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A14: Extensive Margins — Heterogeneity by Strategic Profile
Controlling for Proxies of Firm Creditworthiness

	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.068**	-0.035	-0.140***	-0.143**
	(0.034)	(0.055)	(0.048)	(0.058)
Age	0.036***	0.022***	-0.016***	-0.018***
	(0.004)	(0.005)	(0.003)	(0.005)
Labor productivity	0.015***	0.018***	0.014***	-0.009
	(0.005)	(0.007)	(0.004)	(0.008)
ROA	0.022	0.000	-0.004**	0.078*
	(0.025)	(0.004)	(0.002)	(0.042)
Total assets	0.063***	0.057***	0.028***	0.082***
	(0.002)	(0.003)	(0.002)	(0.003)
Leverage	-0.150***	-0.105***	0.000	-0.033
	(0.015)	(0.019)	(.)	(0.022)
Liquidity	-0.001***	-0.000	0.000	-0.000
	(0.000)	(0.000)	(.)	(0.000)
Relationship lending	0.170***	0.112***	0.000	-0.026
	(0.012)	(0.018)	(.)	(0.018)
Sample:	R&D=0	R&D=1	Export=0	Export=1
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	36,059	16,290	28,804	23,545

Notes: This table replicates the analysis of Table 4, while additionally controlling for proxies of firms' creditworthiness to mitigate concerns that the credit-supply instrument may capture borrower quality rather than exogenous financial shocks. These proxies include *Leverage*, *Liquidity*, *ROA*, and *Relationship lending*. By conditioning on these balance-sheet variables and proxies of soft information accumulated by the lender bank (length of the relationship), we reduce the risk that our results reflect assortative matching between more creditworthy firms and less risk-averse banks, rather than genuine supply-side constraints. The table reports the marginal effects derived from a bivariate probit model that jointly estimates two binary outcomes: *Export* (columns 1–2) or *R&D* (columns 3–4), and *Credit rationing* (coefficients not reported). The bivariate specification is adopted because the sample is split according to firms' R&D or export status, which precludes the joint estimation of the full trivariate system. The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Marginal effects are evaluated at observed sample values. Other untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. Standard errors, clustered at the firm level, are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A15: Extensive Margins — Heterogeneity by Strategic Profile
Alternative Definitions

	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.087***	-0.018	-0.168***	-0.162**
	(0.031)	(0.076)	(0.043)	(0.073)
R&D	0.181***			
	(0.007)			
Export			0.134***	
			(0.005)	
Sample:	% R&D $\leq$ p33	% R&D > p33	% Export $\leq$ p33	% Export > p33
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	41,818	10,531	36,877	15,472

Notes: This table replicates the analysis of Table 4, while adopting different sample-splitting criteria. Instead of splitting firms based on their export or R&D status, we classify them according to the intensity of their engagement in these activities. Columns (1)–(2) report results for firms below and above the 33$^{\text{rd}}$ percentile of the *R&D intensity* distribution, respectively, while columns (3)–(4) present results for firms below and above the 33$^{\text{rd}}$ percentile of the *Export intensity* distribution, respectively. The table reports the marginal effects derived from a bivariate probit model that jointly estimates two binary outcomes: *Export* (columns 1–2) or *R&D* (columns 3–4), and *Credit rationing* (coefficients not reported). The bivariate specification is adopted because the sample is split according to firms' R&D or export intensity, which prevents the joint estimation of the full trivariate system (at least in columns 2 and 4). The model allows for correlation in unobserved factors affecting these decisions through unrestricted correlation coefficients between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Marginal effects are evaluated at observed sample values. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are reported in Appendix Table A1. Standard errors, clustered at the firm level, are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A16: Extensive Margins — Additional Heterogeneities
Richer Fixed Effects Structure

	Panel A: Firm Size			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.071*	-0.107**	-0.137***	-0.295***
	(0.038)	(0.053)	(0.039)	(0.058)
Sample:	Small	Medium–Large	Small	Medium–Large
N obs.	38332	14017	38332	14017
	Panel B: Firm Productivity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.081*	-0.098**	-0.122***	-0.209***
	(0.044)	(0.039)	(0.043)	(0.043)
Sample:	Low Productivity	High Productivity	Low Productivity	High Productivity
N obs.	26206	26143	26206	26143
	Panel C: Firm Liquidity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.107***	-0.065	-0.146***	-0.142**
	(0.033)	(0.072)	(0.039)	(0.055)
Sample:	Low Liquidity	High Liquidity	Low Liquidity	High Liquidity
N obs.	25714	26635	25714	26635
	Panel D: External Financial Dependence (EFD)			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.041	-0.130***	-0.113***	-0.182***
	(0.056)	(0.041)	(0.035)	(0.042)
Sample:	Low EFD	High EFD	Low EFD	High EFD
N obs.	25900	26449	25900	26449
Creditworthiness proxies	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y

