

# Impact of funding sources on innovation: evidence from Brazilian software companies

Tan Yigitcanlar <sup>1</sup>, Jamile Sabatini-Marques<sup>2</sup>,  
Md. Kamruzzaman<sup>3</sup>, Francisco Camargo<sup>4</sup>,  
Eduardo Moreira da-Costa<sup>5</sup>, Giuseppe Ioppolo<sup>6</sup> and  
Fernanda Elisa Demore Palandi<sup>7</sup>

<sup>1</sup>School of Civil Engineering and Built Environment, Queensland University of Technology, 2 George Street, Brisbane, QLD 4001, Australia. tan.yigitcanlar@qut.edu.au

<sup>2</sup>Engineering and Knowledge Management, Federal University of Santa Catarina, Campus Universitário, Trindade, Florianópolis, SC, CEP 88040-900, Brazil. jamile.sabatini@abes.org.br

<sup>3</sup>School of Urban Planning and Design, Monash University, Melbourne, Australia. md.kamruzzaman@qut.edu.au

<sup>4</sup>Brazilian Association of Software Companies, Av. Ibirapuera, 2907 – 80. Andar, CJ 811, CEP 04029-200, São Paulo, SP, Brazil. francisco.camargo@abes.org.br

<sup>5</sup>Engineering and Knowledge Management, Federal University of Santa Catarina Campus Universitário, Trindade, Florianópolis, SC, CEP 88040-900, Brazil. eduardo@labchis.com

<sup>6</sup>Department of Economics, University of Messina, Piazza Pugliatti, 1 98122 Messina, Italy. giuseppe.ioppolo@unime.it

<sup>7</sup>Engineering and Knowledge Management, Federal University of Santa Catarina, Campus Universitário, Trindade, Florianópolis, SC, CEP 88040-900, Brazil. fernanda@labchis.com

**This paper aims to investigate the impacts of different sources of innovation funding on company performances in the context of an emerging economy. Brazilian software companies are selected as a case for this investigation. Data – related to the types of funding support received and eight types of company performances measured in binary scales – was collected through an online survey from 188 companies located across Brazil. A multivariate probit model was estimated to assess the impacts of different funding schemes on company performances – controlling for other confounding effects. The findings confirmed the critical importance of public innovation funding, and revealed that companies that: (1) Used public funds were more likely to become nationally competitive; (2) Used loans from commercial banks were less likely to become nationally and internationally competitive; (3) Reinvested revenues were more likely to gain market share, and help in increasing the number of employees; (4) Not aware of public funding schemes were less likely to invest on research, development, and innovation. The overall findings suggest the positive impacts of innovation funds on company performance. They can serve as a policy guide to develop targeted**

**performance strategy to determine which funding scheme would be effective to foster what outcomes.**

## 1. Introduction

In the age of global knowledge economy, innovation is seen as one of the fundamental instruments of growth for companies to enter into new markets, increase the existing market share, and develop a competitive edge (Gunday et al., 2011; Sarimin and Yigitcanlar, 2012; Jung et al., 2016). In other words, innovation is the commercialisation of invention, and the only way for companies to achieve economic sustainability (Massa and Testa, 2008; Doran and Ryan, 2012; Yun et al., 2017). Similarly, for cities, regions, and countries, it is a critical element for securing a long-term prosperity (Baum et al., 2009; Lonnqvist et al., 2014; Yigitcanlar et al., 2016, 2017a).

Companies are, however, often confronted with various problems constraining their innovation activities. One of the most frequently cited barriers of innovation is financial – e.g., a lack of funds for innovation, high financial risk associated with innovation activities, and expensive technology infrastructure (Kaufmann and Tödtling, 2002; Lee et al., 2008; Rosenbusch et al., 2011). Nonetheless, as innovation is a major stimulus to national economic growth, many countries have introduced a range of funding mechanisms as a part of their national innovation strategies in order to support innovation activities of locally based industries (Guan and Yam, 2015; Sabatini-Marques et al., 2015b). The aim of these funding schemes includes developing national capacities for innovation, improving productivity, enhancing conditions for competitive enterprises, strengthening interactions among actors in the innovation ecosystem, and creating a right environment for innovation (Guan and Yam, 2015; Howell, 2017; Arbolino et al., 2018).

