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**How Does Firms' Export Strategy React to Government Subsidies? Innovation
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ABSTRACT

Facing an unprecedented and turbulent environment, market and non-market actors attempt to align purposefully and efficiently their strategy and resource allocations. This paper asks how firms' export strategies react to institutional support via innovation. Based on a novel and rich longitude dataset of SMEs covering 2006-2018, first, we examine how government subsidies impact firms' innovation performance, i.e., investment in research and development (R&D). Second, by applying propensity score match, we evaluate the government subsidies' impact: the mediation role of policy-induced R&D in SMEs' export strategies regarding the export decision, product diversification, market diversification, and export value. Empirical results indicate that government subsidies do trigger firms' additional investment in R&D, which positively diversifies SMEs' export. Our findings contribute to the understanding of how institutional factors affect firms' innovation and export performance and provide implications for policymakers on which and how institutions can best equip their home-grown businesses to succeed in international markets, especially for small open advanced economies.

Keywords: Government Subsidies, SME, Export Strategies, Innovation, Propensity Score Match

1. INTRODUCTION

Within an uncertain external global context which includes the impact of the Covid-19 pandemic, a rise in “Techno-nationalism,” and protectionism fueled by populism, nationalism, and the resultant interventionist state (Petricevic & Teece, 2019; Buckley, 2022). Meanwhile a rise in supporting programs and policies created by governments to drive economic growth and resilience. Emerging research, correspondently, start to evaluate the added value of subsidy and funding programs on firms’ innovation outcomes and growth (Jugend et al., 2020; Lenihan et al., 2021; Mulier & Samarin, 2021; Mulligan et al., 2022). However, the literature recognizes both the added value of institutional support on firms’ innovation outputs and the impact of innovation as a main source of competitive advantage for firms’ export and growth, poorly understands the issue of the considerable impact of institutional support on firms’ export performance via innovation activities, especially in SME context. Furthermore, limited research shows conflicts among countries (Freel et al., 2019; Lawless et al., 2019). For instance, Freel et al. (2019) find that SME innovation policy in Germany, regardless of source, does not play a significant role in converting non-exporters into exporters but positively impacts SMEs’ export intensity. This finding contrasts with UK evidence. Harris and Li (2009) and Ganotakis and Love (2011) suggest that innovation drives the decision to export but does not increase the export intensity. Through a large sample of Chinese manufacturing firms, Wu et al. (2022) even show that government support diminishes the positive effect of technological innovation on firms’ export. It is important for policymakers, especially in small and open economies, to understand how state interventions and policies affect firms’ behavior, not just on innovation input (i.e., R&D) but also output, such as export performance, in a broader institutional context.

From a historical perspective, the variety of capitalism (VOC) provides possible reasons for this conflict among countries. VOC systematically compares liberal market economy (LME) and coordinated market economy (CME) and analyzes differences in public policies and innovations derived from various national institutional coherence and configuration (Hall & Soskice, 2001). For example, in LMEs, firms gain resources primarily via hierarchies, competitive market arrangements, and public policy that sustains existing institutional advantages will be chosen. In CMEs, firms depend heavily on non-market relationships (such as industry associations) to build competencies and in which public policy that supports collaborative relationships works (Wood, 2001, p.251). Therefore, with consideration of specific domestic institutional conditions, similar public policies, as formal institutions, can

harvest different impacts and outcomes (Hall & Soskice, 2001; Boyer, 2005; Allen et al., 2006; Schneider et al., 2010; Hall, 2014; Witt & Jackson, 2016; Hall & Hall, 2016). As recently emphasized by Andreosso O’callaghan and Lenihan (2016), institutions within nations or regions form complementary sets or holistic configurations. These institutions then condition economic performance across a range of indices, posing whether they should be the object of national economic policy. Therefore, by integrating the institutional environment and government subsidy, this study provides the first evaluation of the impact of government subsidies on SMEs’ export diversification via innovation. The result suggests policy lessons for other counties, like Ireland, which are small and open economies, wanting to develop and scale up their indigenous SMEs in world markets.

This study makes two significant contributions to the existing literature on government support for innovation and export. First, scholars shed light on innovation which shadows the studies on export performance. Previous research mainly details and conceptualizes various measurements and proxies to capture firms’ innovations. For example, the research analyzes innovation input by measuring investment in R&D, innovation output by measuring patents and sales from new products, and innovation types by distinguishing radical and incremental innovation (Ganotakis & Love, 2011; Hottenrott & Lopes-Bento, 2014; Beck et al., 2016; Freel et al., 2019; Mennens et al., 2022; Robbiano, 2022; Wu et al., 2022). Export performance is under research, remaining at the initial export decision stage, and export intensity which measured by firms’ financial revenues. There is less research on organizational outcomes related to export strategies and performance (Zahoor et al., 2020). As an intermediate output, innovation is rarely a goal itself but a means to achieve broader potential goals. It matters largely to the extent that it enhances competitiveness (Borras & Edquist 2013:1515; Cannone & Ughetto, 2014). Some scholars (Freel et al., 2019) argue that export is likely to be a better indicator of competitiveness. Therefore, our first contribution is to go beyond whether government subsidies change firms’ innovation inputs and extend SMEs’ export performance from export revenue to product and market diversification. By distinguishing private and policy-induced R&D, we evaluate the effectiveness of government subsidies and our results indicate the innovation mechanism of government subsidies on diversifying SMEs’ export.

