Public Funding, Innovation and Market Expansion for SMEs:

A fifteen-year longitudinal study in Germany

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Introduction

This article intends to understand the effect of public funding to R&D and innovation on the market expansion of SMEs. It is widely believed that the economic justification of public support for private sector innovation activities is driven from the 'market failure' arguments (Arrow, 1962), a central argument of the Bolton Report and has been reiterated many times since (Bannock, 2005; Bannock and Peacock, 1989; Bennettt, 2006 and 2008; Storey, 1994; Martin and Scott, 2000; Audretsch et al., 2002). The issue of market failure especially concerns with SMEs. Given that SMEs are small they lack control of the markets in which they operate and are hence less able to prevent their research findings and innovations to spill over to other firms. R&D and innovation often requires a minimum investment in lab infrastructure and human capital which imposes high fixed costs and a substantial financial burden that may go beyond the internal financing capacities of an SME. In addition, innovation imposes a higher risk on SMEs as a failed innovation project may jeopardize the entire firm. As a result, SMEs often underinvest in R&D and innovation. Notably, prior studies also suggest that the enhanced performance by SMEs, as with any part of the economy, can yield positive externalities in the form of social benefits (see e.g. Potter and Protor, 2007; Doh and Kim, 2014). These arguments suggest a role for government as a regulator (to impose an obligation on all firms in specific fields) or as a supplier (e.g. to provide government-financed support).

However, innovation and product development require certain amount of time, so does the product launch in the form of market expansion. Given the length of time involved, the effect of initial public assistance is likely to be blurred. Focusing on SMEs, this study addresses this issue by examining the effect of public funding to R&D and innovation projects on market expansion through *exporting* in Germany. Market expansion of SMEs is certainly a key factor to growth and job creation in small firms. This is particularly true for Germany—as for any other European Union (EU) member state. While the EU has been developing a single market providing a huge domestic demand, most small firms within the EU are still not fully leveraging this opportunity. Besides language barriers and non-tariff barriers to trade, a lack of reputation outside the home market is a main obstacle for market expansion of SMEs within the EU. Innovation has proved to be a critical strategy for SMEs to overcome this 'liability of foreignness' (Schmidt and Sofka, 2009; Sui and Baum, 2014; D'Angelo et al., 2013; Zaheer, 1995) allowing them to successfully compete over domestic firms in foreign markets (see also Love and Roper, 2015; Harris and Li, 2011; Cassiman et al., 2011; Cassiman and Golovko, 2011).

We focus on *exporting* as a key market expansion strategy rather than foreign direct investment for two reasons: First, exporting is by far the most relevant internationalization of SMEs within the EU as it is associated with less transaction costs and less fixed costs compared to establishing subsidiaries abroad. Secondly, and more important, market expansion through exporting has a direct impact on firms' growth and job creation at domestic locations. Whereas foreign direct investment involves shifting resources and growth opportunities to locations abroad, expanding exports implies growth at the firm's home base. And this growth impact is exactly what public funding is aiming for.

Our study unveils the effect of public funding for R&D and innovation on exporting of German SMEs exploiting a representative firm panel data set covering both manufacturing

and service sectors for the past 15 years (2000 to 2014). The study reveals how three different regional levels of public funding—state, federal and EU— impact on the internationalization efforts of SMEs through exporting respectively. This article contributes to the literature and practice both on public support to innovation and on the determinants of export activities of SMEs. First, prior studies on the effectiveness of public funding of R&D and innovation mainly focused on output with respect to innovation outcome (e.g. sales with new products, patent applications) and productivity. We add the perspective of market expansion by investigating how public funding of innovation contributes to export performance. Furthermore, this perspective also augments to the extant literature on the determinants of export activities of SMEs. So far, the literature about policy impacts on SME exporting remains biased on direct export subsidies and export services provided by government institutions (Freixanet, 2012; BIS; 2011; Spence, 2003). Our study, considering R&D and innovation policy programmes and their (indirect) effect on export performance provides a more diverse picture on the role of governments for market expansion of SMEs.