Notes: This table replicates the analysis of Table 5, while adopting a richer fixed-effects structure. Specifically, sector–year interacted effects replace separate sector and time dummies, capturing unobserved industry-specific shocks that vary over time—such as fluctuations in demand, technological change, or policy interventions—that may jointly influence firms' export, innovation, and financing decisions. The table reports the marginal effects of *Credit rationing* estimated across different subsamples of firms to test the model prediction that financing frictions exert heterogeneous effects depending on firms' structural characteristics. The estimates are derived from trivariate probit models jointly modelling three binary outcomes—*Export*, *R&D*, and *Credit rationing*—allowing for correlation in unobserved factors through unrestricted correlations between equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Panels A–D present results for alternative firm groupings. Panel A splits firms by size (*Small* vs *Medium–Large*), following the Eurostat definition. Panel B classifies firms as *Low*- or *High*-productivity based on whether labor productivity lies below or above the sample median. Panel C separates firms by liquidity (*Low* or *High*), according to the median ratio of liquid assets to total assets. Panel D distinguishes firms operating in sectors with *Low* or *High* external financial dependence (EFD), computed following Rajan and Zingales (1998) as the sector-level average of firms' external financing needs, defined as the ratio of investment to operating cash flow. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *R&D* (in columns 1–2), *Export* (in columns 3–4), *Age*, *Labor productivity*, *Total assets*, and *ROA*. Conditional averages by size, productivity, liquidity, and EFD used to derive the implied multipliers are reported in Table A2. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A17: Extensive Margins — Additional Heterogeneities
Mundlak-Chamberlain Adjustment

	Panel A: Firm Size			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.077**	-0.027	-0.161***	-0.220***
	(0.035)	(0.050)	(0.042)	(0.065)
Sample:	Small	Medium–Large	Small	Medium–Large
N obs.	38332	14017	38332	14017
	Panel B: Firm Productivity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.075**	-0.064	-0.134***	-0.209***
	(0.038)	(0.039)	(0.047)	(0.044)
Sample:	Low Productivity	High Productivity	Low Productivity	High Productivity
N obs.	26206	26143	26206	26143
	Panel C: Firm Liquidity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.083**	-0.064	-0.170***	-0.085
	(0.033)	(0.054)	(0.042)	(0.054)
Sample:	Low Liquidity	High Liquidity	Low Liquidity	High Liquidity
N obs.	25714	26635	25714	26635
	Panel D: External Financial Dependence (EFD)			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.037	-0.103***	-0.100***	-0.206***
	(0.048)	(0.039)	(0.037)	(0.046)
Sample:	Low EFD	High EFD	Low EFD	High EFD
N obs.	25900	26449	25900	26449
Mundlak adjustment	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y

Notes: This table replicates the analysis of Table 5, while accounting for unobserved firm-level heterogeneity. The Mundlak–Chamberlain correction (Mundlak, 1978; Chamberlain, 1982) is implemented by augmenting each equation with the firm-specific time averages of all time-varying regressors, thereby controlling for potential correlation between these covariates and time-invariant unobserved characteristics. The table reports the marginal effects of *Credit rationing* estimated across different subsamples of firms to test the model prediction that financing frictions exert heterogeneous effects depending on firms' structural characteristics. The estimates are derived from trivariate probit models jointly modelling three binary outcomes—*Export*, *R&D*, and *Credit rationing*—allowing for correlation in unobserved factors through unrestricted correlations between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Panels A–D present results for alternative firm groupings. Panel A splits firms by size (*Small* vs *Medium–Large*) following the Eurostat definition: fewer than 50 employees and either annual sales or total assets below €10 million. Panel B classifies firms as *Low*- or *High*-productivity based on whether labor productivity lies below or above the sample median. Panel C separates firms by liquidity (*Low* or *High*), according to the median ratio of liquid assets to total assets. Panel D distinguishes firms operating in sectors with *Low* or *High* external financial dependence (EFD), computed following Rajan and Zingales (1998) as the sector-level average of firms' external financing needs, defined as the ratio of investment to operating cash flow. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *R&D* (in columns 1–2), *Export* (in columns 3–4), *Age*, *Labor productivity*, *Total assets*, and *ROA*. Conditional averages by size, productivity, liquidity, and EFD used to derive the implied multipliers are reported in Table A2. Variable definitions are provided in Appendix Table A1. *,