Our second contribution provides a potential mechanism and explanation of why the outcome of institutional support on firms' export performance shows conflicts among countries. On the one hand, research on the impact of government policies and subsidies neglects the institutional environment where both policymakers and firms are embedded (Zahoor et al., 2020). On the other hand, new phenomena challenge previous research on how the institutional environment impacts innovation and export performance. Recent research shows that important but neglected institutional factors, including institutional capital in international activities and short-term government interventions, must be integrated into the VOC to understand innovation and firms' international performance (Witt & Jackson, 2016; Hall & Hall, 2016). In VOC, it considered the historical and domestic impact but ignored the global connection is getting closer and closer, especially for a small, advanced open economy. Therefore, by integrating a specific Irish institutional environment, a highly export-oriented economy characterized by a large presence of foreign MNEs, and government subsidies, this paper contributes to advance the explanation of the impact of formal institutions on firms' export strategies in a comprehensive picture.

Our analysis is based on a new novel panel dataset, which merges trade data from the Irish Central Statistics Office (CSO). Trade Research Microdata File provides information on firms' export and a corresponding breakdown of export into an export commodity, export partner countries, and export value, which form the key outcome variables for the analysis. The final dataset is an unbalanced panel with 10,045 observations, covering the time from 2006 to 2018, which can capture the dynamic policy impact in the long term. The analysis investigates the impact of government subsidies on firms' R&D and export performance in 1) export decision; 2) export product diversification; 3) export market diversification; and 4) export value. While the export decision is the initial international stage, export production and market diversification show the process and pattern of how SMEs operate in foreign markets (Bai et al., 2022). In addition, compared with export value as financial performance, export diversification may indicate SMEs' comparative advantages and export capabilities as organizational outcomes. However, examining the potential lagged impact of government funding on firms' R&D investment and export performance is vitally important. Therefore, the analysis examines the impact of government subsidies on SMEs' R&D and export in the 1–3-year periods after the start date of receiving subsidies.

Our economic analysis applies propensity score matching (PSM), ensuring that subsidized SMEs are matched with an appropriate control group. Several methods have been developed to correct the issue of selection into treatment. Following Beck et al. (2016), Freel et al. (2019), and Mulligan et al. (2022), we use two-stage estimation procedures. First, we use PSM to estimate the contribution of subsidies to firms' R&D performance. In the second stage, we use the results from stage one to estimate the impact of policy-induced R&D on firms' export performance by a random effects panel model, which controls for significant firm-level heterogeneity (Freel et al., 2019). Our findings demonstrate that government subsidies significantly lead SMEs to invest additionally in R&D. This policy-induced R&D higher SMEs' export propensity and intensity. In addition, subsidized SMEs significantly diversify their exporting products and markets.

The rest of the research is organized as follows. Section 2 introduces the context of the Irish institutional framework and public policy regarding subsidies. Section 3 discusses the existing literature regarding the relationship between institutional support, innovation, and export performance and the logic behind the hypotheses presented. Section 4 describes the method, including data, study design, and measures. Section 5 contains empirical results. Section 6 provides managerial and theoretical implications based on the discussion.

2. IRISH INSTITUTIONAL CONTEXT: SMALL, OPEN, AND ADVANCED

Before we start the literature review, we would like to identify unique institutional factors in the Irish context and explain why it is well-suit for the research question in this research. Ireland is an open, small, and advanced economy, has performed extraordinarily well for decades, and was among the first in the European Union to recover from the 2008 financial crisis (OECD, 2022; CSO, 2023). First, it is open. Ireland is not only a highly export-oriented economy but also characterized by a large presence of foreign MNEs. It is widely acknowledged that foreign MNEs have had a transformative effect on the Irish economy (DBEI, 2014; OECD, 2018). Especially in R&D, foreign-owned firms accounted for two-thirds of Ireland's total business expenditure on R&D (CSO, 2023). Its' openness, to the most degree, is caused by the Irish government's continued pursuit of an FDI-led growth model (Bohle & Regan, 2021). The role of the state and its institutions has been primarily to shape a favorable business environment by offering attractive elements (particularly a low corporate tax rate) to would-be (mostly US)

foreign investors (O'callaghan & Lenihan, 2016). All other policy domains (financial, labor, education, governance, and welfare state) have become subordinate to the primary goal of attracting multinational enterprises (MNEs) (Bernadette et al., 2016). However, this FDI-led growth model has also been questioned over several decades for leaving the economy vulnerable to external shocks, coupled with what some commentators regard as a neglect of domestic Irish firms (OECD, 2018; Bailey & Lenihan, 2015).

Second, it is a small, advanced economy. According to GDP level and population, Ireland is a small economy in which small and medium-sized enterprises (SMEs) account for more than 99% of the total enterprises (CSO, 2020), and family businesses account for more than 75% of all firms (CSO, 2022). Compared with MNEs, SMEs with limited resources. Even faced with the liability of smallness and newness, Irish SMEs are active in the international market and take the main ratios of exporters in the Irish economy. This is because the size of the home market in Ireland makes it necessary for SMEs to look for international market opportunities in the early stages of new business development (OCED, 2019). In addition, Enterprise Ireland, as the main government agency, provides support (funding, advice, and expertise) to SMEs and can potentially help to stimulate export activity. According to IMF criteria, Ireland is an advanced country, such as per capita income and export diversification. Ireland's continuous economic growth is boosted by exports which remain the main driver of Ireland's economic performance (CSO, 2022).

Ireland, as a small economy with limited natural resources, has a strong national competitiveness which its institutional foundation endorses. According to VOC, Ireland is an LME where market-based institutions structure economic activities, encouraging radical innovation and market competition. In summary, institutions within nations or regions form complementary sets or holistic configurations. These institutions then condition economic performance across a range of indices, posing whether they should be the object of national economic policy (Andreosso O'Callaghan & Lenihan, 2016). Therefore, although we aim to analyze and evaluate the impact of formal institutions (government subsidy) on SMEs' innovation and export, institutions are just the starting points. We need to integrate government

subsidies as a formal institution and the Irish institutional context with high export-oriented features to evaluate policy impact on Irish SMEs' export performance comprehensively.

