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Abstract

Foreign Direct Investment (FDI) can inject technology and knowledge into host- country economies, potentially influencing their firms' R&D investments and export capacities; as a result, these firms may engage in R&D (exports), potentially shaping the interaction between the two strategies. This paper investigates whether and when these strategies are complementary and reinforce each other, or whether they are substitutes, and should not be jointly pursued, as well as how combining the two strategies may lead to synergies positively affecting growth. The analysis was conducted on four clusters of firms using panel data of Tunisian manufacturing firms over the period 2016-2018. The first and second clusters include any exporting firms (differentiating exporters from non-exporters) without and with foreign participation, respectively. The third and fourth clusters are made up of fully exporting firms without and with foreign involvement, respectively. The findings suggest that R&D and exports positively reinforce each other in a dynamic virtuous circle to boost exports for firms with no foreign participation, whereas substitutability effects emerge for R&D activity, primarily for firms with foreign participation. The findings are also consistent with complementarities between the two activities in boosting the growth of fully exporting firms with foreign ownership.

Keywords: manufacturing industry, exports,R&D investment, foreign participation, complementarities, substitutability effects, Multiple Imputation, Tunisia.
JEL Classifications: F140, L250, L63, L67, O55, O32.

ملخص

يمكن للاستثمار الأجنبي المباشر أن يضخ التكنولوجيا والمعرفة في اقتصادات البلدان المضيفة، مما قد يؤثر على استثمارات شركاتها في مجال البحث والتطوير وقدراتها التصديرية ؛ ونتيجة لذلك، قد تشارك هذه الشركات في البحث والتطوير (الصادرات)، مما قد يشكل التفاعل بين الاستراتيجيتين. وتبحث هذه الورقة ما إذا كانت هذه الاستراتيجيات متكاملة وتعزز بعضها البعض، أو ما إذا كانت بدائل، ولا ينبغي متابعتها معاً، وكذلك كيف يمكن أن يؤدي الجمع بين الاستراتيجيتين إلى أوجه تآزر ليكون لها تأثيراً إيجابياً على النمو. تم إجراء التحليل على أربع مجموعات من الشركات باستخدام بيانات مسح لشركات التصنيع التونسية خلال الفترة 2016-2018. وتشمل المجموعتان الأولى والثانية أي شركات مصدرة (تفرق بين المصدرين وغير المصدرين) بدون مشاركة أجنبية وأخرى بمشاركة أجنبية، على التوالي. وتتألف المجموعتان الثالثة والرابعة من شركات مصدرة بالكامل بدون مشاركة أجنبية وأخرى بمشاركة أجنبية على التوالي. وتشير النتائج إلى أن البحث والتطوير والصادرات يعززان بعضهما البعض بشكل إيجابي في دائرة حميدة ديناميكية لتعزيز الصادرات للشركات التي ليس لها مشاركة أجنبية، في حين تظهر آثار قابلية الاستبدال بالنسبة لأنشطة البحث والتطوير، في المقام الأول بالنسبة للشركات ذات المشاركة الأجنبية. تتوافق النتائج أيضًا مع أوجه التكامل بين النشاطين في تعزيز نمو الشركات المصدرة بالكامل بملكية أجنبية.

1. Introduction

The literature has firmly established the interdependence between two fundamental growth strategies within firms: exporting and innovation. These strategies can either harmonize synergistically and complement each other or act as substitutes. Complementarity emerges when one strategy amplifies the benefits or curbs the costs of the other (Golovko and Valentini, 2011; Aw, Roberts, and Xu, 2011; Bernard and Jensen, 1999). Conversely, they can be viewed as alternative avenues for growth, as effectively pursuing both requires simultaneously allocating limited organizational resources, requiring prioritization over time (Roper and Love, 2002; Kumar, 2009).

Despite substantial theoretical and empirical research on the interplay between exporting and innovation, international strategy studies have predominantly focused on whether these strategies complement or substitute each other, while investigations into factors that shape the nature of their interaction have remained scarce, with some few exceptions. And what little we do know generally suggests that the interaction between these two strategies is complex and context-dependent, likely contingent on various internal and external factors. Internal factors such as absorptive capacity (Ren et al., 2015), marketing capacity (Ren et al., 2015), firm size (Wakelin, 1998), and state ownership (Shen et al., 2022) have been identified as influencing the reciprocal learning effect between exports and innovation. Whereas external factors including country of origin (Bahl et al., 2021), industrial environment (Salomon and Jin, 2008), and institutional quality (Xie and Li, 2018) can also matter (i.e., strengthen/weaken this relationship).

Nonetheless, it is critical to recognize that the nature of interplay between these strategies is dictated not only by internal and external factors, but also by a firm's strategic decisions, referred to as "contextual interaction." This theoretical perspective aligns with Porter and Siggelkow's (2007) assertion that the nature of interaction between a firm's strategic activities depends on other decisions made by the company. Essentially, a firm's choice of other activities can profoundly impact whether and how these two activities interact— determining whether they harmonize and reinforce each other's benefits or serve as substitutes in the strategic landscape.

In this regard, inward Foreign Direct Investment (FDI) emerges as a potential game-changer intertwined with innovation and exports, promising both opportunities and challenges. Inward FDI involves the inflow of capital, assets, and resources from foreign entities into the economy of a host nation. While most research has traditionally centered on inward greenfield FDI (UNCTAD, 2000; Kim, 2009), there is growing prominence of cross-border merger and acquisitions (M&As) since the 1990s as a key foreign market entry strategy. Years like 1995, 2000, 2004, and 2007 saw a surge in M&A activity in terms of both volume and value (Pradhan, 2007). This trend persisted; for instance, in 2018, net cross-border M&As totaled $816 billion across 6,821 transactions (UNCTAD, 2019). Yet, research on their impact on innovation and exports in integrated firms is still limited, as the research on the post-acquisition firm performance is undertaken mostly for the

acquiring firm with a focus on developed economies (see Hagedoorn, and Van Kranenburg, 2006; Stiebale, 2013; Girma, Kneller, and Pisu, 2005).

Importantly, this highlights a notable gap in existing research, as there is a limited number of studies examining the repercussions of M&As on the subsequent performance of firms in developing countries—whether they are the acquired, acquiring, or merged entities (Song et al., 2021; Tarba et al., 2020). Bridging this gap is crucial, as insights drawn from the current body of literature, predominantly based on developed economies, may not seamlessly apply to the unique contexts of developing nations. These countries exhibit distinct political, organizational, institutional, and cultural characteristics that set them apart from the settings explored in extant research. This research gap is especially pertinent to African economies (Battisti et al., 2021, Gupta et al., 2021, Stevens and Newenham-Kahindi, 2021), given that Africa presents promising research and business opportunities characterized by its rapid transformation, the challenges of navigating turbulence, a substantial informal sector, and the development of innovative products and services (Nachum et al., 2023). Furthermore, Africa's increasing engagement with the East, as an alternative to its traditional post-colonial relations with the West, adds to its significance (Kamoche and Wood, 2023). Addressing this gap in the literature is imperative to better understand the dynamics of M&As in the distinctive and evolving landscape of African economies.

Accordingly, the primary objective of this study is to contribute to the ongoing debate by investigating *how the presence of cross-border M&As shape the dynamics of the integrated firms' activities in exporting and innovation, elucidating situations where these strategies complement each other and instances where they compete*. Furthermore, we explore whether the synergy between these two strategies contributes to firm growth. By focusing on these issues, we go beyond conventional evaluation in terms of isolated impacts on productivity, innovation, and exports, and encompass a comprehensive understanding of how it intricately shapes the dynamic interplay between the two growth strategies: exporting and innovation. To the best of our knowledge, no study has investigated the influence of M&As on the dynamics of exports and innovation of integrated firms.

We address this issue using an imbalanced panel dataset spanning 1668 Tunisian manufacturing firms from 2016 to 2018. Despite the best efforts of the interview team, we have a problem with missing data due to (item) non-response. We use the Multiple Imputation (MI) technique to account for missing units and correct for potential bias caused by non-random sample selection.

In light of the substantial presence of subcontracting regimes within Tunisia's industrial landscape, where firms that export their entire production often function as subcontractors and the strategic decisions of these firms are notably influenced by stringent contractual agreements, it becomes pivotal to approach our data classification dually. This involves not only differentiating it based on the FDI levels, to underscore the impact of FDI on the relationship between exports and innovation,

but also according to the export differentiation (Mattoussi and Ayadi, 2017). Consequently, we established four distinct groups of manufacturing firms for our study. The first and second clusters consist of any exporting firm (differentiating exporters from non-exporters) without and with foreign ownership, respectively. The third and fourth clusters include firms that are fully exporting (exporting 100% of their output) without and with foreign involvement, respectively.

The contribution of this paper is twofold. Firstly, it deepens our understanding of how M&As influence the dynamics between two critical growth strategies crucial for firm growth and survival: exports and innovation. As such, our findings suggest that complementarities between the two strategies prevail for exporting activity primarily in the clusters of firms with no foreign ownership, whereas, substitutability effects emerge primarily for R&D activity, particularly for clusters of firms with foreign participation, with substitutability being more pronounced for firms exporting their entire output than others. The findings are also consistent with the complementary effect having a positive impact on firm growth for fully exporting firms with foreign ownership. These combined findings hold important implications for both policy and practice.

Second, we advance the IB research on Africa, particularly relevant in light of the growing interest in IB studies on Africa, as investigating Africa's role in the global economy becomes increasingly imperative (Kamoche and Wood, 2023), by addressing the limited research on M&As, which only commenced in 2010 (van Vuuren et al. 2010). Additionally, we investigate the issue in a country that shares organizational and cultural characteristics with many other African countries, emphasizing widespread subcontracting—a common feature in African economies, where subcontractors who export their entire output may benefit or be bid on by contractual export arrangements. Moreover, concerning innovation, most African countries prioritize R&D to enhance absorptive capacity rather than merely for innovation purposes.

The paper proceeds as follows. In section 2, we review the relevant literature, examining the nature of interaction between local firms' growth strategies, exports, and innovation, as well as the impact of inward FDI on these dynamics. We also explore whether the existence of complementarities between these strategies positively influences firm growth. We subsequently generate competing hypotheses. Section 3 describes the data, and the methodology used in this study. Section 4 presents the empirical results and discussions, and section 5 concludes.

2. Theoretical background and hypotheses

2.1. Cross-border mergers and acquisitions (M&As) impact on the dynamics of exports and innovation

We investigate the influence of M&As on the interplay between innovation and exports within a firm, analyzing how their presence or absence shapes this dynamic and providing compelling arguments for each scenario.

We start the analysis by examining the scenario in which M&As occur and discuss how they would affect post-acquisition innovation and export performance, and potentially the nature of their interaction within the integrated unit. Regarding post-acquisition innovation, the resource-based view (RBV) and learning-based view (LBV) posit those disparities in firms' innovative performance, stem from differences in their knowledge sources (Bierly and Chakrabarti, 1996). As a result, a firm's long-term competitive advantage is determined by its ability to acquire, transfer, and integrate acquired knowledge into its base (Barney, 1986). We should, however, recognize that not all acquisitions are driven purely by technology learning objectives (Krug and Nigh, 2001; Hamel, 1991). M&As may also be motivated by market-entry strategies, market structure considerations, the desire to expand international product portfolios (Berkovitch and Narayanan, 1993; Chakrabarti et al., 1994; Trautwein, 1990), or the pursuit of financial synergies and market power (Chatterjee, 1991; Capron, Dussauge, and Mitchell, 1998).

The literature often suggests that non-technological acquisitions lacking technological input may not significantly enhance the acquirer's knowledge base, potentially limiting innovation (Cloodt et al., 2006). This is attributed to managerial problems, integration issues, and transaction expenses associated with M&A, which can divert organizational focus and cause delays in technological decision-making (Hitt et al., 1996; Carayannis et al., 2017). When companies conduct M&A, the cost of integrating and adjusting resources due to cultural systems and other differences leads to technology spillover and suboptimal performance (Edamura et al., 2014). However, such acquisitions may compensate for these challenges by offering financial synergies and providing access to a larger pool of resources for R&D investments, ultimately benefiting innovation (Cincera, 2003; Czarnitzki, 2003).

Technological acquisitions, in turn, provide inputs that can broaden the acquiring firm's knowledge base, influencing innovation output (Singh and Montgomery, 1987; Lane and Lubatkin, 1998). The knowledge size is one important factor that is highlighted in existing research when assessing the knowledge bases of acquired and acquiring organizations. Ahuja and Katila (2001) define knowledge base size as the absolute size of knowledge bases obtained through M&As. It measures the amount of knowledge assets brought into the merged company. Knowledge base aggregation potential is enhanced by the larger size (Grant, 1996). Transferring knowledge entails both sending

and receiving it (Grant, 1996). Reception is linked to a firm's absorptive capacity, especially in fundamental research (Cassiman et al., 2000; Rosenberg, 1990), and it is crucial for developing the receiver's absorptive capacity. This capacity is critical for screening and exploiting external knowledge (Cohen and Levinthal, 1989). External R&D enhances internal R&D efficiency, and improves the firm's innovative performance (Veugelers, 1997; Cohen and Levinthal, 1989, 1990). Another benefit is the possibility for M&As to produce economies of scale and scope in R&D activities, hence increasing efficiency (Cassiman et al., 2005). Merging firms are motivated to enhance innovative capabilities and increase R&D budgets, thereby spreading fixed costs and promoting higher investment in fundamental research across diverse technology segments (Cassiman et al., 2000).