Many scholars argue that innovation-driven economic development must be supported by governments through various incentives. These incentives range from tax holiday to indirect subsidies, and from production, export, employment, and direct subsidies in the form of financial assistance and low interest rate loans to free training opportunities (Scotchmer, 2004; Von Hippel and Von Krogh, 2006; Yigitcanlar, 2009; Szopik-Depczyńska et al., 2017). Nevertheless, only a few countries across the globe have managed to allocate adequate incentive programs to support companies' innovation activities (Guan and Yam, 2015).

The effectiveness of funding support on company performance has been studied since the early 1980s. However, there has been a resurgence in these types of studies in recent years – due to the increasing global competition for innovation. Despite a rapidly growing attention on innovation support (e.g., Radas et al., 2015; Liu and Rammer, 2016; Macdonald, 2016; Yigitcanlar et al., 2017b), existing literature fails to differentiate the impacts of different types of funding support on company performances. Likewise, the performance outcomes measured in existing studies are narrow in scope (e.g., employment growth).

These gaps in the literature raises the concern of which funding support schemes affect what type of performance outcomes. An understanding of these links is critical as it: (1) Contributes to define the role of various funding mechanisms; (2) Helps governments align their programs accordingly to increase desired outcomes; (3) Supports the formation of a healthy innovation ecosystem for entrepreneurs. This relatively understudied issue forms the central research question of the study – Do different sources of funding for innovation support have varied levels of influence on various performance outcomes?

This paper empirically examines the abovementioned question using data collected from the software companies of Brazil. As presented in an earlier study by Yigitcanlar et al. (2017b), Brazil is an interesting case to study because over the last few years it has made significant efforts in moving towards a knowledge economy as evidenced by the Federal government's introduction of a new national innovation policy focusing on incentive programs to support innovation activities. Data was collected from 188 software companies located across major regions in Brazil in late 2016. A multivariate probit regression model was estimated to investigate the impact of different types of innovation support on various performance outcomes of software companies. The findings of this study generate insights into Brazil's emerging national innovation ecosystem, and they highlight which innovation funding source can be used to foster what type of outcomes.

## 2. Literature review

Global competition became particularly tough after the British and American neo-liberalist policies of the

1980s, which forced companies to refocus their business strategies on innovation (Hodgetts and Kuratko, 2001; Gunday et al., 2011). Today, innovation is seen as a critical factor for the success and survival of companies (Carrillo et al., 2014; Yun et al., 2016). Presently, in the era of global knowledge economy, improving companies' innovation performance is fundamental for regional and national outcomes (Millar and Ju Choi, 2010; Yigitcanlar, 2016). Since the analysis of Schumpeter (1951), finance has been a vital part of innovation process and performance (Mazzucato, 2013). There exists – besides companies using their own funds – two mainstream funding sources to provide financial support to companies for innovation – i.e., public and private.

Public funds and incentives play an important role in increasing innovation capabilities of companies (Cohen et al., 2002). They are provided through government organisations in several ways. Stated by Yigitcanlar et al. (2017b, p. 2), 'the first method is the provision of financial subsidies, where the funds provided by the government do not return back to the financing agency. The second one is the provision of low-interest and long-term loans, where companies are given some lead-time to bring innovation to the market before repaying back the debt. The third method is tax reduction, which provides tax offsets for promoting innovation and ideas boom'. These methods are seen as critical and have been widely used in OECD countries to generate more research, development and innovation (RDI) outputs (Guellec and Potterie, 2003; Lerner and Wulf, 2007). The innovation strategies of OECD (2010) focus on: (1) Empowering people to innovate; (2) Unleashing innovation in companies; (3) Creating and applying knowledge; (4) Applying innovation to address global and social challenges; (5) Improving the governance and measurement of policies for innovation.