3. THEORY BACKGROUND AND HYPOTHESES

In this paper, two theories in particular- the variety of capitalism (VOC) and resource dependency theory (RDT), provide the rationale for understanding innovation and the interaction between institutions and firms' strategies in a broader institutional environment. From a historical perspective, the VOC provides a systematic method to understand how institutional coherence can generate comparative advantages in two types of technological innovations, radical and incremental, which help compare and explain the different industrial advantages across countries (Hall & Soskice, 2001; Boyer, 2005). Within this research stream, recent research shows that some important but neglected institutional factors, such as institutional capital in international activities and short-term government interventions, need to be integrated into the VOC to understand innovation and firms' international performance (Witt & Jackson, 2016). VOC considers the historical and domestic impact but ignores the global connection that is getting closer and closer. Therefore, this research aims to consider the impact of the international environment and activities and integrate short-term government intervention into the historical institutional coherences to analyze export performance at the firm level. Irish institutional context suits this study.

We are consistent with the current VOC research showing that the institutional environment can shape firms' behavior by acting as an incentive or constraint. Although constrained by their context, managers can act to reduce environmental uncertainty and dependence where they are embedded (Pfeffer & Salancik, 1978; Hillman et al., 2009). Therefore, it is important to understand this topic from an organizational perspective, such as the RDT approach, which mainly captures how firms react to external factors and a web of relationships in which they are embedded. On the one hand, firms inevitably depend on the uncertain external environment, which constrains firms' operations (Hillman et al., 2009). On the other hand, in response, firms are motivated to manage their inter- and intra-organizational resource exchanges and power dynamics to absorb, countervail, or avoid their dependence constraints (Jiang et al., 2023). The crux of this study is that, while SMEs cannot reduce uncertainty and interdependence on the larger social system (including the government), they undertake other means to gradually

reduce the uncertainty and interdependence from these environmental contingencies, such as increasing their comparative advantages and power (Hessels & Terjesen, 2010).

In international activities, the essence is to secure, exchange, and deploy firm-specific resources through intra- and inter-organizational arrangements with internal and external players (Ghoshal & Bartlett, 1990; Hitt, Li, & Xu, 2016). Therefore, based on the VOC and RDT, we can capture the interaction between institutions and organizations in cross-border activities in a border institutional environment. The theoretical framework is shown in Figure 1.

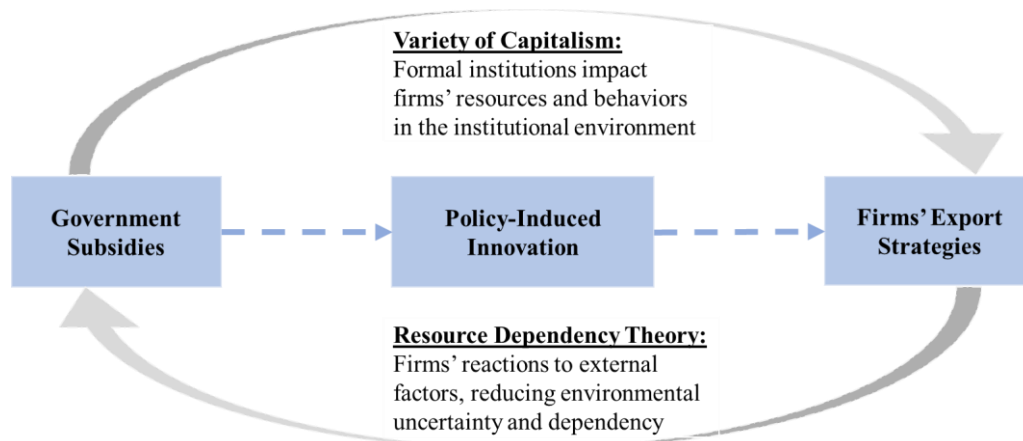


Figure 1 Theoretical Framework

3.1 The Role of Government Subsidies in Firms' R&D

Firm level innovation (i.e., patent, R&D), underpinning economic growth and productivity gains, makes a unique and crucial contribution to national, industrial, and firm competitiveness (Appelt et al., 2016; Coccia, 2018; Mulligan et al., 2022). SMEs, especially, are always considered the core source of radical innovations in the market and changing technology (Schneider and Veugelers, 2010; Czarnitzki and Delanote, 2015). However, innovation is risky, requiring significant investments and entailing uncertain outcomes (Hall, 2002; Hud and Hussinger, 2015). Therefore, the actual allocation of innovative resources may be inconsistent with the ideal allocation, resulting in underinvestment in technological innovation and affecting countries' long-term growth (Arrow, 1972; Chiappini et al., 2022). In this context, a government subsidy is an important external financial source to address market failure by

mitigating negative externalities and producing positive externalities (e.g., investment in research and development) and affecting firms' strategic decisions regarding input and output, entry, exit, or expansion (Liu et al., 2019; OECD, 2022).