Now shifting focus to post-acquisition export performance, M&As provide both direct and indirect advantages for the export activities of merged units. Direct effects arise from export-platform FDI, where foreign-owned firms, set up production facilities to serve both the host country and its neighboring countries (Ito, 2012; Kneller and Pisu, 2004), and capitalize on the existing distribution channels of acquired firms with prior exporting experience (Kneller and Pisu, 2004). Indirect effects, on the other hand, may improve merged units' export capability by boosting productivity and potentially lowering export costs (Fontagne, 1999; Aitken, Hanson, and Harrison, 1997). They operate through various channels, such as injecting financial, technological, and managerial resources into acquired firms, giving local acquired firms immediate access to foreign entrant's global network, distribution channels, and established customer base in foreign markets.

According to the learning-based and resource-based views, M&As serve as catalysts for technological advancement, generating spillover effects and increasing incentives for R&D activities. Internalization theory states that acquiring firms transfer their intangible assets, such as well-established branding or advanced technology, to acquired affiliates abroad (Dunning, 1998; Damioli and Gregori, 2021). This extension subsequently translates into productivity enhancements within the acquired firms due to post-acquisition technological progress (Salis, 2008; Keller, 2004). Moreover, it is argued that disparities in firms' export competitiveness can be partially attributed to differences in their innovative capabilities and their capacity to accumulate and integrate resources (Chabowski et al., 2018; Rodríguez and Rodríguez, 2005; Yi et al., 2013). Innovative firms, equipped with the ability to navigate technological advancements and environmental uncertainties, can leverage technological progress over time, refining their processes and products. This, in turn, shifts their export demand curve outward, leading to advancements along a "quality ladder" (Roper & Love, 2002).

Drawing insights from the above arguments, we conclude that M&As can enhance post-acquisition innovation (exports). With external support from the acquiring firm, the merged firm would start with high levels of innovation (exports), potentially reducing the need for additional costly investments compared to an independent innovation (exports) effort. Therefore, its primary focus

should be on sustaining this capacity, which is more cost-effective than establishing a new foundation.

Establishing innovation (export) capabilities often incurs higher startup costs, including fixed costs and sunk costs, than maintaining innovation (export) capabilities. These costs for innovation include expenses related to researching promising technologies, establishing R&D divisions, and recruiting suitable personnel. Sutton (1991) and Manez Castillejo et al. (2004) emphasize that R&D decisions involve a long-term perspective, and firms opting for R&D activities must invest in building R&D departments or hiring and training R&D staff. Once these fixed investments are made, they are generally not recoverable and are thus classified as sunk costs. Such sunk costs may deter non-R&D performers from engaging in these activities, as potential entrants have to take these costs into account in their pricing decisions, unlike established R&D performers. Similarly, participation in exports also entails fixed and sunk costs associated with entering foreign markets. For instance, exporters may incur expenses related to packaging, market research in foreign countries, and establishing sales channels abroad. These costs are likely to be lower for exporters compared to non-exporters (Roberts and Tybout, 1999).

Consequently, a portion of organizational resources may become available to potentially fuel alternative growth strategies, such as exports (innovation), suggesting a substitution relationship between the two. This is in line with Roper and Love's (2002) findings, who observed that innovation success, a measure of commercial success, had a negative effect on export probability for German manufacturing firms. Given heavy investments in R&D to maintain domestic competitiveness (because the domestic market is very demanding for high quality innovative products), further scaling up innovation may yield less pronounced returns compared to countries with relatively low average levels of R&D investments, particularly in the short time horizon. Indeed, in terms of life-cycle dynamics, German enterprises may achieve the best marginal return by selling in a sophisticated domestic market; but there is a time lag until technology stabilizes and export markets become profitable for them.

In light of this, we propose that the presence of M&As could bolster a firm's innovation (export) capabilities, potentially starting from a higher level compared to firms without M&As. This could facilitate the reallocation of limited organizational resources toward exporting (innovation), given the competition between these strategies for such resources. Therefore, we put forward the following hypothesis:

- **Hypothesis1:** When a company relies on external support from M&As, innovation and exports compete for limited organizational resources.

The above research highlights an important question: in the absence of M&As, which growth strategy (s) would a firm relying on its own resources prioritize to drive growth, and how would

these strategies interact? Firms, particularly small and medium-sized entreprises (SMEs), rely heavily on growth to ensure their survival. When it comes to growth strategies, SMEs typically have two main options: expanding and enhancing product markets through innovation or internationalizing and entering new geographical markets, primarily through exporting (Ansoff, 1965; Freeman, Carroll, & Hannan, 1983).

Several studies have highlighted the positive impact of innovation and exports on SME growth. While some studies have examined exports and innovation separately, focusing solely on their individual effects, others have recognized their joint effect, suggesting that combining these strategies can lead to even greater growth (Golovco and Valentini, 2011). This perspective acknowledges the potential synergies and complementary nature of these strategies, where one can enhance the benefits or mitigate the costs of the other (Golovko and Valentini, 2011; Aw, Roberts, and Xu, 2011; Bernard and Jensen, 1999).

In line with the learning-based view (Li, 2010), learning processes are fundamental mechanisms that augment firms' stock of knowledge, which expand overseas to access knowledge from other countries (Salomon and Shaver, 2005; Tse et al., 2017), herein referred to as "learning by exporting". This exposure to diverse knowledge inputs enhances their resource base and technological expertise, aligning with the "post-entry hypothesis" that emphasizes leveraging foreign operations to enhance innovation and fuel R&D activities (Castellani et al., 2017; Tse et al., 2017).

On the other hand, the literature suggests that differences in firms' export competitiveness can be attributed, at least in part, to disparities in their innovative capabilities and their ability to accumulate and combine resources (Chabowski et al., 2018; Rodríguez and Rodríguez, 2005; Yi et al., 2013). This is consistent with the resource-based view (RBV), which emphasizes how innovation boosts exports by raising firm productivity (Lages et al., 2009). The RBV emphasizes the critical role of internal business resources, particularly innovation and investments in R&D, in enabling productivity improvements as an essential prerequisite for local enterprises to self-select into export markets (İpek, 2018; Peng, 2001; Singh, 2009).

Furthermore, the importance of innovation in increasing exports extends beyond increased productivity; it is also pivotal for adapting products and services to meet the preferences and requirements of foreign customers offer a wider array of goods that enjoy global demand (Deng et al., 2014; Braymen et al., 2010). Equipped with the ability to navigate technological advancements and environmental uncertainties (Golovko and Valentini, 2011), innovative firms can harness technological progress over time, enhancing their processes and products and shifting their export demand curve outward along a "quality ladder" (Roper and Love, 2002).

Additionally, from the perspective of new trade theory, investments in technological resources not only enhance a firm's organizational knowledge and learning capabilities but also play a pivotal role

in the firm's capacity to cultivate international competitive advantages based on cost or/and differentiation. Regarding product characteristics, McGuinness and Little (1981) show that firms concentrating on the development of unique and distinctive products are better positioned to cater to the specific requirements and preferences of foreign markets. Giving priority to new product development and process innovations enables firms to enhance their export performance and establish a robust presence in international markets (Ganotakis and Love, 2011; Eriksson et al., 1997; Pla-Barber and Alegre, 2007).
Finally, from the standpoint of cost efficiencies within the industrial organization theory, firms with a technological advantage based on R&D can expand into new overseas markets at minimal or no marginal cost compared to developing this advantage in the domestic market (Davis and Harveston, 2000). Additionally, exporting broadens the potential customer base, enabling firms to recover the costs associated with activities that have predominantly fixed costs, such as R&D, through increased sales volume (Love and Mansury, 2009).

Recognizing the innovation-export interplay, it can be argued that engaging in one growth strategy can have a cost-reducing effect on the other. Extensive research consistently shows that firms entering the export market tend to exhibit higher levels of productivity than non-exporting firms, enabling them to absorb the supplementary costs of exporting (Melitz, 2003; Bernard et al., 2003; Melitz and Ottaviano, 2005; Griffith et al., 2006; Huergo and Jaumandreu, 2004).

In a similar vein, exporting can influence the costs linked to innovation. Participating in innovation activities typically involves substantial expenses that offer delayed returns, potentially reducing the motivation for firms, particularly those with limited financial resources, to invest in such initiatives. Furthermore, access to external financial resources may be constrained due to imperfections in credit markets, leaving firms reliant on their internal financial capabilities.

Exporting can serve as a solution to this challenge, as firms engaged in foreign markets can gain access to additional internal financial resources and external financing for their innovation investments (Salomon and Shaver, 2005b; Shaver, 2011). According to Salomon and Shaver (2005b), exporting firms can stabilize their cash flows due to the imperfect correlation of business cycles across national markets. This stability in cash flow can facilitate greater access to internal financial resources for investments in innovation. Moreover, by alleviating liquidity constraints, exporting can provide external sources of funds with increased confidence in the firm's ability to fulfill its financial obligations effectively (Shaver, 2011).

Drawing from the above arguments, we conclude that firms operating without external support from M&As and relying on their own resources may observe a positive correlation between growth strategies when one strategy complements the other by enhancing benefits or reducing costs. Thus, innovative firms are more inclined to expand into foreign markets, while exporting firms are more likely to engage in innovation activities. Hence, we propose the following hypothesis:

- **Hypothesis 2:** When a company grows through internal resources rather than outside assistance from M&As, there will be a synergetic relationship between innovation and exports as each growth strategy reinforces and complements the other.

2.2. Complementarity between exports and innovation as a catalyst for sales growth

The role of exports in driving sales growth is contingent upon two essential factors: the quantity of goods that can be exported and the pricing dynamics in international markets (Golovko and Valentini, 2011). According to Bughin (19926), when venturing into foreign markets, companies often encounter lower mark-ups compared to their domestic counterparts. This can be attributed to intensified competition and the additional costs associated with exporting, both of which lead to lower mark-up levels (Golovko and Valentini, 2011).

Furthermore, the price differences between domestic and export markets are mostly influenced by variations in pricing strategies among companies operating within the same market. These variations reflect differences in product attributes and quality (Aw, Chen, and Roberts, 2001) and can be ascribed to investments in innovation (Golovko and Valentini, 2011).

A comprehensive analysis conducted by Braymen, Briggs, and Boulware (2011) on newly established North American companies reveals the significant impact of R&D investment on the production of superior product varieties with global demand. Similarly, McGuinness and Little (1981) deduce that enhancing the unique features of products and differentiating those leads to improved export performance and sales growth. Furthermore, investing in innovation for export purposes can yield positive spillover effects on the domestic market (Golovko and Valentini, 2011). Notably, producers who export a specific product variety often attain premium prices for the same variety in the domestic market. This pricing advantage is closely related to an increase in investment activity following the release of the new variety (Iacovone and Javorcik, 2012).

Building upon these arguments, it is expected that the complementarity between exports and R&D will have a significant impact on sales growth. Notably, innovative companies engaged in exporting can augment their sales by offering superior products in foreign markets, leading to larger quantities sold or earning better prices. Furthermore, positive spillover effects from sales in the domestic market contribute to the pricing advantage of these superior-quality products (Golovko and Valentini, 2011). We therefore propose the following hypothesis:

- **Hypothesis 3:** There is a complementary relationship between innovation and exports in driving firms' sales growth.

3. Materials and method

3.1. Data and summary statistics

Our empirical analysis draws on three firm-level datasets derived from the annual accounting, industrial, and export flow surveys of Tunisian manufacturing firms conducted between 2016 and

2018. Datasets collected by the Institut National de la Statistique in Tunisia contain missing values due to (item)[5] non-response. According to sample statistics, only 90% of the observations were complete; thus 10% of the data contained missing values (so many respondents will be excluded from the analytic sample due to their missing values). Scrutiny of our missingness mechanism revealed that the data are missing at random[6] (MAR) (Royston and White, 2011), implying that complete cases are not a random sample (missingness diagnosis appears in the appendix). Indeed, observed variables predict missingness - the likelihood of a specific value being missing is determined solely by observed data. That is why we use the Multiple Imputation (MI) method, in which an imputation model, i.e. a model for the distribution of the missing values given the observed data, is specified. To create a complete set of data, the missing values are replaced with values generated at random by this model. The entire procedure is repeated independently M times, resulting in M imputed datasets. The analysis model is fitted to each of these in turn and the estimated parameters are averaged over the datasets.

There is no agreement on how many imputations should be used. Standard MI texts suggest that small numbers of imputed datasets, on the order of three to five imputations, produce excellent results (Rubin, 1987; Schafer and Olsen, 1998).