Table A18: Extensive Margins — Additional Heterogeneities
Controlling for Proxies of Firm Creditworthiness

	Panel A: Firm Size			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.053*	-0.045	-0.131***	-0.234***
	(0.031)	(0.043)	(0.040)	(0.061)
Sample:	Small	Medium–Large	Small	Medium–Large
N obs.	38332	14017	38332	14017
	Panel B: Firm Productivity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.072**	-0.031	-0.122***	-0.180***
	(0.034)	(0.035)	(0.043)	(0.045)
Sample:	Low Productivity	High Productivity	Low Productivity	High Productivity
N obs.	26206	26143	26206	26143
	Panel C: Firm Liquidity			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.087***	-0.055	-0.138***	-0.135***
	(0.029)	(0.051)	(0.039)	(0.051)
Sample:	Low Liquidity	High Liquidity	Low Liquidity	High Liquidity
N obs.	25714	26635	25714	26635
	Panel D: External Financial Dependence (EFD)			
	(1) Export	(2) Export	(3) R&D	(4) R&D
Credit rationing	-0.036	-0.088***	-0.093***	-0.169***
	(0.045)	(0.034)	(0.034)	(0.047)
Sample:	Low EFD	High EFD	Low EFD	High EFD
N obs.	25900	26449	25900	26449
Creditworthiness proxies	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y

Notes: This table replicates the analysis of Table 5, while additionally controlling for proxies of firms' creditworthiness to mitigate concerns that the credit-supply instrument may capture borrower quality rather than exogenous financial shocks. These proxies include *Leverage*, *Liquidity*, *ROA*, and *Relationship lending*. The table reports the marginal effects of *Credit rationing* estimated across different subsamples of firms to test the model prediction that financing frictions exert heterogeneous effects depending on firms' structural characteristics. The estimates are derived from trivariate probit models jointly modelling three binary outcomes—*Export*, *R&D*, and *Credit rationing*—allowing for correlation in unobserved factors through unrestricted correlations between the equation error terms. Each endogenous variable is instrumented using the same external instruments as in Table 3. Panels A–D present results for alternative firm groupings. Panel A splits firms by size (*Small* vs *Medium–Large*), following the Eurostat definition: fewer than 50 employees and either annual sales or total assets below €10 million. Panel B classifies firms as *Low*- or *High*-productivity based on whether labor productivity lies below or above the sample median. Panel C separates firms by liquidity (*Low* or *High*), according to the median ratio of liquid assets to total assets. Panel D distinguishes firms operating in sectors with *Low* or *High* external financial dependence (EFD), computed following Rajan and Zingales (1998) as the sector-level average of firms' external financing needs, defined as the ratio of investment to operating cash flow. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Other untabulated controls include *R&D* (in columns 1–2), *Export* (in columns 3–4), *Age*, *Labor productivity*, *Total assets*, and *ROA*. Conditional averages by size, productivity, liquidity, and EFD used to derive the implied multipliers are reported in Table A2. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A19: Intensive Margins — Richer Fixed Effects Structure

	(1)	(2)
	% Export	% R&D
Credit rationing	-0.220***	-0.042**
	(0.049)	(0.017)
%R&D	1.976***	
	(0.103)	
% Export		0.349***
		(0.045)
Sector × Time FE	Y	Y
Region FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, while allowing for a richer fixed-effects structure. Specifically, sector–year interacted effects replace separate sector and time dummies, capturing unobserved industry-specific shocks that vary over time—such as changes in demand, technology, or policy—that may simultaneously influence firms' export, innovation, and financing decisions. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A20: Intensive Margins — Mundlak-Chamberlain Adjustment