Facing external shocks and environmental uncertainty, including COVID-19 recovery, climate change, fragile and disrupted global value chains, and digital transformation, subsidies and government interventions have rapidly increased in recent years (OECD, 2022). In the literature, emerging research, by applying propensity score matching (PSM) and difference in difference (DID), focuses on evaluating the added value of subsidy and funding programs on firms' innovation outcomes (Jugend et al., 2020; Lenihan et al., 2021; Lenihan et al., 2021; Mulier & Samarin, 2021; Mulligan et al., 2022). Most studies on specific innovation support find that firms receiving innovation support from the government invest more in R&D than if they would not support, which is policy-induced R&D (Beck et al., 2016). Different from specific innovation supports, general government subsidies have no requirement on firms' R&D. Therefore, government subsidies for promoting enterprise innovation behavior show an incentive effect and crowd out impact (Atzeni and Carboni, 2006, Wallsten, 2000; Luo et al., 2016, Jia and Ma, 2017; Liu et al., 2019). In other words, the original high-cost innovation financing could be replaced by government subsidies (Almus & Czarnitzki, 2003; Feldman & Kelley, 2006). As a result, firms may rely on external resources from subsidies rather than increase their competitiveness in the long term (Feldman & Kelley, 2006). Therefore, the government needs to decide through which approach to access SMEs and incentivize their innovation. Whatever the goal, the theory of economic policy embodies a preference for efficiency in policy intervention: doing so at the lowest cost in terms of the objective function.

There has been, so far, no cohesive conclusion on the nexus between government subsidies and innovation (Martin, Overman, Van Reenen, 2019, Domadenik, Koman, Prašnikar, 2018, Girma, Görg, Strobl, 2007, Harris, Li, 2019). On the one hand, SMEs with limited resources face difficulties in the financing market for innovative activities. By filling the capital gap, government subsidies ease SMEs' financial constraints and impact SMEs' innovation activities (Martin, Overman, Van Reenen, 2019). On the opposite side, government subsidies are a type of non-operating income that enterprises can obtain without making any effort (Liu et al., 2019) and cause a crowd out (Harris, Li, 2019). However, the impact outcomes vary among countries.

According to VOC, in an LME, where markets mediate relations between firms, the state will be more effective if it restores and sharpens market mechanisms. In the Irish context, market institutions encourage competition and provide firms with radical innovation resources. Although subsidies not specific on innovation can also trigger SMEs' additional investment in R&D. First, directly filling in the capital gap and easing financial constraints, government subsidies help SMEs overcome discrimination in the financial market. Moreover, with the impact of foreign MNEs with stronger innovation capacity, indigenous Irish SMEs receive government subsidies and tend to invest more in R&D in an innovative and highly competitive market environment.

Second, according to resource dependency theory, SMEs, compared with MNEs, are less likely to reduce uncertainty and interdependence on the larger institutional environment. Instead, by increasing their comparative advantages and power, SMEs can gradually reduce their dependence on external factors. Therefore, through investing in innovation, SMEs endorse their comparative advantages and competition in the market, reducing their dependence on government and foreign MNEs. Most studies find that firms receiving public support invest more in R&D than if they would not support, which is policy-induced R&D (Beck et al., 2016). Therefore, taking both directions- the institutional environment provides SMEs with innovative resources and fierce competition, and SMEs' reaction to government support and market, into consideration, we have our first hypothesis:

Hypothesis 1: institutional support from the government, such as subsidies and funding, produces investment additionality in firms' research and development (R&D).

3.2 The mediation role of innovation in export decision

There is ample research on how innovation impacts firms' export performance (Damijan et al., 2010; Golovko & Valentini, 2011; Azar & Ciabuschi, 2017; Bodlaj et al., 2020). Innovation provides firms with comparative advantages in technology endorsement, which further impacts firms' export decisions and performance (Coccia, 2018), which is more likely to be apparent in smaller firms (Cassiman & Golovko, 2011). In general, innovation incentivizes export mainly by i) developing differentiated products and services (Azar & Ciabuschi, 2017b), ii) scaling production and reducing cost, and iii) improving quality and changing internal

structures (Mol & Birkinshaw, 2009) to improve firms' comparative advantages and empower export. While the literature recognizes the impact of institutional coherence on innovation resources and the importance of innovation as a main source of competitive advantages for firms' export and growth (Makhmadshoev et al., 2015; Bodlaj et al., 2020), it poorly understands the issue of institutional factors' considerable impact on SMEs' export performance via innovation activities.

Limited research on the impact of government subsidies on firms' export performance via innovation behavior, which is policy-induced R&D, has no clear agreement and even displays conflicts among countries (Freel et al., 2019; Lawless et al., 2019). On the one hand, research on Germany, a typical CME, which is also an export-oriented economy, shows that firms successfully innovating without public innovation funding are more likely to be exporters. Regardless of sources, policy-induced innovation did not significantly convert non-exporters into exporters (Beck et al., 2016). The reason is the low cost of entering export markets, even for small firms, especially in Europe. In other words, if SMEs identify export opportunities, they can export without government support. Therefore, the efficiency of innovation support is low, which does not strengthen SMEs' export probability. Conversely, research on the UK, a typical LME, shows that innovation policy significantly positively impacts SMEs' export likelihood (Harris and Cher Li, 2009; Ganotakis and Love, 2011). SMEs receiving government support for developing innovative products or processes are more likely to engage in export activities endorsed by their comparative advantages in technologically advanced products. Based on conflicts above, we can presume government support might have no significant impact on SMEs in CMEs but a significant impact on SMEs in LMEs. In other words, policy-related innovation may have a more obvious and direct impact on SMEs in LMEs than on SMEs in CMEs.

In LMEs emphasizing market competition, SMEs, as the vulnerable groups, need more external resources from the non-market side, such as government intervention (Hervás-Oliver et al., 2021). Policy-induced R&D is productive as it significantly impacts radical innovation and translates it into marketable products (Hottenrott & Lopes-Bento, 2014). Specifically, in the Irish context, we mainly consider three institutional features: first, Ireland is a market-oriented economy with an open business environment that brings national competitiveness in innovation

and export and facilitates SMEs' export activities. Second, as a member of the European Union, Ireland also has strong networks with foreign MNEs, especially from the UK and US, which lowers institutional barriers in SMEs' export activities. Whether funded by the government may not significantly transfer SMEs from non-exporters to exporters, but policy-induced R&D equips SMEs with stronger innovation capability and will increase the likelihood of SMEs' export. In other words, as the barrier is low, firms will start exporting once they can gain comparative advantages through innovation investment.