Recently, the consensus has shifted towards higher values of M (White and Royston, 2011) for example, propose a rule of thumb that M should be at least equal to the percentage of incomplete cases in the dataset, implying that we should run 10 imputations in our study. Stata, on the other hand, recommends 20 imputations, and Graham, Olchowski, and Gilreath (2007) contend that a higher number of imputations is even better because it may yield increased power. In the light of all this we choose to follow stata and perform 20 imputations.[7]

We impute using the chained equations approach (MICE)[8] (also known as full conditional specification) (Royston and White, 2011; Van Buuren, Boshuizen, and Knook, 1999; White and Royston, 2011) for the following reasons. Data with missing values do not account for a very large proportion of observations (only 10 percent of the data contain missing values). The missing pattern is arbitrary, with datasets containing different variable types ranging from continuous to binary. Furthermore, continuous variables have skewed distributions. White and Royston (2011) discuss two approaches to dealing with such variables: transformation to normality and Predictive

[5] Item non-response occurs when a sample member responds to some of the survey questions but fails or refuses to provide answers for particular items (Lessler and Kalsbeek, 1992; Madow, Nisselson, and Olkin, 1983).

[6] Multiple imputation is becoming the standard route to estimating models with missing covariate data under a missing-at-random assumption (Royston and White, 2011).

[7] Econometric estimates using data with 10 imputations are qualitatively similar to those using data with 20 imputations.

[8] Multiple imputation under chained method tends to be mostly indicated when the variables are highly skewed, or there are too many count or categorical variables in the model (Royston and White, 2011; White and Royston, 20.

Mean Matching (PMM). Instead of regressing, we use the PMM technique[9] in this case. The rationale for this choice is that PMM can be a useful alternative when the normality of the residuals is not guaranteed. It is also an easy-to-use and versatile method that is less prone to model misspecification than other methods. Furthermore, imputations are realistic because they are based on values observed elsewhere. Additionally, imputations outside of the observed data range will not occur, avoiding the issues associated with meaningless imputations (e.g., negative capital or sales). The method also works best with large samples and provides imputations that possess many characteristics of the complete data **(**Kleinke, 2017).

We chose this particular sample of firms, because of the high percentage of small and medium-sized enterprises (SMEs) representing around 73% of the total sample, where SMEs are pivotal in driving profit, job creation, livelihood development, innovation, and social stability, both in developing and developed economies (Baumol, 2009; Daskalakis & Psillaki, 2008; Hussain et al., 2006; Gregory et al., 2005; Servon, 1999). Globally, they constitute approximately 90% of all businesses (ITC, 2021). In the case of Tunisia, SMEs are the cornerstone of the economy, accounting for approximately 80% of the economic landscape and employing over 70% of the private sector workforce. Moreover, they make a substantial contribution, exceeding 50%, to Tunisia's Gross Domestic Product (GDP) (National Institute for Statistics of Tunisia, 2018).

Our data include information on the status of exports and R&D investment as well as sales, financial resources, and direct and indirect foreign ownership of firms. We also have information on the number of employees and the number of years the company has been in business. The literature uses R&D expenditures as a common measure of firms' technological and innovation activities, and we use the same strategy here. The firm's innovator status is defined as a 1 if it reports positive R&D expenditures and a 0 if it does not. It is important to note that companies can spend money on R&D even if they are not innovating.

In our analysis, we use four firm clusters and both the export and foreign participation differentials. We first differentiate firms based on their exporting behavior, resulting in two groups of firms. In the first group (referred to as any exporting firms), we distinguish exporters (including partially and fully exporting firms) from non-exporters. In the second group (referred to as fully exporting firms), we distinguish firms exporting 100 percent of their output from partially exporting firms and non-exporters. Following that, each of these two groups is distinguished by the presence or absence of foreign capital in the capital of its firms. The four clusters are as follows. The first and second clusters are made up of any exporting firms without and with foreign participation, respectively. While the third and fourth clusters include fully exporting firms without and with foreign participation, respectively.

[9] Marshall, Altman, and Holder (2010) used the Predictive Mean Matching method in a simulation study that addressed skewed data and concluded that this method "produced the least biased estimates and better model performance measures."

The rationale for the exporting differential (see, Mattoussi and Ayadi, 2017) is driven by a peculiarity of the Tunisian manufacturing sector: nearly 70% of exports come from the offshore sector, which is primarily composed of subcontractors (Jacobson and Lindberg, 2005) that may benefit from various advantages such as technology transfer and export guarantees or be bid by strict contractual arrangements.

The primary reason for the FDI differential is the opportunities for exporting, as well as for innovation, managerial expertise, and technological transfer that foreign firms may provide to (subsidiary) firms. These opportunities may enable (subsidiary) firms to benefit from the available stock of knowledge and financial resources to carry out their own R&D activities (Esteve-Pérez and Rodriguez, 2013) and enhance export capabilities (Moran, Graham, and Blomstrom, 2005) or they may obstruct these activities because (subsidiary) firms are very likely to become the most technologically advanced, and thus the least likely to have higher returns from the R&D activity (exports). Furthermore, lumping together partially and fully exporting firms (firms without and with foreign participation) may obscure the true characteristics of fully exporting firms (resp. whether and how foreign participation may shape the dynamics of exports and R&D activities). Table 1 displays the variable definitions as well as summary statistics. Table 2 summarizes the firms' export and R&D status in the final sample. Approximately 70 percent of the firms are exporters (about 45 percent of the firms export 100 percent of their output), with the proportion of exporting firms increasing from 70.14 percent in 2016 to 70.68 percent in 2018 (with the proportion of firms exporting their entire production increasing from 44.84 percent in 2016 to 44.96 percent in 2018). R&D activities are reported by approximately 23.4 percent of firms in the sample, ranging from 24.4 percent in 2016 to 23.1 percent in 2018.

Table 2 shows some variation in export and R&D over time, as well as significant variation in each of these activities across firms in different exporting categories (partially exporting firms versus fully exporting firms) and across firms in the same export category when considering the FDI differential. We focus on reporting statistics for the latter category of firms, which is of interest for our study to examine how FDI would shape the interaction between export and R&D activities. In the category of any exporting firms, 13.69 percent of firms with no foreign participation report R&D activities (37.61 percent report export), whereas only 1.04 percent of firms with foreign ownership undertake R&D (32.89 percent export). For the class of fully exporting firms, 1.80 percent of firms with no foreign participation engage in R&D (19.60 percent export), whereas only 0.4 percent of firms with foreign ownership carry out R&D (25.26 percent export).

This dataset provides an appropriate setting for testing the impact of inward FDI on the interaction between export and R&D activities, as well as whether the presence of complementarities between the two strategies improves firm performance. First, the data allows for the tracking of firms and their export, R&D, and whether they have foreign ownership or not over a three-year period.

Second, exporting firms account for a large proportion of the sample and exhibit some variation in their exporting behavior over time, as well as significant variation in export across firms in the same export class when the FDI differential is taken into account. Third, we have data on R&D activity, and when the FDI differential is considered, the sample shows some variation in R&D over time as well as a significant variation across firms in the same export class.

Table 1. Empirical variable definitions and summary statistics

Variable	Description	Observations	Mean	Std. Dev.	Min.	Max.
Firm characteristics						
AGE_1	Years in operation (lagged)	100079	20.7046	13.8064	1	144
CAPITAL_1	Financial resources, in constant (2004). US dollars (lagged)	100079	3.30e+07	4.09e+08	21969	2.54e+10
PRODUCTIVITY_1	Value-added per employee, in constant (2004) US dollars (lagged)	100079	98465.16	901011.4	0.0022	5.86e+07
SALES	Total sales, in constant (2004) US dollars	100080	15.2276	3.7417	0.15	213.8845
SIZE_1	Number of employees (lagged)	100079	218.176	546.149	2	9950
Exports						
ANYEXPNOFP	Dummy: 1 if firm is an exporter with no foreign participation; 0 otherwise	100080	0.2398	0.4269	0	1
ANYEXPWFP	Dummy: 1 if firm is an exporter with foreign participation; 0 otherwise	100080	0.3185	0.4659	0	1
TOTEXPNOFP	Dummy: 1 if firm exports 100% of its output and has no foreign participation; 0 otherwise	100080	0.196	0.397	0	1
TOTEXPWFP	Dummy: 1 if firm exports 100% of its output and has foreign participation; 0 otherwise	100080	0.2426	0.4345	0	1
R&D						
RD	Dummy: 1 if firm has positive R&D expenditures; 0 otherwise	100080	0.2336	0.4231	0	1
Exports and R&D combined						
ANYEXPNOFPONLY_1	Dummy (lagged): 1 if ANYEXPNOFP=1 and RD=0; 0 otherwise	100079	0.2398	0.4269	0	1
RDANYEXPNOFP_1	Dummy (lagged): 1 if ANYEXPNOFP=1 and RD=1; 0 otherwise	100079	0.1363	0.3431	0	1
RDANYEXPWFP_1	Dummy (lagged): 1 if ANYEXPWFP=1 and RD=1; 0 otherwise	100079	0.0104	0.1014	0	1
RDNOFPONLY_1	Dummy (lagged): 1 if ANYEXPNOFP=0 and RD=1; 0 otherwise	100079	0.0973	0.2964	0	1
RDWFPONLY_1	Dummy (lagged): 1 if ANYEXPWFP=0 and RD=1; 0 otherwise	100079	0.2232	0.4164	0	1
RDTOTEXPNOFP_1	Dummy (lagged): 1 if TOTEXPNOFP=1 and RD=1; 0 otherwise	100079	0.01798	0.1329	0	1
RDTOTEXPWFP_1	Dummy (lagged): 1 if TOTEXPWFP=1 and RD=1; 0 otherwise	100079	0.00399	0.06309	0	1
TOTEXPNOFPONLY_1	Dummy (lagged): 1 if TOTEXPNOFP=1 and RD=0; 0 otherwise	100079	0.17806	0.3825	0	1
TOTEXPWFPONLY_1	Dummy (lagged): 1 if TOTEXPWFP=1 and RD=0; 0 otherwise	100079	0.2486	0.4322	0	1
Sector						
ELECT	Dummy: 1 electric, mechanical and electronics sector; 0 otherwise	100080	0.1768	0.3815	0	1
TEXILE	Dummy: 1 if textile sector; 0 otherwise	100080	0.4358	0.4958	0	1
ENER_MIN_MISCEL	Dummy: 1 if other sector; 0 otherwise	100080	0.3049	0.4604	0	1
AGROFOOD	Dummy: 1 if agrofood sector; 0 otherwise	100080	0.3049	0.4604	0	1

Source: Compilation of variables and calculations are made by the authors.

Table 2. Export and R&D status (expressed in percent) during the sample period, 2016- 2018

Exporters	2016	2017	2018	Total
Any exporting firms with no foreign participation	37.59	37.71	37.53	37.61
Any exporting firms with foreign participation	32.55	32.97	33.15	32.89
Fully exporting firms with no foreign participation	19.54	19.66	19.60	19.60
Fully exporting firms with foreign participation	25.30	25.12	25.36	25.26
Firms carrying out R&D				
Any exporting firms with no foreign participation	14.69	12.77	13.43	13.63
Any exporting firms with foreign participation	1.38	0.78	0.96	1.04
Fully exporting firms with no foreign participation	2.46	1.20	1.74	1.80
Fully exporting firms with foreign participation	0.78	0.12	0.30	0.40

Source: Authors' calculations.

Table 3 displays a transition matrix, which shows the probability that a firm will adopt a given strategy in a specific year, given the strategy it was following in the previous year. Several patterns are clear.

First, there is significant persistence in some activities. Of firms with no foreign participation (resp. with foreign participation) that did not export or conduct R&D in previous periods, 78.86 percent (resp. 79.92 percent) are in the same category in subsequent periods. Firms without (resp. with) foreign participation that export but do not carry out R&D have an 81.96 percent (resp. 90.51 percent) chance of remaining in that category the following year. As a result, there is a strong persistence in exports.

Second, firms with no (resp. with) foreign participation that do not export but invest in R&D have a probability of 65.33 percent (resp. 65.47percent) to remain in the same category the following year. This suggests the persistence in R&D investments.

Third, firms with no foreign participation (resp. with foreign participation) and doing both R&D and exports in previous periods, 84.34 percent (resp. 51.25 percent) will continue to do both activities in subsequent periods. These statistics indicate that there are complementarities between exports and R&D decisions.

Fourth, 38.56 percent of firms with foreign participation that did both activities in previous periods will abandon R&D in subsequent periods. These statistics may suggest that in some cases, one activity crowds the other out. In the presence of foreign participation, exports tend to crowd R&D out.

Overall, the statistics indicate that while export and R&D strategies tend to be persistent, they also show significant variation across firms in different exporting categories (partially exporting firms versus fully exporting firms) and across firms in the same export category when considering the FDI differential. Trade flows and R&D investment, in particular, may complement or compete with one another, and as such, they should be modeled jointly. Furthermore, they assert that foreign involvement may influence how these various strategies interact with one another.