Background Literature

Today, as markets are more open and dynamic, market expansion through internationalization is becoming increasingly important to the competitiveness of all size of firms. In particular, SMEs that with an internationalization strategy are deemed to be able to move quickly to take advantage of cross-border activities, providing opportunities for also knowledge exchange, capabilities enhancement, and hence for revenue growth (Love and Roper, 2015; Wilson, 2007). In this regard, it is well recognized and evidenced that SMEs performance is significantly associated with national economic development, employment growth, and hence improving social benefits (Potter and Proto, 2007; Bennett, 2008; Doh and

Kim, 2014). Many governments as well as public institutions therefore have embarked on schemes to support SMEs (see Irwin, 2007; Falk, 2007; Czarnitzki and Delanote, 2015).

Furthermore, prior studies indicate that market expansion through internationalization takes different forms, among which exporting is the most used by SMEs. As mentioned earlier, this is because that comparing with other forms (such as foreign direct investment or joint venture), exporting tends to be more cost effective, lower risk and easier to exist, that better suit SMEs' 'limited resources' nature (Ganotakis and Love, 2011). The literature also suggest that there exists a positive association between exporting and innovation in SMEs (Del Castillo and Barroeta, 2007; Feldstein, 2000). While there exist incentives to innovate and to expend market through exporting, barriers also exist. Within which, 'market failures' are among the most studied (Doh and Kim, 2014; Bennettt, 2008; Wilson, 2007). Public financial schemes therefore kick in to support or stimulate SMEs innovation and exporting.

A very large amount of literature explored the relationship between SMEs' innovation and exporting (e.g. Laforet and Tann, 2006; Wagner and Hansen, 2005; Love et al., 2009; Roper et al., 2008; Brambilla et al., 2012; Love and Roper, 2009). Prior studies have found that SMEs which have prior innovation experience are more likely to export and more likely to export successfully than non-innovating firms (see European Commission, 2010). It is also found that European SMEs that export grow more than twice as fast as those that do not (European Commission, 2010). To better understand the successful factor, the strengths of SMEs that lead to successful innovation and exporting have been widely discussed. For example, Vossen (1998) has highlighted that SMEs' entrepreneurial dynamism, flexibility, efficiency, proximity to the market and motivation contribute to the positive association between innovation and exporting. Along the same line, Love and Ropert (2015) also emphasize that rapid decision-making, willingness to take risks and flexibility in responding to new market opportunities are SMEs strengths in promoting innovation and exporting.

Another important theory relates to SMEs' innovation and exporting is the concept of 'self-selection'. According to economic theory, there are fixed costs involved in entering export market, and therefore, market entry is easier for more productive firms (Helpman et al., 2004). In this sense, it can be expected that exporters to be more productive than non-exporters (Helpman et al., 2004). Taken together, it is suggested that highly productive SMEs in innovation output are more likely to become exporters (i.e. self-selection) (Love and Roper, 2015).

While the strengths of SMEs are well discussed, the weaknesses of SMEs that may fail or underinvest innovation, so as to exporting, are also widely discussed (e.g. Potter and Protor, 2007; Sui and Baum, 2014; Czarnitzki and Delanote, 2015). Within which, 'market failure' has drawn much research interest (see Doh and Kim, 2014; Bennettt, 2008; Wilson, 2007). The central argument of market failure is rooted in the disadvantage of SMEs' small size and limited resources. For example, in studying SMEs in the UK, Bennettt (2008) has found that because SMEs are small they lack control of the markets in which they operate. The lack of control is perceived as inducing of high risk of failure. This issue relates to the issue of appropriability and the nature of knowledge as a public good. Innovation is a costly investment and the opportunism behaviour in foreign countries often is beyond a SME's control. These perceived risks largely impede SMEs investment on innovation. Furthermore, lack of information and skills and inadequate management capabilities also impede SMEs' development through innovation and exporting. High fixed costs from expensive infrastructure, R&D lab and human capital further compound the barrier to SME innovative activities (Falk 2007; Doh and Kim, 2014).