From the RDT perspective, SMEs shall improve their capabilities to reduce the dependence on the domestic environment dominated by foreign MNEs. Export strategies can allow SMEs to learn from other firms and gain capabilities by exporting (Wu et al., 2021). Although different modes of internationalization, such as export and foreign direct investment, exporting is often the first stage in the SME context. The relationship between innovation and export has been investigated in previous studies. For instance, Paul et al. (2017) imply that SMEs will gain competitive advantages over their competitors by introducing innovation in products or services, which will help their internationalization process. In general, we stand with the positive relationship between innovation and export. Endorsed by comparative advantages and export capabilities, innovative SMEs are more likely to export than non-innovative SMEs (Becker & Egger, 2013; Cassiman et al., 2010; Paul et al., 2017; Rodríguez & Rodríguez, 2005). In addition, several researchers (e.g., Geldres Weiss et al., 2016; Leonidou et al., 2007; Pla-Barber & Alegre, 2007; Azar & Ciabuschi, 2017a) emphasize the importance of adopting an innovation strategy for exporting firms. Therefore, we have the second hypothesis:

Hypothesis 2: Policy-induced R&D drives firms to engage in export.

3.3 Export performance in three aspects

Up to date, empirical studies on the innovation-internationalization link within the SME context are inconclusive (Freixanet et al., 2020). Moreover, compared with rich and multi-dimensions of innovation measures, export performance is simplified as export propensity, whether firms export to a foreign market or not, and export intensity, the ratio of export revenue to turnover (Saridakis et al., 2019). Comparatively, the organizational outcomes, such as firms' institutional capability, innovation capability, and efficiency in obtaining and transferring

knowledge related to the comparative advantages of export, are under-researched, especially in the context of SMEs (Love & Roper, 2015). Only a few research addressed the significant impact of innovation on SMEs' export capabilities and competencies. In order to advance the understanding of how innovation affects export performance, we follow Bodlaj et al. (2020) and Miocevic (2021) and break firms' export performance into three aspects: (i) market diversification (MD) as "a strategy through which a firm expands the sales of its goods or services across the borders of global regions and countries into different geographic locations or markets" (Hitt, Ireland, & Hoskisson, 2007), (ii) product diversification (PD) which entails a strategy in which a firm expands into different and unrelated product categories (Hitt et al., 1994), and (iii) export value, which is measured by export revenue per employee. Through the above three aspects, we measure and trace SMEs' export performance in finance and organizational outcomes.

To engage in any diversification, firms need to have excess assets to be allocated to new products or market operations and have a pool of shared resources and capabilities that would help the firm to achieve economies of scale, which is market diversification, and economies of scope, which is product diversification (Helfat & Eisenhardt, 2004). Next, we will analyze the impact of policy-induced innovation on SMEs' export strategies on markets and products separately.

3.3.1 Policy-induced R&D and market diversification (MD)

At the firm level, market diversification refers to the number of a firm's export markets (Cieřlik et al., 2012). It is a proxy for internationalization performance, which is always used to understand how firms' export impact and mediate their growth productivity (Dikova et al., 2016). Miocevic (2021) finds that exporting SMEs might need higher innovativeness to enter new markets and exploit increased opportunities brought by MD (Dikova et al., 2016; Miocevic, 2021). But how policy-induced innovation impacts SMEs' export strategy regarding allocate resources geographically has little research on it. At the country level, Önder and Yilmazkuday (2014) measure trade partner diversification and found that trade with diverse partners positively influences economic growth. Through entering and diversifying export markets, firms can i) explore new opportunities and access to resources in various foreign markets, ii) realize scale economies by increasing production volume for a product and reducing its average

unit cost (*Reference*), and iii) increase their resilience and deal with risks (*Reference*). According to RDT, to gain economies of scale and reduce dependence on the external environment, SMEs tend to enter more markets to gain economies of scale and reduce dependence on the external environment (*Reference*).

Current research distinguishes firms' innovation into radical and incremental innovation and evaluates the effect of public policy on it. For example, by conducting a treatment analysis, Hottenrott and Lopes-Bento (2014) use Belgian SMEs data to test the subsidy receipt's effect on the firms' internal R&D spending. Their results show that policy-induced R&D positively correlates with export products with novel innovation. Beck et al. (2016), combining propensity score match (PSM) with the difference in difference (DID), also analyze the impact of a policy-induced R&D. Their results show policy-induced R&D only has a significant impact on radical innovation but no impact on incremental innovation. Following the VOC, as an LME, Ireland has comparative institutional advantages in radical innovation, encouraging innovator and price strategies (Hall, 2001). With radical innovation, firms easily meet customers' needs in different markets by providing new products. Therefore, policy-induced innovation (R&D) positively impacts SMEs' export market diversification, and we have the third hypothesis:

Hypothesis 3: Policy-induced R&D has a positive relationship with firms' export market diversification degree.