	(1)	(2)
	% Export	% R&D
Credit rationing	-1.021***	-0.227***
	(0.220)	(0.085)
% R&D	1.721***	
	(0.111)	
% Export		0.336***
		(0.040)
Mundlak adjustment	Y	Y
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, while accounting for unobserved firm-level heterogeneity. The Mundlak–Chamberlain correction (Mundlak, 1978; Chamberlain, 1982) is implemented by augmenting each equation with the firm-specific time averages of all time-varying regressors, thereby controlling for potential correlation between these covariates and time-invariant unobserved factors. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A21: Intensive Margins — Analysis on Switchers

	(1)	(2)
	% Export	% R&D
Credit rationing	-0.181***	-0.043**
	(0.064)	(0.018)
R&D	0.762***	
	(0.122)	
% Export		0.364***
		(0.042)
Sample	Export_{t-1}=0	$\text{R\&D}_{t-1}$=0
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, restricting the sample to firms that had not exported or undertaken R&D activities prior to period t. The estimated coefficients therefore capture the effects on the intensive margins of export and R&D activity for new starters. This approach helps address potential persistence and path dependence in firms' strategic choices, ensuring that results reflect the determinants of entry into exporting and innovation rather than the continuation of pre-existing behaviors. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A22: Intensive Margins — Controlling for Proxies of Firm Creditworthiness

	(1)	(2)
	% Export	% R&D
Credit rationing	-0.223***	-0.044**
	(0.053)	(0.017)
% R&D	1.884***	
	(0.096)	
% Export		0.375***
		(0.043)
Creditworthiness proxies	Y	Y
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, while additionally controlling for proxies of firms' creditworthiness to mitigate concerns that the credit-supply instrument may capture borrower quality rather than exogenous financial shocks. These proxies include *Leverage*, *Liquidity*, *ROA*, and the *Relationship lending*. By conditioning on these balance-sheet variables and proxies of soft information accumulated by the lender bank (length of the relationship), we reduce the risk that our results reflect assortative matching between more creditworthy firms and less risk-averse banks, rather than genuine supply-side constraints. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Other untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A23: Intensive Margins — Controlling for Proprietorship and Managerial Characteristics

	(1)	(2)
	% Export	% R&D
Credit rationing	-0.212***	-0.042*
	(0.060)	(0.024)
%R&D	1.921***	
	(0.104)	
% Export		0.336***
		(0.078)
Controls for proprietorship and management	Y	Y
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, while additionally controlling for firms' proprietorship structure and managerial characteristics to address potential heterogeneity in access to finance and strategic decision-making. The additional variables include *Family firm*, *Group*, *% Manager past experience*, and *% Manager degree*. *Family firm* is a dummy equal to one if the firm is family-owned; *Group* is a dummy equal to one if the firm belongs to a corporate group; *% Manager past experience* measures the share of managers with previous managerial experience in other firms; and *% Manager degree* captures the share of managers holding a university or postgraduate degree. Together, these variables account for ownership structure, organizational complexity, and managerial quality, which may influence firms' access to external finance, innovation, and export performance. Controlling for these dimensions helps mitigate concerns that the estimated effects reflect persistent firm-specific characteristics rather than exogenous credit-supply shocks. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Other untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A24: Intensive Margins — Alternative Measure of Credit Rationing

	(1)	(2)
	% Export	% R&D
Bank credit rationing	-0.356***	-0.067**
	(0.080)	(0.027)
%R&D	1.940***	
	(0.098)	
%Export		0.358***
		(0.041)
Sector & Region & Time FE	Y	Y
Firm-level controls	Y	Y
N obs.	49991	49991

Notes: This table replicates the analysis of Table 6, while employing an alternative definition of credit constraints, *Bank credit rationing*. In this specification, the variable captures only cases of explicit loan rejections by banks, thereby excluding *discouraged borrowers*—firms that refrained from applying for credit due to anticipated denial. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. In column (1), the dependent variable is *% Export*, while *% R&D* and *Credit rationing* are treated as endogenous. In column (2), the dependent variable is *% R&D*, with *% Export* and *Credit rationing* treated as endogenous. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A25: Intensive Margins — Heterogeneity by Strategic Profile
Richer Fixed Effects Structure

	(1)	(2)	(3)	(4)
	% Export	% Export	% R&D	% R&D
Credit rationing	-0.123**	-0.049	-0.052**	0.024
	(0.054)	(0.146)	(0.022)	(0.040)
R&D	4.031***	1.923***		
	(0.143)	(0.267)		
% Export			0.469***	0.287***
			(0.056)	(0.076)
Sample:	% R&D $\leq$ p33	% R&D $>$ p33	% Export $\leq$ p33	% Export $>$ p33
Sector $\times$ Time FE	Y	Y	Y	Y
Region Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	41818	8173	35833	14158