In viewing the above issues, many SME researchers have claimed that these barriers which are mainly derived the perceived market failure demand national and regional governments' attention (e.g. Hottenrott and Lopes-Bento, 2014; Bennettt, 2008; Doh and

Kim, 2014). For example, the European Commission's European Network for SME Research (ENSR) survey results (2004) have found that the high cost of the internationalisation process appears to be the most frequently cited barrier. In an OECD study, Irwin (2007) has also found that one of the most important barriers to SMEs is access to finance. Ayyagari et al. (2003) also empirically evidence that lack of access to finance was robustly associated with the restraining the growth of the SME sector. Any governments and public organizations (e.g. EU and UN) have already noticed the urgency of this issue, leading to many different schemes to support SMEs. Given the proximity to SMEs, public institutions from regional to national and local levels are very active in the design and delivery of direct financial support for SMEs innovation. However, as mentioned earlier, given the length of time involved in the innovation process and exporting, the effect of initial public assistance is likely to be blurred. Not only is it easily to be overlooked when time goes by, but also because the longitudinal panel data are rare. This paper addresses this issue. Our first hypothesis is based on the argument that market expansion of SMEs (i.e. exporting in this study) nurtures social benefits, demanding public support. Therefore, H1: Public funding to research and development (R&D) and innovation positively impacts on SMEs export performance. Furthermore, results of our literature review seem to suggest that public funding is often used to tackling the market failures in innovation; and innovation performance impacts on exporting of SMEs, therefore, H2: The effect of public funding on exporting is through SME innovation performance. Finally, since exporting concerns with internationalisation issues, therefore we assume H3: On SME exporting, the effect of international (e.g. EU) public funding is stronger than the effect of the national public funding?

Research Method

Data and Measures

Our study uses data from the German Innovation Survey which is part of the Community Innovation Surveys (CIS) coordinated by the Statistical Office of the European Commission. In contrast to most other national CIS, the German Innovation Survey is an annual survey based on a panel sample. It is conducted by the Centre for European Economic Research (ZEW) on behalf of the German Federal government. In this paper, we focus on a 15-year period, ranging from 2000 to 2014. The year 2000 is the first year after the exchange rates between Euro currencies had been fixed at 01.01.1999. By abolishing fluctuations in currency exchange rates for many of the most important trading partners of Germany, market expansion was significantly eased for SMEs. By starting our panel one year after this trade enhancing event, we want to avoid that our results are confused with effects stemming directly from this reduction in barriers to international trade.

For testing our hypotheses, we employ three key variables: export sales, product and process innovation, and public funding for innovation. Export sales are measured in Euro and include all sales to customers located outside Germany. Product innovation refers to new or significantly improved products (goods as well as services) that have been introduced in the market in the previous three year period (i.e. for the year 2000, a product innovator is a firm having introduced product innovations in 1998 to 2000). We distinguish the degree of novelty by separating between new-to-the-market innovations and product innovations that were only new to the firm (which one may call imitations as the firm has adopted an innovation already put to the market by another firm before). Process innovation refers to new or significantly improved process for producing or delivering goods or services that have been introduced in the firm in the previous three year period. We distinguish process innovation that resulted in a change of unit costs from other process innovation (e.g. increasing the quality of goods or

services). Both for product and process innovation success, we use dummy variables indicating whether a firm has introduced the respective type of innovation. To measure the extent of innovation success we follow the following procedure. For product innovations, we follow the standard approach employed in CIS-based empirical studies (see Laursen and Salter, 2006; Leiponen and Helfat, 2010; Mairesse and Mohnen, 2002) and use the share of sales generated by product innovations. For process innovations, we use the share of unit cost reduction achieved by cost saving process innovation (see Piening and Salge, 2015). For other types of process innovation, the increase in sales due to quality improvements resulting from process innovations is used as a proxy. Public funding of innovation refers to any financial support provided by governments to innovation activities in firms (including R&D). In Germany, SMEs can choose among several support programmes at the state, federal and EU level.