3.3.2 Policy-induced R&D and export product diversification (PD)

Innovation can be the endogenous factor that impacts the whole product strategy instead of just innovative products, especially in the SME context (Azar & Ciabuschi, 2017b). Here, in our research, instead of distinguishing novel and incremental product innovations, we count the number of a firm's export products and examine whether policy-induced R&D diversifies or intensifies firms' export products. Expanding export products would give a firm a greater advantage in many markets. In this case, a firm can i) explore similarities among product groups, transferring the capabilities learned in one product category into another (Kumar, 2009), ii) use its existing marketing infrastructure to cater to the needs of different product groups in its portfolio (Hoskisson & Hitt, 1990), and iii) realize effects of economies of scope (Singh, Gaur & Schmid, 2010). In the context of export diversification, including product, industry,

and trade partner, product and industry diversification supports the resilience of economies, industries, and firms in a crisis (Camanho & Romeu, 2011). However, diversifying export products burden SMEs with higher costs, especially in creating a spillover effect (Zahavi & Lavie, 2013). In most European small open economies, export adjustment following the recent economic crisis has taken place mainly at the intensive margin through the reduction of export sales (due to smaller quantities exported and the price charged), while entry and exits of firms and products played a less important role (Lawless et al., 2019). Against this background, it can be speculated that exporting SMEs with higher innovation investment has higher product diversity capacity in their exporting markets. Public support provides firms with more resources against external risk. Therefore, we have the fourth hypothesis:

Hypothesis 4: Policy-induced R&D has a positive relationship with firms' export product diversification degree.

3.3.3 Policy-induced R&D and Firms' export value

There is ample research on R&D and firms' export performance. The key argument states that firm-level R&D makes a unique and crucial contribution to firm performance, underpins economic growth and productivity gains (Appelt et al., 2016; Coccia, 2018), and improves export. SMEs that pursue innovation are likely to be more productive and have profitable returns in broad markets. Through innovation activities, SMEs can gain and maintain a sustainable competitive advantage in overseas markets, utilizing the opportunities in international markets, economies of scale, and economies of scope (Guarascio et al., 2017, Fernández-Mesa and Alegre, 2015). Moreover, R&D, developing new products, processes, and organizational structures to adapt to the external environment, or improving already existing processes and products, plays a crucial role in the international success of companies (Guarascio et al., 2017; Hamel, 2006; Roper and Love, 2002; Wanget al., 2008; Alvarez, 2004). Considering the policy-induced R&D, it should have the same impact on firms' performance. Therefore, we have the fifth hypothesis:

Hypothesis 5: Policy-induced R&D has a positive relationship with firms' export value.

In summary, by integrating Irish, as an LME, its national institutional framework into government subsidy, a formal institution, this study dives into the relationship between

institutional factors and export performance, tracking the impact mechanism behind it. By detailing and breaking export performance into an export propensity, export intensity, product diversification, and market diversification, this research advances the understanding of how government subsidies impact SMEs' export strategy via innovation behavior. Our research framework is displayed in Figure 2 below:

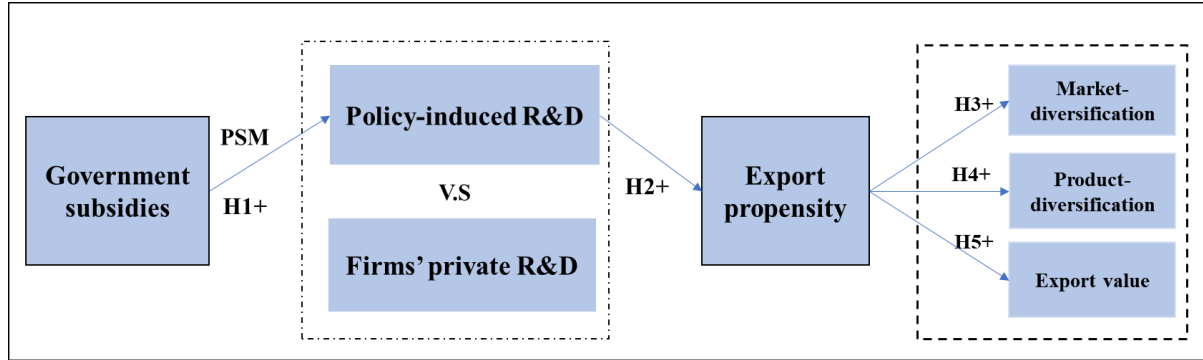


Figure 2 Research Hypotheses Framework

4. METHODOLOGY AND DATA

4.1 Selection into treatment: A two-stage approach

A key issue when examining the impact of government subsidies on firms' performance is selection bias. This issue arises because firms self-select into the treatment. For instance, in our study, the observed difference between funded and non-funded firms could reflect that the funded firms have lower or higher capabilities. Some funded firms lack resources and need funding. On the other hand, firms are funded since they have higher capabilities, which means they are more active in accessing and applying all external information and resources. Moreover, government agencies select better-performing firms for funding and subsidies, the so-called 'picking winners' strategy. Therefore, we employ a PSM model to correct this selection bias.

Several methods have been developed in the existing literature to address the issue of selection into treatment. To correct for selection into treatment, we apply two-stage estimation procedures similar to Beck et al. (2016), Freel et al. (2019), and Mulligan et al. (2022). In stage one, we use PSM to estimate the contribution of subsidies to firms' R&D performance. Stage two uses the results from stage one to estimate the impact of policy-induced R&D on firms' export performance (relative to privately financed R&D). In line with Freel et al. (2019), the

second stage applies a random effects panel model, which controls for significant firm-level heterogeneity, when examining the impact of policy-induced R&D on firm performance.