Notes: This table replicates the analysis of Table 7, while adopting a richer fixed-effects structure. Specifically, sector–year interacted effects replace separate sector and time dummies, capturing unobserved industry-specific shocks that vary over time—such as fluctuations in demand, technological change, or policy interventions—that may jointly influence firms' export, innovation, and financing decisions. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. Columns (1)–(2) present results for the *% Export* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% R&D expenditure* distribution (conditional on positive R&D spending). Columns (3)–(4) report results for the *% R&D* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% Export* distribution. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—together with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A26: Intensive Margins — Heterogeneity by Strategic Profile
Mundlak–Chamberlain Adjustment

	(1)	(2)	(3)	(4)
	% Export	% Export	% R&D	% R&D
Credit rationing	-0.473*	-0.299	-0.261***	0.073
	(0.252)	(0.746)	(0.089)	(0.170)
% R&D	3.698***	1.686***		
	(0.162)	(0.236)		
% Export			0.435***	0.272***
			(0.055)	(0.072)
Sample:	% R&D $\leq$ p33	% R&D $>$ p33	% Export $\leq$ p33	% Export $>$ p33
Mundlak adjustment	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	41818	8173	35833	14158

Notes: This table replicates the analysis of Table 7, while accounting for unobserved firm-level heterogeneity. The Mundlak–Chamberlain correction (Mundlak, 1978; Chamberlain, 1982) is implemented by augmenting each equation with the firm-specific time averages of all time-varying regressors, thereby controlling for potential correlation between these covariates and time-invariant unobserved characteristics. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. Columns (1)–(2) present results for the *% Export* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% R&D expenditure* distribution (conditional on positive R&D spending). Columns (3)–(4) report results for the *% R&D* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% Export* distribution. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.

Table A27: Intensive Margins — Heterogeneity by Strategic Profile
Controlling for Proxies of Firm Creditworthiness

	(1)	(2)	(3)	(4)
	% Export	% Export	% R&D	% R&D
Credit rationing	-0.110**	-0.085	-0.053***	0.025
	(0.046)	(0.148)	(0.020)	(0.034)
% R&D	3.903***	1.902***		
	(0.162)	(0.240)		
% Export			0.483***	0.310***
			(0.058)	(0.081)
Sample:	% R&D $\leq$ p33	% R&D $>$ p33	% Export $\leq$ p33	% Export $>$ p33
Creditworthiness proxies	Y	Y	Y	Y
Sector & Region & Time FE	Y	Y	Y	Y
Firm-level controls	Y	Y	Y	Y
N obs.	41818	8173	35833	14158

Notes: This table replicates the analysis of Table 7, while additionally controlling for proxies of firms' creditworthiness to mitigate concerns that the credit-supply instrument may capture borrower quality rather than exogenous financial shocks. These proxies include *Leverage*, *Liquidity*, *ROA*, and the *Relationship lending*. By conditioning on these balance-sheet variables and proxies of soft information accumulated by the lender bank (length of the relationship), we reduce the risk that our results reflect assortative matching between more creditworthy firms and less risk-averse banks, rather than genuine supply-side constraints. The table reports the average marginal effects obtained from Poisson Pseudo-Maximum Likelihood (PPML) estimations. Columns (1)–(2) present results for the *% Export* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% R&D expenditure* distribution (conditional on positive R&D spending). Columns (3)–(4) report results for the *% R&D* equation, estimated separately for firms below and above the 33$^{\text{rd}}$ percentile of the *% Export* distribution. Endogeneity is addressed through a two-stage control-function (residual inclusion) approach. In the first stage, each potentially endogenous regressor is regressed on its corresponding external instruments—identical to those used in Table 3—along with all exogenous firm-level controls and fixed effects. The resulting residuals, which capture the endogenous components unexplained by the instruments, are included as additional covariates in the PPML estimation to correct for endogeneity bias. Marginal effects are evaluated at observed sample values. Standard errors, clustered at the firm level, are reported in parentheses. Other untabulated controls include *Age*, *Labor productivity*, *Total assets*, and *ROA*. Variable definitions are provided in Appendix Table A1. *, **, *** indicate statistical significance at the 10%, 5%, and 1%, respectively.