Model

In order to test our hypotheses, we run a series of inter-related regression models. The two central models are an innovation output model and an export model. The innovation output model relates the four types of product and process innovation described above to public funding while the export model relates export performance to innovation output:

$$INN_{z,it} = {}^{I}\alpha_{z} + \sum_{y} {}^{I}\beta_{y,z}\, PUB_{y,z,it} + {}^{\mathbf{I}}\boldsymbol{\chi}\ \mathbf{CTR(inn)}_{z,it} + {}^{I}\varepsilon_{z,it} \quad (1)$$

$$EXP_{it} = {}^{E}\alpha + \sum_{z} {}^{E}\beta_{z}\, INN_{z,it} + {}^{\mathbf{E}}\boldsymbol{\chi}\ \mathbf{CTR(exp)}_{it} + {}^{E}\varepsilon_{it} \quad (2)$$

EXP denoting a firm's degree of international market expansion, measured through its export share (sales to customers abroad as a share of total sales). *INN* represents the type *z* of

innovation output. *PUB* is an indicator for a firm having received public funding for R&D and innovation, differentiating three types *y* of public funding (state, federal, EU). CTR(inn) and CTR(exp) are sets of control variables. α, β and χ are coefficients to be estimated, and ε is a firm-specific error term. *i* is the firm index and *t* the time index. The control variables for the export model are inspired by related studies (Arnold and Hussinger, 2010; Beise-Zee and Rammer, 2006; Cassiman et al., 2010) include indicators on price and quality advantages (unit labour costs, labour productivity, stock of trade marks) as well as firm-specific resources and capabilities (size, age, capital intensity, proximity to an international border, part of a multinational group). The control variables employed in the innovation output model follow the seminal paper of Crépon et al. (1998) and include innovation expenditure as a measure of quantitative input and R&D activities as a proxy for the quality of knowledge inputs. All models also include industry and time dummies.

One should consider a potential selection bias as the group of firms receiving public funding is not a random sample of all firms but may be focussed on firms with a particularly high potential to transfer financial support into innovation success (Hussinger, 2008). We control for such a selection bias by using a selection correction model of the Heckman (1979) type. Adirect test at the firm level compares the effect of innovation output for firms having received public funding for innovation (INN_PUB1) with the effect of innovation output on export performance for firms without public funding (INN_PUB0):

$$EXP_{it} = {}^{E}\alpha + \Sigma_y \Sigma_z {}^{E1}\beta_{y,z}\, INN\_PUB1_{y,it} + \Sigma_z {}^{E0}\beta_z\, INN\_PUB0_{it} + {}^{E}\boldsymbol{\chi}\ \mathbf{CTR(exp)}_{it} + {}^{E}\varepsilon_{it} \quad (2a)$$

Based on model (2a), H1 and H2 would be supported if ${}^{E1}\beta_{y,z}$ is significantly larger than ${}^{E0}\beta_z$ for each type of innovation output *z* and each public funding body *y*. H3 is tested by

comparing the coefficients of ${}^{E1}\beta_{y,z}$ among the public funding bodies *y*. All models are estimated for SMEs only. Following the SME definition of the European Union, we use a 250 employee threshold to delineate SMEs from larger enterprises.

Empirical Results and Discussion

We first observe the effects of three types of public funding on different types of innovations. See Table 1. We find that both state funding and federal funding, but not EU funding, are positively associated with new-to-market product innovation, suggesting that local and national public funding contributes to SMEs new product innovation, particularly with regard to new-to-market innovations.

<Insert Table 1 here>

We also find that whether pubic funding impacts on export performance or not (H1) is not that straightforward. Data indicate that public funding to 'other product innovation' (i.e. less innovative or merely new to firm product innovation) significantly impacts on exporting in year *t*. However it is public funding to cost saving process innovation that significantly impacts on exporting in year *t+1*. One explanation is that due to 'new-ness' of new-to-market innovation, it may takes more time to be acceptable in the exporting countries. Therefore, the impact of public funding supported less innovative (but easier to be accepted by foreign customers) has a more immediate effect. In addition, our data suggest that when time goes by (in year *t+1*), it is 'cost saving process' innovation supported by public funding significantly contributes to exporting performance. This result coincides the public failure literature, highlighting that public supported innovation helps SMEs to expand their markets

where they have better control and less concerns with appropriability. When looking at the innovation performance (i.e. share of sales), we find that it is the public funding through the cost saving process innovation performance that significantly impacts on exporting in both year *t* and year *t+1*. However, we are not able to associate other types (new-to-market, other product and other process) of innovation performance with the link between public funding and exporting. This provides partial support to our second hypothesis and highlight that the effect of public funding on exporting is through (or mediated by) the performance of cost saving process innovation. This result further enhances the market failure argument that SMEs tend to expand markets to foreign countries with less chance of opportunism. It also explains that public supported cost saving process innovation, which involves less innovativeness, significantly contributes to SMEs market expansion through cost reduction process innovation. Table 2 illustrates these results.