As is common in the literature, we refer to firms that receive government subsidies as ‘treated’ and all other firms as ‘untreated’. PSM facilitates creating a control group of untreated firms that are statistically identical to treated firms, thus enabling accurate analysis of treatment effects. In stage one, we match treated and untreated firms based on their propensity to receive the treatment. We calculate the propensity score using a probit model on the probability of receiving a treatment:

$$Treatment_{ki(t+1)} = \beta_0 + \beta_1 X_{it} + \varepsilon_{it} \quad (1)$$

The term $Treatment_{ki(t+1)}$ is a dummy variable indicating whether firm i received instrument k in time t , X_{it} is a set of independent variables for firm i in time t . The β s in Equation (1) indicates the model coefficients, and ε_{it} is the error term. By exact matching on specific firm characteristics and the propensity score, we improve the quality of matching. Given both values, it is possible to generate a further counterfactual of privately funded R&D expenditure for treated firms, as follows:

$$PrivateRD_{it}^C = PrivateRD_{it} - \alpha_{subsidies,it} \quad (2)$$

In the second part, we turn to the analysis of how the additional policy-induced R&D investment translate into firms’ export decision and performance by estimating Equation (3):

$$\begin{aligned} Firm\ Export\ Performance_{i(t+1)} \\ = \beta_0 + \beta_1 \alpha_{subsidies,it} + \beta_2 PrivateRD_{it}^C + \beta_3 z_{it} + \mu_i + \mu_t + \varepsilon_{it} \end{aligned} \quad (3)$$

In Equation (3), $Firm\ Export\ Performance_{i(t+1)}$ following Bodlaj et al. (2020) and Miocevic (2021), our outcome variables indicate product diversification, measured as the total number of products a firm export to foreign markets; market diversification, measured as the total number of the export market a firm export its products and services; and export value, measured as the total export revenue per year. The term z_{it} is a matrix of control variables for

firm i in time t , and β_3 are the associated coefficients, while μ_i are time invariant firm fixed effects, and μ_t are time fixed effects. While the year and firm fixed effects control for significant unobserved heterogeneity, the term z_{it} also captures a series of time-varying independent variables (defined in Table 1).

Table 1: Definition of variables used in the analysis

Variable	Definition
<i>Stage one dependent variable</i>	
R&D	Firm's total capitalized R&D, natural logarithm in t
<i>Stage two dependent variables</i>	
Exports Decision	Dummy variable, whether firm export or not in $t+1$ and $t+2$
Exports Value	Firm's exports revenue per employee in $t+1$ and $t+2$
Product Diversification	The sum of export products in $t+1$ and $t+2$
Market Diversification	The sum of export markets in $t+1$ and $t+2$
<i>Treatment variables</i>	
Subsidies	The binary variable equals 1 if a firm received subsidies from the State and Europe; 0 otherwise in t
<i>Control variables</i>	
Firm_age	Number of years in t since the firm started the business, natural logarithm
Firm_size	Number of employees in t , natural logarithm
Unit_labour_productivity	Unit labor productivity (sales per employee) in t , natural logarithm
C_Patent	Capitalized patent value in t : 1 = Firms in the lowest capitalized patent value quartile in a given year; 2 = Firms in the second lowest capitalized patent value quartile in a given year; 3 = Firms in the second highest capitalized patent value quartile in a given year; 4 = Firms in the highest capitalized patent value quartile in a given year
Sector	Categorical variables representing 40 NACE sectors (defined in Appendix Table C1 in Supplementary material)
Region	Categorical variables NUTS2 (defined in Appendix Table C1 in Supplementary material)
Year	Categorical variables t : 0 = 2006; 1 = 2007; 2 = 2008; 3 = 2009; 4 = 2010; 5 = 2011; 6 = 2012; 7 = 2013; 8 = 2014; 9 = 2015; 10 = 2016; 11 = 2017; 12 = 2018

4.2 Data

Our analysis is based on merging three datasets. Firstly, we use the Trade data from the Irish Central Statistics Office (CSO). Trade RMF provides information on firms' export and a corresponding breakdown of export into an export commodity, export partner countries, and export value. These measures form the key outcome variables for the analysis. Trade RMF also provides a series of other R&D-related firm characteristics, which are used as control variables in the analysis, covering 2006-2018. Secondly, the study draws on the CSO's Census of Industrial Production (CIP), which not only provides key information on firms' turnover, productivity, and exporting behavior but also provides information on firm size, sector, age, and location, which are also used as control variables in the analysis.

The Trade survey is merged with CIP data, which captures whether firms got government subsidies (i.e., operating subsidies, export refunds) from 2006 to 2018. This information is used to create the treatment variable used in the analysis, which is the dummy variable, whether the firm received funding from the government or not and continuing the funding. Therefore, the treatment variable is defined as whether a firm had government subsidies each year. However, examining the potential lagged impact of government funding on firms' R&D investment, innovation, and export performance is vitally important. Our data covers the time from 2006 to 2018, which can capture the dynamic policy impact in the long term.

4.3 Description of variables

4.3.1 Outcome variables

Our analysis is separated into two main parts. For the treatment effects analysis, our outcome variable reflects the firms' R&D investment, measured as the R&D expenditures. In the second part, following Bodlaj et al. (2020) and Miocevic (2021), our outcome variables indicate product diversification (PD), measured as the total number of products a firm export to foreign markets; market diversification (MD), measured as the total number of the foreign market a firm export its products and services; export decision (ED), measured as whether firm export or not per year; and export value (EV) measured as the ratio of export revenue per employee per year.

4.3.2 Control variables

For the treatment variables in stage one, we employ binary variables, which take a value of one if a firm received a subsidy from the State or EU in year t (or a value of 0 otherwise), which range from 2006 to 2018. We control for firms' current export status for the stage-two model on firm export performance (see Table 1). Beck et al. (2016) deems these variables to be key indicators of price and quality advantages when examining the impact of public R&D support on firm export performance. Appendix Table 1 in the Supplementary material accompanying this paper provides summary statistics for all variables used in our sample (Witt & Jackson, 2016b).

5. EMPIRICAL RESULT

5.1 Impact of subsidies on R&D

To perform our stage one PSM analysis, we match treated and untreated firms based on their propensity to receive the treatment. Table 2 reports the marginal effects from the probit models used to estimate firms' propensity scores. These results are a necessary first step in our analysis but are not central to our hypotheses. We first examine Hypothesis 1, in which government subsidies incentivize firms to input additional investment in R&D. The findings presented in Table 2 demonstrate that government subsidies positively and significantly impact firms' additional investment in R&D.