Table 3. Transition matrix for exports and R&D activities

Status year t- 1/ Status year t	No exports, no R&D, and no foreign participation	No exports and no R&D, but foreign participation	Exports, but no R&D, and no foreign participation	Exports and foreign participation, but no R&D	R&D, but no exports and no foreign participation	R&D and foreign participation, but no exports	Exports and R&D, but no foreign participation	Exports, R&D, and foreign participation
No exports, no R&D and no foreign participation	0.7886	0.0066	0.0414	0.0151	0.131	0.0046	0.0126	0.0001
No exports and no R&D, but foreign participation	0.0485	0.7992	0.0118	0.0317	0.0027	0.1046	0.0015	0.00
Exports, but no R&D and no foreign participation	0.03	0.0003	0.8196	0.0794	0.0035	0.0001	0.0646	0.0026
Exports and foreign participation, but no R&D	0.0081	0.0035	0.0592	0.9051	0.0025	0.0001	0.0082	0.0133
R&D, but no exports and no foreign participation	0.3152	0.0007	0.0114	0.0099	0.6533	0.00	0.0093	0.0003
R&D and foreign participation, but no exports	0.0726	0.2613	0.0019	0.0057	0.0028	0.6547	0.0009	0.00
Exports and R&D, but no foreign participation	0.0174	0.0004	0.1102	0.0205	0.0066	0.0001	0.8434	0.0014
Exports, R&D, and foreign participation	0.0192	0.00	0.0625	0.3856	0.001	0.00	0.0192	0.5125

Source: Authors' calculations.

3.2. Exporting, investment in R&D, and firm performance: Methods and conceptual framework

3.2.1. Modelling exporting and R&D activities

Our exporting model relates the likelihood of firm i exporting in period t to the 1-year lags in exports, R&D, and other firm characteristics such as capital intensity, size, age, and labor productivity. The probit specifications for the first, second, third, and fourth clusters of firms are shown in equations (1), (2), (3), and (4), respectively:

$$\text{Prob}(ANYEXPNOFP_{i,t} = 1) = \Phi(ANYEXPNOFP_{i,t-1}, RD_{i,t-1}, Z_{i,t-1}) \quad (1)$$

$$\text{Prob}(ANYEXPWFP_{i,t} = 1) = \Phi(ANYEXPWFP_{i,t-1}, RD_{i,t-1}, Z_{i,t-1}) \quad (2)$$

and

$$\text{Prob}(TOTEXPNOFP_{i,t} = 1) = \Phi(TOTEXPNOFP_{i,t-1}, RD_{i,t-1}, Z_{i,t-1}) \quad (3)$$

$$\text{Prob}(TOTEXPWFP_{i,t} = 1) = \Phi(TOTEXPWFP_{i,t-1}, RD_{i,t-1}, Z_{i,t-1}) \quad (4)$$

where $ANYEXPWFP_{i,t-1}$ and $ANYEXPNOFP_{i,t-1}$ represent lagged exports for any exporting firms (including partially and fully exporting firms) with and without foreign participation, respectively; $TOTEXPWFP_{i,t-1}$ and $TOTEXPNOFP$i,t-1 represent lagged exports for fully exporting firms with and without foreign participation, respectively; $RD_{i,t-1}$ is the lagged R&D investment; $Z_{i,t-1}$ is a vector of lagged control variables capturing the above-mentioned firm characteristics; and t and i are time and firm indices, respectively. We include the 1-year lagged values of both exports and R&D to control for the possible persistence in the innovation and exporting activities. Furthermore, the inclusion of a lagged dependent variable allows for the capture of state dependence as well as the resolution of serial correlation issues (Bigsten et al. 2004; **29.** Damijan and Kostevc, 2006; Keiko and Lechevalier, 2010; Nickell, 1996). Previous export participation accounts for sunk costs, primarily at the start of the activity but also as the activity progresses (Bernard and Jensen, 1999a). Such sunk costs may include the cost of packaging, improving product quality, establishing marketing channels, and gathering demand information (Roberts and Tybout, 1999). Furthermore, firms that sell their products in a foreign country may be at a disadvantage when compared to domestic firms because they must typically bear additional transportation and administrative costs. All of these costs act as a barrier to entry and have the potential to induce state dependence. Regarding R&D, the greater the firm's prior investment in R&D, the more likely its products and/or services will become innovative and competitive, positively influencing exports and thus gaining a competitive advantage (Cassiman and Martinez-Ros, 2007; Lachenmaier and Woessmann, 2006).

We also assume that the likelihood of exporting is affected by lags in firm size, age, capital intensity, and labor productivity. The age of a firm (measured in years in business) has an ambiguous effect on exports. On the one hand, because firms' resources and capabilities accumulate over time and age, older firms are more likely to have the necessary resources (financial and knowledge) to export. Firms can gain expertise in entering new foreign markets from experience and this lowers the fixed costs of entering any additional new markets in the coming years (Sheard, 2014). A similar argument can be made for the number of products exported. If a company successfully exports one good and learns how to adapt it to customer preferences or legal regulations in a foreign market, how to prepare a user manual in a foreign language, how to set up a distribution network, and so on, the fixed costs of exporting any other goods are reduced, and the company will begin to export more goods in the future (Wagner, 2015). On the other hand, if younger firms are more proactive, flexible, and aggressive, age and exports may have a negative relationship (Esteve-Pérez and Rodriguez, 2013). Because it is difficult to predict which effect will be dominant a priori, the coefficient sign is uncertain.

The relationship between firm size and export performance is examined in current literature, but the empirical results seem inconsistent (Majocchi, Bacchiocchi, and Mayrhofer, 2005).

Competitive advantages can be found in both large and small firms (Moen, 1999). Firm size may have a fixed-cost interpretation because exporting is typically associated with fixed costs that are prohibitively expensive for small businesses. These costs are thought to include product compliance research, distribution networks, advertising, and so on. Firm size can affect export behavior in the search for economies of scale and scope to spread costs across expanded markets **(**Esteve-Pérez and Rodriguez, 2013; Freixanet and 2022; Gabbitas and Gretton, 2003; Majocchi, Bacchiocchi, and Mayrhofer, 2005). Larger firms can also take advantage because of the significance of R&D expenditure, their capacity for taking risks, and the potential for price discrimination (Patibandla, 1995). Smaller firms, on the other hand, should not be viewed as less competitive, they have different competitive advantages, which are associated with niche products that are cutting-edge technologically or unique in their market (Moen, 1999). The competitiveness of small firms is more dependent on the quality of their products and on how easily they can enter and exit foreign markets (Bonaccorsi, 1992).

Labor productivity is used as a proxy of firms' efficiency, to capture a potential self-selection process by which certain firms choose to enter export markets because they are relatively efficient. We also include the vector of year dummies to control for macroeconomic conditions that are common to all firms, as well as a set of sector dummies intended to correct industry-specific factors.

We follow Girma, Görg, and Hanley (2008), and Aw, Roberts, and Xu (2008) in assuming that the determinants of R&D activity are the same as those used to determine export status. The innovation equation is represented as a probit regression of firm i's R&D activity in period t on the 1-year lagged R&D, exports, and other firm characteristics (the same characteristics used for the exporting equation). The estimation procedures for the first, second, third, and fourth clusters of firms are provided by equations (5), (6), (7), and (8), respectively:

$$\text{Prob}(RD_{i,t}=1)=\Phi(ANYEXPNOFP_{i,t-1},RD_{i,t-1},Z_{i,t-1}) \quad (5)$$

$$\text{Prob}(RD_{i,t}=1)=\Phi(ANYEXPWFP_{i,t-1},RD_{i,t-1},Z_{i,t-1}) \quad (6)$$

And

$$\text{Prob}(RD_{i,t}=1)=\Phi(TOTEXPNOFP_{i,t-1},RD_{i,t-1},Z_{i,t-1}) \quad (7)$$

$$\text{Prob}(RD_{i,t}=1)=\Phi(TOTEXPWFP_{i,t-1},RD_{i,t-1},Z_{i,t-1}) \quad (8)$$

Where $Z_{i,t-1}$ is the control variable vector used in the exporting equation. The main variable of interest in this equation is lag in exports, as its coefficient indicates whether exporting firms are more or less likely to be innovators than non-exporters. Previous export participation captures a potential learning-by-exporting effect, in which the stock of knowledge accumulated externally through exports may lead exporters to improve their knowledge base, thereby increasing their innovative capacity and ability to create higher-quality innovations (Golovko and Valentini, 2011). Is state dependence also expected in the case of innovation? According to Peters (2009), there is a "success breeds success" effect in which previous successful innovations stimulate subsequent successful innovations as a result of increased market power and/or broader technological

opportunities. State dependence may also have a fixed cost interpretation. R&D involves fixed and sunk costs, which are thought to include the costs of establishing R&D divisions, researching promising technologies, searching for people capable of performing these activities, and so on. These costs are likely to be lower for firms that have previously carried out R&D. Labor productivity is included to capture a selection process resulting from the direct effect of the firm's productivity on the profitability of R&D investment.

Firm size appears to be an important determinant of R&D, but its impact on stimulating subsequent R&D is unclear. On average, larger firms may have more financial resources to carry out R&D (Golovko and Valentini, 2011) because they have better access to credit markets and/or a larger set of non-financial resources (managerial, scale economies). Small firms, on the other hand, may have more favorable conditions for innovation to flourish, as they may have more flexible management structures that allow them to adapt to changing competitive environments (Esteve-Pérez and Rodriguez, 2013). The effect of age on subsequent innovation is unclear. Older firms can accumulate resources, managerial knowledge, and the ability to deal with uncertainty **(**Herriott, Levinthal, and March, 1984; Levitt and March, 1988) as well as a reputation and market position, all of which help facilitate relationships and contacts. Mature firms may also benefit from their previous investments in innovation because of learning effects, which enable these firms to innovate more effectively by building on previous routines and capabilities **(**Levitt and March, 1988). Younger companies, on the other hand, are less affected by organizational inertia and are not burdened by rigid routines that stifle innovation, allowing them to respond more quickly and easily to useful new knowledge (Hannan and Freeman, 1984; Hansen, 1992; Huergo and Jaumandreu, 2004b). Younger companies may also need to invest more in R&D to survive and grow (Coad, Segarra, and Teruel, 2016; Sorensen and Stuart, 2000). The sign of the coefficient is unknown because it is impossible to predict which effect will dominate a priori.

In the subsequent analysis, we investigate the dynamics of exports and R&D decisions to see if they complement or crowd each other out. Specifically, we examine whether the presence of complementarity between the two strategies fosters the adoption of both export and R&D activities, or whether the two strategies compete and should not be jointly pursued. Following Aw, Roberts, and Xu (2008), Girma, Görg, and Hanley (2008), Golovko and Valentini (2011), and Esteve-Pérez and Rodríguez (2013), we estimate a seemingly unrelated bivariate probit model to test the direct effect of the decision to export on the R&D decision, and vice versa. The model allows for correlation between the error terms Esteve-Pérez and Rodríguez (2013), which may result from the potential high serial correlation and the correlation between export and R&D decisions.

In this model, we replace the simple exports and R&D dummies with a vector of mutually exclusive dummy variables D_1 (for the two clusters of any exporting firms) and D_2 (for the two clusters of fully exporting firms) that captures the combination of previous exports and R&D decisions [39]:

D_1={$RDNOFPONLY_{i,t-1}$,$RDWFPONLY_{i,t-1}$,$ANYEXPNOFPONLY_{i,t-1}$,$ANYEXPWFPONLY_{i,t-1}$,$RDANYEXPNOFP_{i,t1}$,$RDANYEXPWFP_{i,t-1}$ }.
And

D_2={$TOTEXPNOFPONLY_{i,t-1}$,$TOTEXPWFPONLY_{i,t-1}$,$RDTOTEXPNOFP_{i,t-1}$, $RDTOTEXPWFP_{i,t-1}$}.

These dummies distinguish the following mutually exclusive cases:
firms that both export and conduct R&D: $RDANYEXPNOFP_{i,t1}$, and $RDANYEXPWFP_{i,t-1}$ for clusters of any exporting firms, and $RDTOTEXPNOFP_{i,t-1}$, and $RDTOTEXPWFP_{i,t-1}$ for clusters of fully exporting firms.

firms that only export: $ANYEXPNOFPONLY_{i,t-1}$, and A$NYEXPWFPONLY_{i,t-1}$, for clusters of any exporting firms, and $TOTEXPNOFPONLY_{i,t-1}$, and $TOTEXPWFPONLY_{i,t-1}$, for clusters of fully exporting firms.

firms that only carry out R&D: $RDNOFPONLY_{i,t-1}$, and $RDWFPONLY_{i,t-1}$ for clusters of any exporting firms.