<Insert Table 2 near here>

Finally, we cannot find any significant effect of international (e.g. EU) public funding on SMEs exporting both in year *t* and year *t+1* (Table 3). This result rejects our third hypothesis. More notably, we find that the *Federal* funded cost saving process innovation significantly impacts on exporting in both year *t* and year *t+1*, suggesting that Federal fund is important for SMEs market expansion, and the effect is particularly through cost saving process innovation performance. This result highlights the importance of national funding scheme in assisting SMEs' growth and development. Instead, state funding that goes along with new-to-market innovations has a positive impact on market expansion of SMEs.

<Insert Table 3 near here>

Conclusions

This study investigated the role of public funding of R&D and innovation in SMEs on market expansion of SMEs using panel data of German firms. We hypothesised that public funding exerts a positive effect on market expansion mediated by innovation performance. In order to closely investigate these relationships, we differentiated three sources of public funding: regional (state), national (federal) and international (European), expecting higher market expansion effects for international funding. Our analysis showed that public funding of R&D and innovation in SMEs seems to have a double edged effect on the firms' market expansion prospects. On the one hand, public funding helps SMEs to develop new products and processes, particularly with regard to new-to-market innovations. And such innovations are clearly helpful for SMEs when attempting to approach foreign markets as they provide a competitive advantage which can compensate for likely disadvantages of SMEs in foreign markets such as lack of reputation. On the other hand, we do not find a positive market expansion effect of new-to-market innovations for SMEs that have received public funding in the period these innovations have been introduced. This result highlights the barriers of lack of control and appropriability when considering going to a foreign market for SMEs. In addition, SMEs receiving public funding for R&D and innovation are less likely to introduce cost saving process innovations whereas unit cost reduction through such innovations has a positive effect on market expansion. The strong focus of public funding on product rather than process innovation is hence not necessarily a support for SMEs when it comes to entering international markets. When differentiating by source of public funding, we could not support our hypothesis. Funding by European agencies does not lead to higher innovation output nor do innovations in SMEs having received European funding yield to higher export

shares. In contrast, state funding that goes along with new-to-market innovations has a positive impact on market expansion of SMEs. One should note, however, that state funding rarely targets new-to-market innovations. Finally, this article provide advice to SME managers and public policy in funding schemes. In seeking SMEs growth, a core strategy lies in market expansion through innovation. Our study suggests, with evidence, that public funding to less newness innovation that assists the best to SMEs market expansion through exporting. It also shows that it is local and national funding, not EU funding, better contributes to this endeavour.

One main limitation of our research is that it mainly focuses on one country (Germany). Nowadays, public funding to assist SMEs development and growth has increasingly become one of the key public policies in many developed and developing countries. The differences in culture, innovation status and market dynamics demand each government to take a closer look to their own funding scheme. We wish, through this study, we shed some light to encourage public policy makers as well as researchers to further research the effect of public funding and SMEs' growth. Another important limitation is that we did not look into the process of how SMEs develop and introduce their innovations. Public support to innovation, at least in the context of Germany, is often linked to cooperation with universities or public research institutes. Such cooperation may restrict short-term international market expansion as such cooperation is typically with domestic research partners. Public funding that goes along with business cooperation may be more likely to result in short-term market expansion success of SMEs. We leave the analysis of this hypotheses to future research.

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Table 1: Estimation results of the impact of public funding on innovations

	New-to-market product innovation		Other product innovation		Cost saving process innovation		Other process innovation	
	Coeff.	z value	Coeff.	z value	Coeff.	z value	Coeff.	z value
Any type of public funding	0.042	1.90	-0.015	-0.95	-0.101*	-4.84	0.043*	2.74
Public funding: State Gvt.	-0.288*	-5.95	0.038	1.19	-0.009	-0.21	0.052	1.64
Public funding: Federal Gvt.	0.306*	4.91	-0.069	-1.66	0.013	0.24	0.050	1.23
Public funding: European	0.124	1.76	0.017	0.37	-0.154*	-2.43	-0.122*	-2.65
Age (log)	-0.061*	-2.90	0.019	1.24	-0.109*	-5.66	0.017	1.14
Size (log # employees)	0.072*	4.66	0.000	0.03	0.214*	14.73	0.034*	3.13
Innovation intensity (log)	0.117*	20.24	0.001	0.22	0.113*	21.73	0.020*	5.28
R&D (continuously)	0.719*	14.59	-0.047	-1.25	0.367*	7.86	-0.066	-1.76
R&D (occasionally)	0.276*	6.74	0.010	0.34	0.190*	4.99	-0.133*	-4.24
# observations	30,018		30,018		29,928		29,928	
# firms	11,543		11,543		11,482		11,482	