Table 2: Propensity score matching results for the impact of subsidies on firm-level R&D

Domestic SMEs that export			
Treatment	Treated	Matched untreated	Difference (α)
R&D expenditure	496.5309	10.2119	486.3189***
Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. For ease of interpretation, the results in Table 3 are expressed in thousands of Euros. Estimation results based on 1:1 nearest neighbour matching. The α term relates to the average policy-induced R&D government subsidies.			

5.2 Impact of public-induced R&D on export performance

Drawing on this matching procedure, we further examined Hypothesis 2 to 5, in which policy-induced R&D impacts firms' export propensity and strategies regarding product and market diversifications. Table 3 presents the link between policy-induced R&D and firm export performance.

Table 3: The link between policy-induced R&D and firm export performance

Variable	Exporter (1/0)	Market	Product	Export value
Private R&D	0.00039*** (0.000141)	0.00388*** (0.00138)	0.00554** (0.00263)	0.156* (0.0925)
Policy-induced R&D	0.00106*** (0.000531)	0.00124*** (0.00030)	0.00322** (0.00125)	0.0497*** (0.015)
Firm size	0.391*** (0.0172)	5.037*** (0.966)	11.00*** (1.912)	34.31 (56.32)
Firm age	0.0963*** (0.184)	-0.0452 (0.395)	2.230** (1.017)	15.91 (18.66)
Unit labor productivity	0.175*** (0.192)	2.393*** (0.485)	4.695*** (0.941)	236.8*** (55.19)
Patent	0.243*** (0.0923)	1.051 (0.669)	2.850* (0.211)	56.88*** (16.41)
Constant	-4.260*** (0.322)	-27.83*** (10.41)	-62.75*** (19.63)	-829.5*** (484.6)
Firm effects	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Observations	10,045	1,715	1,715	1,715

Notes: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors are in parentheses. The policy-induced R&D variables correspond to the α term defined in Equation (2). The number of observations changes in each model due to missing values in the dependent variables. For ease of interpretation, the variables *Private R&D* and *Policy-induced R&D* have been scaled by 1 thousand.

H2: supported, both policy-induced R&D and private R&D positively impact firms' **export decisions**. Compared with private R&D, the results show that policy-induced R&D has a stronger incentive for firms' decision to export, in a larger, though less robust average effect. We also checked the time $t+2$, and the results show the same. However, the private has a similar impact, but the impact of policy-induced R&D is greatly reduced.

H3: supported Both policy-induced R&D and private R&D positively impact firms' **export market diversification**. The results show that, compared with private R&D, policy-induced R&D has less impact on firms diversifying products. We also checked the time $t+2$, and the results show that private R&D has a similar impact, but the impact of policy-induced R&D is not significant anymore.

H4: supported. Both policy-induced R&D and private R&D positively impact firms' **product diversification**. The results show that, compared with private R&D, policy-induced R&D has less impact on firms diversifying products. We also checked the time $t+2$, and the results show that private R&D has a similar impact, but the impact of policy-induced R&D is not significant anymore.

H5: supported. Both policy-induced R&D and private R&D positively impact firms' **export value**. The results show that, compared with private R&D, policy-induced R&D has less impact on firms' export value.

6. DISCUSSION AND CONCLUSION

Based on a novel and rich dataset on government subsidies and SMEs' export strategy covering the time from 2006 to 2018, this paper tracks and captures the long-term and dynamic impact of government funding. First, by distinguishing private and policy-induced R&D, our empirical results evaluate the effectiveness and efficiency of government funding and contribute to understanding how institutional factors impact innovation and export performance. Our research context- Ireland- is a typical small, open, advanced economy that often attracts foreign direct investment, therefore is less research on outward cross-border activities of indigenous firms. By integrating a specific Irish institutional environment, an LME, and government subsidies, and aim is to advance the explanation of the impact of formal institutions on firms' export strategies embedded in institutional structure.

Second, by extending SMEs' export performance from export revenue to product and market diversification, we reveal the relationship between institutional support and export strategies. By comparing the impact of private R&D and policy-induced R&D on SMEs' export market selection, whether it diversifies or intensifies SMES' export products, we reveal the relationship between institutional support and SMEs' resource allocations; Through compare

the impact of private R&D and policy-induced R&D on SMEs' export market selection, whether it diversifies or intensifies SMEs' export markets, we reveal how institutional support impact firms' institutional capability. Moreover, we contribute to understanding public support's impact on different innovations by expanding comparisons between product and process innovation to comparisons on product and market diversifications. Our research provides a possible proxy to measure the impact of public policy and firms' innovation and export performance. Last but not least, based on untangling how firms' innovation and export strategy react to government funding, we provide important implications for governments on which and how institutions can ultimately best equip their home-grown business to succeed in the marketplaces and international markets.

Although our study significantly contributes to the literature on public funding for firms' R&D and export strategies, especially in the SME context, it has limitations. But we note that these limitations provide some fruitful directions for future research. First, as the data limitation, we focus only on the manufactory sector. Future research is necessary to examine and compare service sectors with manufacturing sectors. Second, we consider government subsidies without categorizing them by goal or level. With the data and sample limitation, we cannot distinguish the subsidies in terms of different levels (i.e., EU, State, regional, local) or different aspects (such as tax credit, tax grant, or innovation-specific subsidies). Therefore, we encourage future research that specifies innovation policies and programs or details subsidies into multi-levels and examines their impact on firms' export performance regarding diversification in products and markets. Third, our research sample is a single country. Future studies can also apply this research to different institutional contexts.

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