The model given by equations (9)–(10), equations (11)–(12), equations (13)–(14)equations (15)–(16) for the first, second, third, and fourth clusters of firms, respectively, relates probabilities of firm i investing in R&D and exporting in period t to lagged dummies capturing the combination of R&D and exports and to lagged firm characteristics:

$$\text{Prob}(R\&D_{i,t} = 1) = \Phi(ANYEXPNOFPONLY_{i,t-1}, RDNOFPONLY_{i,t-1}, RDANYEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (9)$$
$$\text{Prob}(ANYEXPNOFP_{i,t} = 1) = \Phi(ANYEXPNOFPONLY_{i,t-1}, RDNOFPONLY_{i,t-1}, RDANYEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (10)$$
$$\text{Prob}(R\&D_{i,t} = 1) = \Phi(ANYEXPWFPONLY_{i,t-1}, RDWFPONLY_{i,t-1}, RDANYEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (11)$$
$$\text{Prob}(ANYEXPWFP_{i,t} = 1) = \Phi(ANYEXPWFPONLY_{i,t-1}, RDWFPONLY_{i,t-1}, RDANYEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (12)$$

$$\text{Prob}(R\&D_{i,t} = 1) = \Phi(TOTEXPNOFPONLY_{i,t-1}, RDTOTEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (13)$$
$$\text{Prob}(TOTEXPNOFP_{i,t} = 1) = \Phi(TOTEXPNOFPONLY_{i,t-1}, RDTOTEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (14)$$
and

$$\text{Prob}(R\&D_{i,t} = 1) = \Phi(TOTEXPWFPONLY_{i,t-1}, RDTOTEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (15)$$

$$\text{Prob}(TOTEXPWFP_{i,t} = 1) = \Phi(TOTEXPWFPONLY_{i,t-1}, RDTOTEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (16)$$

The coefficients of the dummies in vectors D_1 and D_2 indicate whether prior R&D/exporting status influences subsequent decisions to undertake R&D/exporting. The two strategies complement each other if the effect of lagged exporting on current exporting (or R&D) is greater if the firm did R&D

in previous periods than if it did not. Similarly, if the effect of lagged R&D on current exports (or R&D) is greater if the firm also exported in previous periods than if it did not. We can expect firms coupling the two activities to be more likely to continue R&D or export than firms that only carry out R&D (exporting). Alternatively, the two strategies may be perceived as substitutes when they compete for finite organizational internal resources and need prioritizing over time, which would suggest that one strategy crowds out the other.

3.2.2. The impact of exports and R&D on firm performance

In this section, we investigate the impact of the independent and joint decisions to export and conduct R&D on firm performance. Our data include manufacturing firms from various industries, so we measure organizational size growth in terms of sales in accordance with Weinzimmer, Nystrom, and Freeman (1998) and Golovko and Valentini (2011). There seems to be a growing consensus, according to Delmar, Davidsson, and Gartner (2003), that if only one indicator is to be chosen as a measure of firm growth, the most preferred measure should be sales.

We regress sales growth on the exclusive combinations of exporting and R&D activities, together with the control variables that might influence growth. In the clusters of any exporting firms, the lagged choices of R&D and export distinguish three cases: firms that carried out both exporting and R&D (*RDANYEXPNOFPi,t-1*, *RDANYEXPWFPi,t-1*), firms that only exported (*ANYEXPNOFPONLYi,t-1*, *ANYEXPWFPONLYi,t-1*), and firms that only conducted R&D (*RDNOFPONLYi,t-1*, *RDWFPONLYi,t-1*). The omitted or base case is a firm that did not engage in any of these activities. However, because fully exporting firms are unable to perform either R&D exclusively or neither of the two activities, there are only two cases that are distinguished by the lagged decisions of R&D and export in these clusters: firms that combined the two activities (*RDTOTEXPNOFPi,t-1*, *RDTOTEXPWFPi,t-1*), and firms that only exported (*TOTEXPNOFPONLYi,t-1*, *TOTEXPWFPONLYi,t-1*).

We follow Golovko and Valentini (2011) and estimate sales growth using a fixed-effects model to control for the possible endogeneity of exports and R&D decisions **(**Hamilton and Nickerson, 2003; Shaver, 1998). This model allows controlling for time-invariant unobserved firm heterogeneity. Each firm has its own individual characteristics that may influence the exporting and R&D variables (for example, the firm's business practices, organizational structure or managerial capabilities may influence these firm's strategic choices). The fixed-effects model removes the effect of those time-invariant characteristics so we can assess the net effect of the predictors that vary over time on the outcome variable (specifically, that the predictors of interest in our analysis all vary over time).

Finally, to account for serial correlation, which in particular may arise for the independent variables R&D and export are serially correlated (this is likely to be the case, as these two variables show

some persistence over time), we use firm-level clustered standard errors. The models for the first, second, third, and fourth clusters are given by equations (17), (18), (19,) and (20), respectively:

$$Salesgrowth_{i,t} = f(ANYEXPNOFPONLY_{i,t-1}, RDNOFPONLY_{i,t-1}, RDANYEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (17)$$

$$Salesgrowth_{i,t} = f(ANYEXPWFPONLY_{i,t-1}, RDWFPONLY_{i,t-1}, RDANYEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (18)$$

and

$$Salesgrowth_{i,t} = f(TOTEXPNOFPONLY_{i,t-}, RDTOTEXPNOFP_{i,t-1}, Z_{i,t-1}) \quad (19)$$

$$Salesgrowth_{i,t} = f(TOTEXPWFPONLY_{i,t-}, RDTOTEXPWFP_{i,t-1}, Z_{i,t-1}) \quad (20)$$

Where $Z_{i,t-1}$ is the same vector of control variables used previously. In this model, previous export participation ($ANYEXPNOFPONLY_{i,t-1}$, $ANYEXPWFPONLY_{i,t-1}$, $TOTEXPNOFPONLY_{i,t-1}$ and $TOTEXPWFPONLY_{i,t-1}$) is included in the model to capture efficiency gains (learning) from exporting. There is support for the learning-by-exporting hypothesis whenever these variables significantly and positively affect sales growth. We content that exports and R&D have a complementary effect on firm growth, when the return in terms of sales growth from undertaking one activity increases if a firm also undertakes the other. There is empirical evidence for this effect whenever the parameters estimates of $RDANYEXPNOFP_{i,t-1}$ and $RDANYEXPWFP_{i,t-1}$ (for the first and second clusters of firms) and $RDTOTEXPNOFP_{i,t-1}$ and $RDTOTEXPWFP_{i,t-1}$ (for the third and fourth clusters of firms) are positive and statistically significant.

4. Empirical results and discussion

In this section, we present the findings of univariate and bivariate models that account for independent and joint decisions to export and carry out R&D. We then report on whether the presence of complementarities between the two strategies would boost firm sales growth. Our empirical findings should be interpreted as indicating only partial correlations rather than causation. Tables 4 and 5 show the average marginal effects (estimated using probit) for the exporting and innovation equations, respectively. All of the specifications listed below allow for a quadratic effect on labor productivity (as the linear and quadratic terms of labor productivity are not independent of each other, calculations of the marginal effects are thus performed accordingly).

4.1. Estimates of exporting activity (Exporting equation)

4.1.1. Any exporting firms with no foreign participation

Lagged exports increase the likelihood of current exports. The average marginal effect is 1.0213, implying that firms that exported previously are 102.13 percentage points more likely to export in the current period than firms that did not. This is consistent with the sunk-cost interpretation, which implies the existence of high entry and exit costs in the export market **(**Roberts and Tybout, 1999). The existence of sunk costs has two interconnected consequences. For starters, it raises entry barriers because firms that enter export markets must make enough money to cover the fixed costs

of entry. Second, substantial sunk costs imply substantial exit costs. When a company stops exporting, its knowledge of the export market rapidly deteriorates, and it loses the expertise gained over years of exporting. Those who have already incurred startup costs are therefore more likely to continue exporting during this period. The combination of sunk costs and uncertainty should induce persistence in exporting status (Sibaa and Gebreeyesus, 2017). Lagged R&D has a positive impact on current exports. Investing in R&D allows a company to develop more innovative and competitive products and/or services, resulting in a competitive advantage and positive effects on exports (Cassiman and Martinez-Ros, 2007; Lachenmaier and Woessmann, 2006). Conducting R&D has also been identified as a relevant factor in explaining exporters' higher productivity when compared to non-exporters, implying that productivity gains allow firms to afford the costs associated with exporting and enable them to achieve a greater ability to meet international market demand, making exporting more profitable (Golovko and Valentini, 2011; Love and Roper, 2015).

Firm age predicts current exports fairly well because older firms may be endowed with more resources (financial and knowledge) that enhance exporting capacities. This is consistent with the findings of Majocchi, Bacchiocchi, and Mayrhofer (2005), who use firm age as a proxy for the duration of firms' internationalization experience, implicitly assuming that age and internationalization experience are both positively related to the extent or intensity of firms' international engagement.

Labor productivity and exports have a nonlinear relationship, with export sales increasing only after a certain threshold is reached (as labor may need some learning phase to take its full effect for productivity gains to be taduced into an increased scale of production and sales). This finding is consistent with the self-selection hypothesis, which holds that more productive firms choose to enter export markets because they are relatively efficient (Bernard and Jensen, 1999a; Greenaway and Kneller, 2007). The remaining control variables are statistically insignificant.

4.1.2. Any exporting firms with foreign participation

Exports in previous periods positively affected exports in subsequent periods. Lagged R&D reduces the likelihood of current exports. We provide an explanation in the absorptive capacity line. Cohen and Levinthal (1990) show in a seminal publication that R&D serves two distinct purposes: it generates innovation and/or increases the firm's absorptive capacity that shapes the extent to which firms can benefit from technological knowledge available in global and local networks (Bell and Giuliani, 2007; Giuliani and Bell, 2005). Firms in host countries must recognize the value of new, external knowledge grafted from FDI inflows, assimilate it, and apply it to the local context. Because R&D and exports are both expensive activities, firms may devote more resources to R&D (to improve absorptive capacity) at the expense of developing export capabilities (rival utilization of limited organizational resources).

Firm size has a positive impact on current exports because large firms may produce and sell on a large scale or have lower fixed costs associated with exporting than small firms. Coherently, Helpman, Melitz, and Yeaple (2004), Madsen and Servias (1997), and Hindinis (2019) point out that larger companies have a better chance of exporting and succeeding in transportation. Large firms, according to Hirsch and Adar (1974), can also afford to take on more risks than small firms, because they benefit from economies of scale in foreign marketing. As a result, large firms demand a lower risk premium from foreign marketing than small ones. Large firms, therefore, tend to export a greater proportion of their output. These theoretical constructs are confirmed by empirical analysis of a sample of several hundred firms from six industries in Denmark, Holland, and Israel. The data show that, with a few exceptions, firm size is indeed positively correlated with the export-to-sales ratio.

The coefficient of *AGE_1* is negative and statistically significant. This is consistent with the findings of Kirpalani and McIntosh (1980), as well as Love, Roper, and Zhou (2016). Love, Roper, and Zhou (2016) criticize studies that use firm age as a proxy for a firm's internationalization experience, arguing that this is more likely to be related to the potential for learning (Johanson and Vahlne, 1977) than to export performance. Firm age, on the other hand, may be associated with sclerotic thinking, inflexibility, and the management team's or the firm's overall inability to change strategy and/or behavior. The coefficients of the remaining control variables are insignificant.

4.1.3. Fully exporting firms with no foreign participation

There is strong statistical support for the positive impact of lagged exports on current exports. The average marginal effect decreased (from 1.0213 to 0.496) in comparison to the first cluster and decreased (from 0.895 to 0.496) in comparison to the second one. This could be attributed to strict contractual arrangements governing fully exporting firms (mostly subcontractors), who are required to export exactly what is mandated by the contracts, and where international demand may be lower this year than last.

R&D is reducing current exports. Similarly, we provide an explanation alongside the absorptive capacity approach as for the previous cluster, except that fully exporting firms, primarily subcontractors, obtain new knowledge from their parent firm (the contractor) rather than FDI flows. Subcontractors can obtain technologies from their parent companies, according to Urata and Kawai (2002), and parent companies frequently press subcontractors to improve their technological capabilities through flexible relationships. In most developing countries, subcontracting relationships with large enterprises, particularly transnational corporations (TNCs) and their joint ventures and corporate affiliates, are regarded as an important source of technological progress for SMEs (UNCTAD, 2001). Furthermore, according to the knowledge-based literature, it is critical for the parent company to improve the absorptive capacities of the subcontractors themselves (Bocquet, 2014; Cohendet and Llerena, 2005). Additionally, Gorodnichenko, Svejnar, and Terrell, 2014) state that domestic corporations' absorptive capacity

is determined by their level of technology/efficiency and skilled workers/human capital. Because technological competence increases firm productivity, subcontractors are more likely to be productive than non-subcontractors. According to Nishiguchi (1994) and Hines (1994), a multi-tier subcontracting system based on specialization and SMEs is viewed as a factor in improving firm efficiency and competitiveness in Japanese manufacturing. All of the preceding arguments may imply that the companies in this cluster are more likely to be productive than other domestic firms, as well as to have skilled workers and/or better human capital. These firms may be better able to absorb, internalize, and apply the knowledge potentially provided by their parent companies, implying that they will be able to more easily adapt this technology and knowledge to the local environment. As a result, they would devote fewer resources to R&D, as opposed to the second cluster.