Private funding is provided through banks loans and venture capital funds. Loans from commercial banks are used as the most common tool to access finance by companies to support their innovation activities. It requires companies to provide collateral or guarantees in exchange for loans. Especially after the credit crunch of 2008, restrictions in credit have worsened the availability of finance for all companies in almost all parts of the world, and also have exacerbated problems for certain companies' access to finance – in particular younger or smaller companies (Lee et al., 2015). Interest rates matter a lot for investments. In some countries, higher interest rates of these loans made financing unaffordable for many companies, which might have an undesirable impact on innovation activities (Kleinknecht, 2016; Botta, 2017).

Venture capital funding is a specialised form of equity capital investment that in principle target new companies with disruptive innovations (Kenney, 2011; Bertoni and Tykvová, 2015). These funds are characterised as high-risk and high-return opportunities. Venture capital is particularly well suited to support the creation of innovative start-up companies (Gu et al., 2018). Frequently these new companies own innovative technologies, but lack financial resources and expertise in terms of market and entrepreneurial knowledge (Faria and Barbosa, 2014). Therefore, one of the key advantages of using venture capital funds is that they offer a complex bundle of value-adding activities – e.g., coaching, professionalisation, and promoting the company to potential customers (Luukkonen et al., 2013). These funds are being offered through both public and private organisations. Despite their effectiveness, unfortunately, venture capital funding system has not been fully established, and is not available in many parts of the world.

In recent years, a number of scholars looked into the effects of different innovation support lines on companies' performances – investigating both developed and emerging economy contexts. For example, Edler et al. (2016) in their book compiled an extensive review on innovation policy impact including literature on the impact of fiscal incentives for RDI in companies. The review highlighted that: (1) Tax incentive schemes tend to produce lower allocative distortions compared to direct RDI subsidies; (2) There is a lower selectivity in terms of companies and industries, since RDI tax incentives are available to enterprises, which are not targeted by direct means of RDI funding; (3) RDI tax incentives, if implemented on a long-term basis, are easier to predict in terms of enterprises' financial planning; (4) Specific components of the tax incentive scheme, for example, stimulation of cooperation or the preference for SMEs, are easy to implement, as tax incentives are highly accepted in the policy area.

In recent years, some studies investigate the availability, use and effectiveness of public funding mechanisms for stimulating innovation activities and outcomes. For instance, Radas et al. (2015) examined the effects of direct grants and tax incentives on recipient SMEs' performance in Croatia – an emerging/upper-middle income economy (according to World Bank, 2017). This study revealed that: (1) Subsidies used alone or with tax incentives strengthen the RDI orientation of SMEs; (2) Although the effects of policy measures are significant when comparison is made to companies that did not use any of the two instruments, not much difference is found when users of direct grants are compared to those who used both the grants and the tax incentives; (3) There are

limitations in the use of tax incentives by SMEs; (4) Subsidies are the primary instrument in SMEs.

In a developed/high income economy context, Liu and Rammer (2016) explored the effects of different public innovation funding programs on the innovation output and export performance of SMEs in Germany. This study revealed that: (1) Public financial support contributes to higher innovation outputs, which in turn translates into higher export success; (2) Innovation support for cutting-edge technology that results in higher sales with new-to-market products shows a significant positive effect on SMEs' export performance; (3) Funding programs run by regional authorities show similar effects though relatively smaller impacts on both innovation output and exporting; (4) Bottom-up funding at the national level – which allows companies to freely define the design of the funded innovation projects in terms of content and cooperation – increases sales with innovations that are only new to the company, but these innovations have limited impacts on export success.

Similarly, Hall and Maffioli (2008) evaluate the impact of RDI funds in four emerging economies from Latin America – namely Argentina, Brazil, Chile, Panama. The study reveals that effectiveness of the funds depend on the: (1) Financing mechanism used; (2) Presence of non-financial constraints; (3) Company–university interaction; (4) Characteristics of the target beneficiaries. According to this study, the potential impacts of RDI funds include: (1) R&D input additionality; (2) Behavioural additionality; (3) Increases in innovative output; (4) Improvements in performance. The study, however, does not elaborate whether these potentials have been realised in the studied emerging economies.