* $p > 0.95$

Table 2: Estimation results (panel OLS models) for any type of public funding source

		Export share in year t		Export share in year t+1		Export share in year t		Export share in year t+1	
		Coeff.	z value	Coeff.	z value	Coeff.	z value	Coeff.	z value
Public funding	New-to-market product innov.	0.004	0.98	-0.001	-0.23				
	Other product innovation	0.008*	2.41	0.003	0.82				
	Cost saving process innovation	0.004	1.10	0.009*	2.28				
	Other process innovation	0.001	0.39	0.003	0.89				
Public funding	Share of sales with new-to-market product innovations					0.009	1.03	0.001	0.11
	Share of sales with other product innovations					0.009	1.06	0.001	0.13
	Share of unit cost reduction owing to process innovation					0.001*	2.50	0.001*	2.11
	Increase in sales due to quality improvement by process innov.					0.000	-1.85	0.001	1.82
	Age (log)	0.006*	3.37	-0.001	-0.63	0.005*	2.73	-0.001	-0.27
	Size (log # employees)	0.031*	19.47	0.030*	16.29	0.033*	18.16	0.030*	14.54
	Wage level	0.045*	13.91	0.045*	12.45	0.047*	12.49	0.051*	12.16
	Material input share	0.051*	8.10	0.029*	4.17	0.055*	7.42	0.039*	4.72
	Multinational enterprise	0.008*	3.22	0.009*	3.24	0.009*	3.01	0.011*	3.23
	log(Trade mark stock)	0.007*	13.40	0.007*	12.66	0.007*	11.88	0.007*	11.36
	Capital intensity	0.002	0.20	0.002	0.26	0.004	0.43	0.002	0.23
	Unit labour costs	-0.029*	-7.72	-0.023*	-5.55	-0.036*	-7.91	-0.027*	-5.60
	# observations	29,005		23,371		21,094		16,249	
	# firms	9,844		7,734		8,882		6,632	

* p > 0.95

Table 3: Estimation results (panel OLS models) for different public funding sources

		Export share t		Export share t+1	
		Coeff.	z value	Coeff.	z value
State fund.	New-to-market product innov.	0.005	1.15	0.011*	2.33
	Other product innovation	0.009*	1.97	0.007	1.48
	Cost saving process innovation	-0.016*	-3.32	-0.013*	-2.45
	other process innovation	-0.008	-1.63	-0.011*	-2.19
Federal fund	New-to-market product innov.	-0.003	-0.78	-0.010*	-2.34
	Other product innovation	0.000	0.13	0.002	0.41
	Cost saving process innovation	0.011*	2.46	0.018*	3.78
	other process innovation	0.006	1.48	0.004	0.86
European f..	New-to-market product innov.	-0.004	-0.74	0.005	0.90
	Other product innovation	0.000	0.05	-0.003	-0.52
	Cost saving process innovation	0.013	1.94	0.006	0.79
	other process innovation	-0.008	-1.11	0.006	0.82
	Age (log)	0.006*	3.21	-0.001	-0.63
	Size (log # employees)	0.031*	19.47	0.030*	16.23
	Wage level	0.044*	13.84	0.045*	12.43
	Material input share	0.051*	8.08	0.029*	4.13
	Multinational enterprise	0.008*	3.20	0.009*	3.25
	log(Trade mark stock)	0.007*	13.42	0.007*	12.67
	Capital intensity	0.001	0.19	0.002	0.26
	Unit labour costs	-0.029*	-7.74	-0.023*	-5.55
	# observations	29,005		23,371	
	# firms	9,844		7,734	

* p > 0.95