Firm size positively affects current exports. There is little support for self-selection, possibly because contractual arrangements may well mask most of the effect of efficiency on exporting. The coefficients of the remaining variables are statistically insignificant.

4.1.4. Fully exporting firms with foreign participation

There is strong statistical support for the positive impact of lagged exports on current exports. The average marginal effect increased (from 0.496 to 0.6208) in comparison to the third cluster. This could be due to foreign participation in these firms' capital, as they may have better access to financial resources, knowledge, and technology, allowing them to produce and sell at a larger scale. Consistently, Moran, Graham, and Blomstrom (2005), point out that if inward FDI is supported by appropriate public actions, it can be a significant driver of local economic development and contribute to the host country's competitiveness by facilitating the transfer of new knowledge and technology among economies and allowing the host country to gain competitive advantages in international markets.

Lagged R&D reduces current exports. The average marginal effect increases in absolute value when compared to the third cluster (from 0.05004 to 0.1122). This is because, in addition to knowledge and technology grafted from parent firms, this cluster's firms benefit from FDI knowledge. In order to adapt this knowledge and technology to the local business environment, they should devote more resources to R&D than the third cluster. The average marginal effect is somewhat smaller when compared to the second cluster (it decreases in absolute value from 0.1274 to 0.1122). This cluster (primarily made up of subcontractors) is more likely than the second to have a higher absorptive capacity because its firms' in-house knowledge is supplemented by new knowledge and technology grafted from the acquiring firmss, for whom it is critical to improve the absorptive capacities of their subcontractors (Bocquet, 2014; Cohendet and Llerena, 2005). These firms may be more efficient than those in the second cluster at adjusting external knowledge brought in by FDI. As Cohen and Levinthal (1990) state, companies require strong internal technological capability to facilitate the adoption and assimilation of new technologies. Wallin (2017) also showed that increased external knowledge diversity benefits firms in the medium-high tech and medium-low tech sectors of Swedish manufacturing exporters only if they have some internal knowledge to boost their absorptive capacity. As a result, these firms may devote fewer resources to R&D for this purpose than the second cluster.

Firm age negatively affects exports (the arguments offered for the second cluster still apply here). The other control variables are statistically insignificant.

Table 4. Exporting equation-marginal effects (univariate probit estimation)

Independent variable	Exporters vs. non-exporters		Fully exporting firms vs. others	
	Firms with no foreign participation	Firms with foreign participation	Firms with no foreign participation	Firms with foreign participation
ANYEXPNOFP_1/ ANYEXPWFP_1/ TOTEXPNOFP_1 /TOTEXPWFP_1	1.0213***	0.8955***	0.4963***	0.6208***
	(0.02315)	(0.0235)	(0.0135)	(0.02054)
R&D_1	0.04701*	-0.1274***	-0.05004***	-0.1122***
	(0.0175)	(0.02307)	(0.01136)	(0.01903)
SIZE_1	7.44e-07	0.00002*	0.00001*	4.46e-06
	(7.02e-06)	(8.97e-06)	(7.47e-06)	(7.41e-06)
AGE_1	0.00068**	-0.00235***	-0.00036	-0.00219***
	(0.00034)	(0.00043)	(0.00024)	(0.00037)
CAPITAL_1	-2.90e-12	-2.61e-11	-6.20e-11**	-2.37e-11
	(8.74e-12)	(2.12e-11)	(2.51e-11)	(1.81e-1)
PRODUCTIVITY_1	2.72e-08*	-1.43e-08	8.94e-09	-1.39e-08
	(1.59e-08)	(1.71e-08)	(8.52e-09)	(2.92e-08)
PRODUCTIVITY_1 squared	-5.68e-16**	4.07e-16	-1.87e-16	4.55e-16
	(2.82e-16)	(3.23e-16)	(1.44e-16)	(2.41e-15)
TEXTILE	0.08224	0.03396	0.00429	0.0414
	(0.06108)	(0.05317)	(0.02230)	(0.0432)
AGROFOOD	0.0838	-0.0616	-0.01798	-0.0355
	(0.0629)	(0.05646)	(0.02466)	(0.0463)
ELECT	0.07230	0.0348	-0.00868	0.0477
	(0.0615)	(0.05556)	(0.02219)	(0.04515)
ENER_MIN_MISCEL	0.01653	-0.04305	-0.04166*	-0.0439
	(0.06071)	(0.05404)	(0.02283)	(0.0442)
YEAR 2016	0.01686	-0.0125	0.01109	0.0029
	(0.0207)	(0.0198)	(0.0119)	(0.01481)
YEAR 2017	0.0173	0.00902	0.01196	-0.0036
	(0.0192)	(0.0174)	(0.0105)	(0.01325)
No. of observations	**100079**	**100079**	**100079**	**100079**

*Note: Heteroscedasticity-Robust standard errors 'clustered within a firm) are in parentheses; *, **, and *** denote variables significant at 10%, 5%, and 1%, respectively.*

Source: Authors' calculations.

4.2. Estimates of R&D activity (Innovation equation)

4.2.1. Any exporting firms with no foreign participation

Lagged R&D investment has a positive impact on current R&D, lending credence to the true state dependence on R&D activity. This finding can be interpreted as "success breeds success" (Peters, 2009) or as having fixed and sunk costs interpretation. These costs are thought to include the costs of establishing R&D divisions (Arqué-Castells and Mohnen, 2015). The positive and statistically significant coefficient of lagged exports provides compelling evidence for the learning by exporting effect. Exposure to international markets can further stimulate innovation by increasing competitive pressure on firms and promoting technological transfer from destination markets, improving a company's technological (but also marketing) knowledge, and laying the groundwork for the development of additional knowledge (Benfratello, Bottasso, and Piccardo, 2022; Yeoh, 2004). Integrating international markets can also boost a company's ability to innovate by allowing it to hire more qualified technologists and gain access to skilled technical expertise (Kafouros et al. 2008).

Furthermore, according to Kotabe, Srinivasan, and Aulakh (2002), internationalization can reduce costs associated with innovation: highly internationalized firms can access many markets around the world, buy materials and R&D from the cheapest available sources, and locate their R&D and other departments in the most productive regions, potentially achieving higher returns from innovation.

Firm age predicts current R&D fairly well because older firms are more likely to be more seasoned and endowed with more resources (financial and human) to carry out R&D, which may be undertaken for two reasons: to generate innovation and/or to increase the firm's absorptive capacity. Several studies have found that absorptive capacity is path-dependent and cumulative, so mature firms will have more experience identifying and exploiting external knowledge (Cohen and Levinthal, 1990).

The relationship between labor productivity and R&D is nonlinear, with labor productivity increasing R&D only after a certain threshold (Labor may require some learning phase to generate efficiency gains, which will also require time to translate into a larger scale of R&D). This captures the self-selection process by which more efficient firms conduct R&D activities.

The average marginal effect of the *ELECT* and *ENER_MIN_MISCEL* sector dummies are positive and significant, indicating that these sectors are the most involved in R&D activity compared to the remaining sectors. The coefficients of the remaining control variables are insignificant.

4.2.2. Any exporting firms with foreign participation

The coefficient of lagged R&D is positive and significant at less than a 1 percent confidence level (not reported). Furthermore, the average marginal effect is slightly smaller when compared to firms in the first cluster. A host of factors may account for this decline. First, firms with foreign participation may start with relatively high average R&D because the firm’s base knowledge may be supplemented by FDI-brought external knowledge **(**Esteve-Pérez and Rodriguez, 2013), implying that there may be fewer clear returns to R&D in terms of innovation. Second, R&D activity in developing countries is focused on building up a firm’s absorptive capacity more than the development of its own innovations **(**Astrid et al. 2008). Firms may then prioritize adapting new technologies and knowledge to local conditions over innovating.

The nonlinear effect of labor productivity on R&D persists. Furthermore, the coefficients of *PRODUCTIVITY_1*'s linear and quadratic terms are smaller than those of the first cluster. Similarily to the interpretation above, FDI as a potential source for knowledge and technology injection into host country economies may allow local firms to experiment with relatively high average R&D, implying that there are fewer clear returns to labor productivity in terms of R&D.

There is no support for the learning by exporting effect. Firm age increases R&D investment (The arguments made for any exporting firms with non-foreign participation may still apply here). The average marginal effect of the *ELECT*, *AGROFOOD*, *TEXTILE*, and *ENER_MIN_MISCEL* sector dummies is positive and significant, indicating that these industries are more involved in R&D than the other sectors. The remaining control variable coefficients are insignificant.

4.2.3. Fully exporting firms with no foreign participation

A 1-year lagged R&D increases the likelihood of current R&D. The average marginal effect is somewhat larger than in the first two clusters, implying a twofold interpretation. First, fully exporting firms (primarily subcontractors) must meet the high-quality product standards demanded by multinational parents in order to meet the needs of a more sophisticated demand in foreign markets. This is consistent with Baudry (2005).

, who shows that subcontractors use coordination mechanisms that are no longer limited to price mechanisms but require practices and tools that reveal a subcontractor's ability to deliver goods in due quality and on time, as well as to innovate. According to Bocquet (2014), subcontractors are no longer only expected to produce but are also frequently pushed to generate the technological knowledge that drives new products and process development. Even though, in most cases, subcontractors are rarely in charge of product design, because it is too specific or risky to be subcontracted. Subcontractors may have no incentive to innovate in either process or product because of the nature of this interfirm relationship. Nonetheless, subcontractors may be able to improve their processes as a result of passive learning effects. Second, fully exporting firms have to invest more in R&D to increase absorptive capacity, which influences how much the firm can benefit from technological knowledge and spillovers grafted from the acquiring firms (Bell and Giuliani, 2007; Giuliani and Bell, 2005).

Firm age increases current R&D. There is no support for the hypothesis of learning by exporting. This finding does not imply that fully exporting firms lack export-based learning; rather, it stems from the peculiarity of Tunisian manufacturing firms, which may be primarily subcontractors (70 percent of exports come from the offshore sector (Jacobson and Lindberg, 2005) with relatively long exporting experience. Hence, they are likely to experience a gradual decline in the scope for learning. Bingham (2012) state that a firm should expect a decrease in the learning ratio as it gains more export experience, owing to the decreasing rate of the learning sequence. Younger firms, according to Hashai and Almor (2004), begin exploring the acceptance of their goods in foreign markets and continue to exploit their advantages based on the knowledge gained during their first international activities. However, when a company starts to export and enters a new stage, it shifts its focus to the exploitation of prior knowledge rather than the exploration of new knowledge.

The average marginal effect of the *ELECT*, *AGROFOOD*, and *ENER_MIN_MISCEL* sector dummies is positive, suggesting that these sectors are more involved in R&D than the other sectors. The remaining findings are similar to those of the second cluster.

4.2.4. Fully exporting firms with foreign participation

Lagged R&D positively affects current R&D. In comparison to the third cluster, the average marginal effect is slightly smaller (it reduces from 0.5305 to 0.4697). Due to the additional technology and knowledge grafted from FDI, firms in this cluster are likely to be more cutting-edge technologically than those in the previous cluster. These companies are probably more R&D-intensive to begin with, so there are fewer clear returns on R&D in terms of investment in R&D.

The marginal effect in the first cluster is twice as large as the marginal effect in the second cluster (it increases from 0.1274 to 0.4697). The same arguments put forth for the previous cluster still hold true. Firm age increases investment in R&D. The remaining findings are qualitatively similar to those from the second cluster, and it is possible that the same reasoning and justifications still apply.

Table 5. Innovation equation—marginal effects (univariate probit estimation)

Independent variable	Exporters vs. non-exporters		Fully exporting firms vs. others	
	Firms with no foreign participation	Firms with foreign participation	Firms with no foreign participation	Firms with foreign participation
ANYEXPNOFP_1/ ANYEXPWFP_1/ TOTEXPNOFP_1 /TOTEXPWFP_1	0.06671***	-0.1655***	-0.0704***	-0.1927***
	(0.00954)	(0.0136)	(0.0132)	(0.0158)
R&D_1	0.51706***	0.4687***	0.53052**	0.4697***
	(0.0209)	(0.0167)	(0.01506)	(0.01606)
SIZE_1	-0.000012	-7.99e-06	-9.93e-06	-0.00001
	(7.95e-06)	(6.91e-06)	(7.70e-06)	(6.56e-06)
AGE_1	0.00108***	0.00056*	0.00122***	0.00052*
	(0.00031)	(0.00031)	(0.00032)	(0.0003)
CAPITAL_1	5.13e-12	3.17e-12	4.39e-12	3.12e-12
	(8.26e-12)	(7.27e-12)	(7.89e-12)	(7.15e-12)
PRODUCTIVITY_1	6.67e-08*	3.86e-08*	3.92e-08	3.44e-08
	(3.46e-08)	(2.32e-08)	(2.68e-08)	(2.27e-08)
PRODUCTIVITY_1 squared	-1.34e-14	-5.32e-15**	-4.86e-15	-4.65e-15*
	(9.58e-15)	(2.61e-15)	(3.09e-15)	(2.49e-15)
TEXTILE	0.04478	0.0783**	0.06317	0.0822**
	(0.03902)	(0.0381)	(0.03946)	(0.03891)
ELECT	0.09078**	0.1196**	0.10194**	0.12377**
	(0.0398)	(0.0388)	(0.0399)	(0.0396)
ENER_MIN_MISCEL	0.0855**	0.0896**	0.0854**	0.0880**
	(0.0395)	(0.0385)	(0.0399)	(0.0394)
AGROFOOD	0.0609	0.0728*	0.0754*	0.0756*
	(0.0406)	(0.0398)	(0.0410)	(0.0405)
YEAR 2016	0.0209	0.02235	0.02026	0.0219
	(0.01597)	(0.0151)	(0.01587)	(0.0151)
YEAR 2017	-0.01625	-0.01716	-0.01743	-0.01620
	(0.01475)	(0.01413)	(0.0149)	(0.01407)
No. of observations	100079	100079	100079	100079

*Note. Heteroscedasticity-Robust standard errors (clustered within a firm) are in parentheses; *, **, and *** denote variables significant at 10%, 5%, and 1%, respectively.*

Source: Authors' calculations.

4.3. Estimates of the interaction between exports and R&D activities

Tables 6 and 7 summarize the estimates of the interplay between exporting and R&D activities for the four clusters of firms.

4.3.1. Any exporting firms with no foreign participation

Firms that do both activities are more likely to continue exporting (carrying R&D) in the current period than firms that did neither activity or previously exported (performed R&D) only (*RDANYEXPNOFP_1* has a larger coefficient than *ANYEXPNOFPONLY_1* and *RDNOFPONLY_1*). The results suggest that exports and R&D complement each other to increase export sales and R&D investment. Complementarities prevail for both activities, because through innovation, firms can enter new geographical markets with novel and improved products, increasing the success of exports (e.g., Hitt, Hoskisson, and Kim (1997). Furthermore, participating in export markets can help firms learn more and improve their innovation performance. Exporting firms may have access to knowledge sources not available in their domestic market, which they can then use to produce more and higher-quality innovations (e.g. Alvarez & Robertson, 2004; Salomon and Shaver, 2005a). Exports and R&D can thus create a virtuous, mutually reinforcing circle, producing more clear returns in terms of export and R&D activities.

The outcomes for the remaining control variables are almost identical to those depicted by Tables 4 and 5. *AGE_1* has a positive impact on both exports and R&D. *SIZE_1* reduces the incentives to invest in R&D in the bivariate model (but has no impact in the univariate model) The sector dummies *ELECT* and *ENER_MIN_MISCEL* positively affect R&D decisions. *PRODUCTIVITY_1* has a nonlinear relationship with R&D. These findings corroborate the majority of the findings of the independent decisions of exporting and R&D.

4.3.2. Any exporting firms with foreign participation

Firms combining both activities in previous periods are more likely to continue exporting (conducting R&D) in subsequent periods compared to firms that did neither activity or only exported (innovated) in previous periods, albeit the coefficient of *RDANYEXPWFP_1* is slightly smaller than that on *ANYEXPWFPONLY_1* for the exporting activity, and the coefficient of *RDANYEXPWFP_1* is smaller than that of *RDWFPONLY_1* for the innovation activity, bringing little evidence for the potential of export-R&D complementarity to boost export sales or R&D investment. However, *RDWFPONLY_1* reduces export sales for the exporting equation and *ANYEXPWFPONLY_1* reduces R&D investment for the innovation equation, supporting the trade-off between the two strategies that should not be pursued jointly.

Prior literature on M&As posits that being a part of a foreign company may facilitate the process of becoming an exporter, as the acquiring firm may transfer new knowledge, technology, and

managerial practices in the acquired firm, which may help the acquired firm to gain competitive advantages and integrate international markets (Basile, 2001; Moran, Graham, and Blomstrom, 2005). Following that, because merged firms are more technologically advanced than non-FDI recipients, they may prioritize developing export capacities over R&D. Acquired firms, on the other hand, may need to invest more in R&D in order to assimilate and apply the external know-how brought by the acquiring firm, because R&D activity in developing countries is focused on increasing a firm's absorptive capacity rather than developing its own innovations (Astrid et al. 2008).

The results for the remaining control variables are nearly the same as those shown in Tables 4 and 5. *AGE_1* boosts R&D while decreasing exports. *SIZE_1* increases exports while reducing R&D; The *AGROFOOD*, *TEXTILE*, *ELECT*, and *ENER_MIN_MISCEL* sector dummies have a positive impact on R&D decisions in the bivariate model (but only the *AGROFOOD* and *TEXTILE* sector dummies increase the incentives to invest in R&D in the univariate model). *PRODUCTIVITY_1* has a nonlinear relationship with R&D. These findings support the majority of the findings from independent decisions to export and carry out R&D.

4.3.3. Fully exporting firms with no foreign participation

In this cluster, firms involved in both activities continue to export more than firms that exported only in previous periods. *TOTEXPNOFPONLY_1* and *RDTOTEXPNOFP_1* both have positive and significant coefficients, with *RDTOTEXPNOFP_1* having a slightly larger coefficient than *TOTEXPNOFPONLY_1*. Overall, the results are consistent with complementarities of export and R&D activities in increasing export sales.

As for the R&D activity, firms that previously exported only have fewer incentives to invest in R&D in subsequent periods (the coefficient of *TOTEXPNOFPONLY_1* is negative and statistically significant), suggesting that exports and R&D are alternative strategies, and they should not be carried jointly. There are two possible explanations for the displacement of R&D by exports. First, firms that export their entire output engage in a large scale of production and sales to face increased international demand. Alternatively, fully exporting firms (mostly subcontractors) may be bid on under strict export arrangements, limiting the firm's ability to diversify along both strategies, exports and R&D. In both cases, these companies must increase their export capacity, which they can afford by foregoing R&D. This finding is consistent with Kumar (2009) who showed that short-run constraints are a source of a negative association between product diversification and international diversification for US firms.

Second, due to the external knowledge and technology grafted from the parent firms, fully exporting firms are very likely to be cutting-edge technologically (compared to others), inducing them to devote more resources to developing exports rather than R&D activities, as further

increases in the scale of innovation for firms starting with a high average R&D may produce less clear returns in terms of investment in R&D.

Substitutability effects are stronger in this cluster than in the second cluster. The coefficient of *TOTEXPNOFPONLY_1* is somewhat larger in absolute value than the coefficient of *ANYEXPWFPONLY_1* (it rises from 0.7358 to 0.9105). This is probably because fully exporting firms produce and sell on a large scale compared to others.
The results for the remaining control variables are as follows: *AGE_1* increases the incentives to invest in R&D while reducing those to export. *SIZE_1* boosts exports and reduces R&D. *PRODUCTIVITY_1* increases the incentives to invest in R&D only after a certain threshhold. The *ELECT, AGROFOOD, TEXTILE,* and *ENER_MIN_MISCEL* sector dummies have all a positive impact on R&D in the univariate model, but only the *ELECT* sector dummy positively affects R&D in the bivariate model. These findings corroborate some of the findings of the independent activities to export and invest in R&D.

4.3.4. Fully exporting firms with foreign participation

The coefficient of *RDTOTEXPWFP_1* is somewhat smaller compared to that of *TOTEXPWFPONLY_1*, giving little support for the complementary effect of the two strategies on boosting exports. Export advantages, such as export guarantees, which benefit fully exporting firms (primarily subcontractors), have the potential to obscure the majority of the effect of the complementarity mechanism on increasing export sales. *TOTEXPWFPONLY_1*, on the other hand, has a negative impact on R&D, providing compelling evidence for the trade-off between R&D and exports - exports are likely to crowd R&D out. This finding is supported by similar results for the second and third clusters, and the same intuition and arguments may still apply.

Substitutability has a greater impact in this cluster than in the third. The coefficient of *TOTEXPWFPONLY_1* is larger in absolute value than the coefficient of *TOTEXPNOFPONLY_1* (it increases from 3.0745to 3.12405). This is because FDI may provide host-country firms with a better understanding of foreign markets, more relationships, and contacts, thereby increasing their export opportunities in terms of quantity and destinations.

Substitutability is also stronger here than in the second cluster. The coefficient of *TOTEXPWFPONLY_1* is twice as large in absolute value as the coefficient of *ANYEXPWFPONLY_1* (it rises from 2.9579 to 3.12405). This is due to the fact that fully exporting firms have more opportunities and involvement in international markets than firms that only partially export. In both cases, firms in this cluster are more likely to be involved with international markets, which encourages them to increase their export sales in order to meet high international demand, which they can only do by foregoing R&D.

The results for the remaining control variables are as follows: *AGE_1* reduces the incentives to export while increasing those to invest in R&D; *SIZE_1* increases exports while decreasing R&D (but has no impact on either activity in the univariate models). *PRODUCTIVITY_1* has a positive impact on R&D in the bivariate model (but has no impact on R&D in the univariate model). The *ELECT*, *TEXTILE*, *AGROFOOD*, and *ENER_MIN_MISCEL* sector dummies boost R&D in the bivariate model, but only the *ELECT*, *TEXTILE*, and *ENER_MIN_MISCEL* sector dummies increase R&D in the univariate model. These findings back up the majority of independent activities' efforts to export and invest in R&D.

Table 6. Estimates of the interaction between exports and R&D activities — Bivariate probit estimation for any exporting firms

Independent variable	*Any exporting firms with no foreign participation*		*Any exporting firms with foreign participation*	
	Exporting decision	R&D decision	Exporting decision	R&D decision
ANYEXPNOFPONLY_1/	2.7307***	0.01046	2.9579***	-0.7358***
ANYEXPWFPONLY_1	(0.0781)	(0.0659)	(0.0827)	(0.0763)
RDANYEXPNOFP_1/	3.251***	2.5238***	2.8368***	1.3344***
RDANYEXPWFP_1	(0.0947)	(0.0762)	(0.2493)	(0.1977)
RDWFPONLY_1	-0.3616***	1.8027***	-0.5273***	2.00619***
	(0.1134)	(0.0848)	(0.0919)	(0.07182)
SIZE_1	-0.000015	-0.00006*	0.000066**	-0.000034
	(0.00002)	(0.00003)	(0.00003)	(0.000029)
AGE_1	0.00245**	0.00531***	-0.008007***	0.00226*
	(0.00099)	(0.00135)	(0.00143)	(0.001365)
CAPITAL_1	-1.74e-11	1.93e-11	-6.58e-11	1.32e-11
	(2.95e-11)	(3.22e-11)	(6.32e-11)	(3.15e-11)
PRODUCTIVITY_1	8.82e-08**	1.97e-07*	-6.17e-08	1.67e-07*
	(4.48e-08)	(1.19e-07)	(5.77e-08)	(9.99e-08)
PRODUCTIVITY_1	-1.82e-15**	2.66e-14*	1.62e-15	-2.28e-14**
squared	(7.92e-16)	(1.44e-14)	(1.11e-15)	(1.12e-14)
TEXTILE	0.1626	0.10515	0.17246	-2.28e-14**
	(0.1796)	(0.17156)	(0.1775)	(1.12e-14)
ELECT	0.1327	0.3022*	0.17097	0.3272**
	(0.1811)	(0.17416)	(0.1856)	(0.16101)
ENER_MIN_MISCEL	-0.01304	0.2968*	-0.0839	0.3713**
	(0.17837)	(0.17434)	(0.1799)	(0.16278)
AGROFOOD	0.1538	0.1801	-0.1382	0.30227*
	(0.1853)	(0.1780)	(0.1881)	(0.16838)
YEAR 2016	0.03859	0.0751	-0.01859	0.0959
	(0.0594)	(0.0647)	(0.06535)	(0.06557)
YEAR 2017	0.0464	-0.0842	0.01514	-0.0696
	(0.0542)	(0.06016)	(0.05802)	(0.06084)
CONSTANT	-1.7386***	-1.7876***	-1.53105***	-1.6856***
	(0.18606)	(0.1832)	(0.1884	(0.1725)
Wald Chi^2 (p-value>chi^2)	23.0041	_	34.3078	_
	(0.0000)		(0.0000)	
No. of observations	100079	100079	100079	100079

*Note. Heteroscedasticity-Robust standard errors (clustered within a firm) are in parentheses; *, **, and *** denote variables significant at 10%, 5%, and 1%, respectively.*

Source: Authors' calculations.

Table 7. Estimates of the interaction between exports and R&D activities – Bivariate probit estimation for fully exporting firms

Independent variable	Fully exporting firms with no foreign participation		Fully exporting firms with foreign participation	
	Exporting decision	R&D decision	Exporting decision	R&D decision
TOTEXPNOFPONLY_1	3.0745***	-0.9105***	3.12405***	-1.5399***
/TOTEXPWFPONLY_1	(0.089)	(0.0749)	(0.0862)	(0.0873)
RDTOTEXPNOFP_1/	3.1635***	0.6056***	2.7788***	-0.6587**
RDTOTEXPWFP_1	(0.1896)	(0.1668)	(0.3424)	(0.3358)
SIZE_1	0.00009*	-0.000106*	0.000036	-0.00011*
	(0.000045)	(0.0000645)	(0.000036)	(0.000057)
AGE_1	-0.003004**	0.00859***	-0.01132***	0.0044*
	(0.00141)	(0.00225)	(0.0018)	(0.00233)
CAPITAL_1	-3.59e-10**	1.80e-11	-1.08e-10	1.17e-11
	(1.52e-10)	(5.21e-11)	(8.43e-11)	(4.97e-11)
PRODUCTIVITY_1	4.97e-08	3.55e-07**	-1.34e-07	3.03e-07*
	(5.32e-08)	(1.67e-07)	(1.53e-07)	(1.62e-07)
PRODUCTIVITY_1	-1.02e-15	-4.10e-14	8.71e-15	-3.85e-14**
squared	(8.98e-16)	(2.53e-14)	(1.42e-14)	(1.69e-14)
PRODUCTIVITY_1	-1.02e-15	-4.10e-14	8.71e-15	-3.85e-14**
squared	(8.98e-16)	(2.53e-14)	(1.42e-14)	(1.69e-14)
TEXTILE	0.0225	0.2697	0.2076	0.4498*
	(0.1482)	(0.2424)	(0.1954)	(0.2435)
ELECT	0.0823	0.553**	0.19504	0.7643***
	(0.1473)	(0.24289)	(0.202)	(0.2435)
ENER_MIN_MISCEL	-0.2663*	0.3967	-0.1857	0.4606*
	(0.1516)	(0.2445)	(0.1977)	(0.2451)
AGROFOOD	-0.12103	0.3547	-0.1374	0.3791
	(0.16104)	(0.2562)	(0.2086)	(0.2578)
YEAR 2016	0.07406	0.0392	0.0395	0.0753**
	(0.0722)	(0.0324)	(0.0702)	(0.0332)
YEAR 2017	0.0477	-0.0307	-0.03702	-0.00835
	(0.0645)	(0.0264)	(0.0645)	(0.0266)
CONSTANT	-1.8241***	-1.1942***	-1.7161***	-1.1353***
	(0.15925)	(0.2498)	(0.2097)	(0.2516)
Wald Chi^2 (*p*- value>Chi^2)	21.9513	–	67.7008	–
	(0.0000)		(0.0000)	
No. of observations	100079	100079	100079	100079

*Note. Heteroscedasticity-Robust standard errors (clustered within a firm) are in parentheses; *, **, and *** denote variables significant at 10%, 5%, and 1%, respectively.*

Source: Authors' calculations.

4.4. Estimates of the growth regression

Table 8 depicts the estimates of the independent and combined impact of exporting and R&D decisions on sales growth. We in particular examine whether the complementarity of the two strategies positively affects firm growth.

4.4.1. Any exporting firms with no foreign participation

The positive, albeit insignificant, coefficient of *RDANYEXPNOFP_1* provides no evidence that coupling R&D and exports influences firm growth. There is little support for the hypothesis of learning by exporting. Labor productivity has a nonlinear effect on growth, increasing sales growth

only after a certain threshold is reached (as labor may need some learning phase to realize its full potential and for productivity gains to be translated into an increased scale of production and sales). Many researchers have studied the relationship between labor productivity and firm performance, concluding that labor productivity leads to additional revenues, which results in higher profits and improved corporate performance (Agiomirgianakis, Voulgaris, and Papadogons, 2006; Farnham and Hutchinson, 2011; Prakash et al. 2017; Salman and Yazdanfar, 2012). The remaining control variables are statistically insignificant.

4.4.2. Any exporting firms with foreign participation

There is no evidence that combining R&D and exports increases firm growth (the *RDANYEXPWFP_1* coefficient is positive but insignificant). Labor productivity continues to have a nonlinear effect on firm performance. Furthermore, the coefficients of the linear and quadratic terms of *PRODUCTIVITY_1* are smaller in absolute value than those of the first cluster, indicating that foreign ownership boosts the productivity of affiliate firms in developing countries through advanced technology, business practices, and modern management (Damijan et al. 2003; Girma et al. 2015). These firms are likely to begin with a relatively large scale of production and sales, implying that labor productivity will produce less obvious sales returns. The remaining control variables are statistically insignificant.

4.4.3. Fully exporting firms with no foreign participation

There is little evidence that coupling R&D and export activities positively affects sales growth. There is also no support for the learning by exporting effect. This finding does not imply that there are no efficiency gains from exporting for these firms; rather, it stems from the unique characteristic of the Tunisian manufacturing sector, in which firms exporting 100 percent of their output may be primarily subcontractors with relatively long exporting experience. Hence, their learning opportunities are likely to dwindle over time.

Labor productivity has a nonlinear effect on sales growth, and the coefficients of the linear and quadratic terms of *PRODUCTIVITY_1_* are slightly smaller in absolute value than in the previous two clusters, possibly, because partially exporting firms (a sub-category of any exporting firms) should put more effort into increasing productivity in order to catch up with fully exporting firms and increase further their scale of sales in foreign markets. An alternative interpretation is alongside the large scale of production and sales fully exporting firms (which export 100 percent of their output) can start with, meaning that labor productivity will produce less clear returns in terms of sales. The remaining control variables are insignificant.

4.4.4. Fully exporting firms with foreign participation

The positive and statistically significant coefficient of *RDTOTEXPNOFP_1* directly suggests that coupling R&D and export activities may lead to synergies positively affecting growth. This indicates that the return from R&D increases as firms export, and vice versa. The two activities complement

one another in terms of knowledge acquisition, cost reduction, and increased firm profits. Exporting firms that also perform innovation activities can increase their sales volume by selling new and improved products in export markets, and therefore either engaging in a larger scale of production and sales or getting better prices (Esteve-Pérez and Rodriguez, 2013; Golovko and Valentini, 2011). On the other hand, innovative firms that enter export markets have the opportunity to gain knowledge through exporting (learning by exporting) and subsequently produce better goods. Thus, these firms will be able to boost their sales in both domestic and international markets, again either by raising prices or profiting from increased demand, or both.

The coefficient of *TOTEXPWFPONLY_1* is not significantly different from zero, suggesting that the combination of both activities—rather than the optimization of export on its own—really matters in explaining the growth of the firms in our sample (Golovko and Valentini, 2011). Labor productivity increases sales growth only after a certain threshold. We have similar results and intuition as the previous cluster. The other control variables are statistically insignificant.

Table 8. Predictors of sales growth-Fixed effects estimation

Independent variable	Any exporting firms with no foreign participation	Any exporting firms with foreign participation	Fully exporting firms with no foreign participation	Fully exporting firms with foreign participation
RDNOFPONLY_1/ RDWFPONLY_1	0.06102	0.07389	_	_
	(0.04116)	(0.04824)		
RDANYEXPNOFP_1/ RDANYEXPWFP_1/ RDTOTEXPNOFP_1/ RDTOTEXPWFP_1	0.39241	0.36816	0.06956	0.04977*
	(0.33658)	(0.37397)	(0.04655)	(0.02625)
ANYEXPNOFPONLY_1/ ANYEXPWFPONLY_1/ TOTEXPNOFPONLY_1/ TOTEXPWFPONLY_1	-0.0616	0.0581	0.0149	0.01963
	(0.07456)	(0.0431)	(0.0093)	(0.0229)
SIZE_1	-0.00002	-0.00002	-0.00004**	-0.00004**
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
AGE_1	-0.01292	-0.01292	-0.01263	-0.01260
	(0.01238)	(0.01235)	(0.01235)	(0.01234)
CAPITAL_1	-2.26e-12	-2.10e-12	-3.03e-12	-3.05e-12
	(2.32e-12)	(2.37e-12)	(2.11e-12)	(2.11e-12)
PRODUCTIVITY_1	-6.15e-08**	-5.85e-08**	-5.64e-08***	-5.61e-08***
	(2.53e-08)	(2.47e-08)	(1.89e-08)	(1.89e-08)
PRODUCTIVITY_1 squared	1.03e-15**	9.82e-16**	9.47e-16***	9.42e-16***
	(4.25e-16)	(4.14e-16)	(3.17e-16)	(3.18e-16)
TEXTILE	-0.00037	-0.00106	-0.01294	-0.01257
	(0.0358)	(0.0354)	(0.0214)	(0.02054)
ELECT	0.01391	0.01776	-0.03035	-0.0345
	(0.0660)	(0.0675)	(0.0264)	(0.02513)
ENER_MIN_MISCEL	0.0694	0.0659	0.0326	0.0266
	(0.0595)	(0.0575)	(0.02047)	(0.01806)
AGROFOOD	-0.04585	-0.0501	-0.01687	-0.0164
	(0.0399)	(0.0432)	(0.0305)	(0.0301)
YEAR 2016	0.02917	0.02952	0.0317	0.0318
	(0.0523)	(0.0526)	(0.0549)	(0.0549)
YEAR 2017	-0.0221	-0.02075	-0.0138	-0.0133
	(0.0161)	(0.0158)	(0.0132)	(0.0132)
CONSTANT	0.23842	0.2159	0.2943	0.2947
	(0.2468)	(0.267)	(0.2523)	(0.2529)
R2 within	0.0033	0.0033	0.0007	0.0007
No. of observations	100079	100079	100079	100079

Note. Heteroscedasticity-Robust standard errors (clustered with a firm) are in parentheses;,**,*** denote variables significant at 10%, 5%, and 1%, respectively.*

Source: Authors' calculations.

5. Conclusions

The interconnections between exports and foreign direct investment (FDI), exports and innovation, and innovation and FDI have been extensively examined in academic literature. Theoretical and empirical analyses of the exports-FDI and exports-innovation links have predominantly focused on assessing whether these strategies complement or substitute for each other. This study advances the discourse by examining the influence of inward FDI, particularly through mergers and acquisitions (M&As), on the dynamics of exports and research and development (R&D). Additionally, it explores whether the integration of these activities has a positive impact on firm growth.

Our empirical analysis relied on firm-level data from Tunisian manufacturing industries from 2016 to 2018. This data are drawn from accounting, industrial, and exporting flow surveys. We identified four types of firms using the export and FDI differentials: (i) The first and second clusters consist of any exporting firms (including partially and fully exporting firms) without and with foreign participation; respectively (ii) The third and fourth clusters of firms are made up of fully exporting firms without and with foreign participation, respectively.

The analysis provided evidence for the learning by exporting effect in the first cluster of firms' R&D activity. In turn, there is strong support for self-selection for most clusters, in particular for the R&D activity. The findings corroborated complementarities between the two strategies for the exporting activity primarily for clusters of firms with no foreign participation, whereas a strategic trade-off between both strategies emerges for the R&D activity, primarily for clusters with foreign ownership. Furthermore, the mutually reinforcing effect of exports and R&D fosters sales growth for fully exporting firms with foreign participation.

We believe that our research sheds some light on the role of foreign participation in shaping the dynamics of exports and R&D in developing countries with a subcontracting regime. First, our findings suggest that the exporting behavior of fully exporting firms (primarily subcontractors) in our sample, and more broadly in the country as a whole, may either mask or obstruct the interaction between R&D and exports because exporting behavior appears to be driven more by strict export arrangements than by efficiency considerations. Second, foreign participation proved important in shaping the interplay between exports and R&D activities, with findings indicating that the two activities complement each other primarily for clusters of firms with no foreign participation, whereas a strategic trade-off between these activities emerges mainly for clusters of firms with foreign participation, particularly for the R&D activity. Third, firm performance improvements do not necessarily come from optimizing exports or R&D on their own, but rather from their combination. Furthermore, the complementarity mechanism positively affects firm growth only for fully exporting firms with foreign ownership, suggesting that FDI is a key contextual variable that influences the extent to which combining R&D and exports increases firm sales growth. This

is most likely because FDI has the potential to stimulate both exports (in terms of quantity or quality or both) and R&D, implying that the functioning of the virtuous circle at the basis of the complementarity between R&D and exports comes into play to boost sales growth only after certain levels of exports and R&D have been reached. This suggests that there are critical sizes for exports and R&D activities above which the complementarity mechanism is effective at boosting firm growth.

In accordance with the "absorptive capacity" argument (Cohen and Levinthal, 1990), Aw, Roberts, and Xu, 2008), and Wallin (2017) have shown that increased external knowledge diversity (resulting from learning from exporting) benefits domestic firms only if they have some internal knowledge and R&D activities. Second, a high export level may indicate a large scale of production of the same good, exporting to a variety of destinations, or a combination of all of these, potentially increasing the scope for learning and the opportunities to bring new knowledge and technology to local economies.

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