In a comparative study between developed/high income economy (Australia) and emerging/upper-middle income economy (Brazil), Yigitcanlar et al. (2017b) investigated the perceptions of software companies, and the views of key actors on the effectiveness of public incentive schemes for innovation. The study revealed that: (1) Direct incentives were perceived as critical for increasing innovation capabilities of companies; (2) Tax incentive and infrastructure development schemes were the most preferred incentive programs among the companies; (3) Effectiveness of existing incentive programs was marginal in fostering Australian and Brazilian software companies' innovation significantly; (4) Governments should further focus on the design, promotion, and delivery methods of the innovation support mechanisms. This study was particularly useful to understand the different challenges and opportunities of both developed and emerging economy contexts in supporting innovation – as there are socio-

political differences in these contexts. For example, Brazilian companies face various bureaucratic challenges in accessing innovation support, while this process is much more straightforward in Australia.

Despite a growing body of literature on the topic in both developed and emerging economies, little understanding exists on the effects of different types of funding support on company performances. More importantly, existing studies made little effort to unveil relationships among the various performance outcomes – e.g., Does a company that perform better locally also perform better internationally?

### 3. Data and methodology

#### 3.1. The Brazilian context

Brazil was selected to satisfy the replication logic of the deductive approach. The reasons for the selection of the case context include: (1) Being a rapidly emerging economy of the world; (2) Despite being traditionally a strong resourced-based economy, during the last decades, Brazil made noteworthy achievements in boosting its RDI capabilities (Trindade, 1980; Ponomariov and Toivanen, 2014); (3) Recently, a new national innovation system was introduced in Brazil containing innovation incentive support mechanisms (CMSS, 2016); (4) There are limited studies investigating the issue particularly in the context of Brazil (Santos et al., 2014); (5) The insights generated from the investigation of Brazil would be useful for other emerging economies. Yigitcanlar et al. (2017b) provided further background information on Brazil and its innovation and knowledge-based economic development ambitions and progress on the perceptions of software companies about public incentive schemes for innovation. Similarly, Melo and Siqueira (2014) provided insights into the Brazilian financial system that has recently started to value intangible knowledge as a critical asset for innovation activities of Brazilian companies.

At large, technology companies (including software companies) have been subjected to scholarly attention due to their innovation potentials (Tremblay, 2016). In an earlier study, Kannebley et al. (2005) identified the key sectors of Brazil's most innovative companies – technology, pharmaceutical, medical, steel products, and agribusinesses. Among these sectors, this research focuses on the technology sector and its software companies. This is due to the rapid growth of the sector in Brazil, various government policies and innovation funds targeting this growth, and numerous challenges still faced by companies (Cahen et al., 2016). The coverage of software

companies includes businesses that focus on provision of software technology services, outsourcing services, custom software development, software product development, consulting, distribution, value added reseller, integration, support, training, and installation.

This research follows a descriptive and quantitative approach, using a comprehensive analysis of primary data. Data regarding software company characteristics, innovation support use and source type, and their performances was obtained through an online survey. The survey contained 17 questions focusing on company characteristics, funding, and performance areas (Appendix A). Survey Monkey online tool was used to conduct the survey with the senior managers of targeted Brazilian software companies. The survey was conducted over a 2-month period in September–October 2016. Company managers' contact details were obtained from the Brazilian Association of Software Companies (ABES).<sup>1</sup> Survey link was also sent to member companies through emails by ABES. Out of 1,098 companies, 188 valid responses were received – a response rate of 17.12%.

### *3.2. Variables of the analysis*

The main exposure variables in this research were derived from the answers of a survey question that asked the companies to state 'what the main sources of funding for your company during the last four years were'. Six sources were specified in the question based on all the different types of funding available to the companies in the case study context: (1) New members funds – i.e., new to market funds; (2) Investment funds – i.e., public and private equity and seed funds; (3) Loans from public institutions – e.g., Brazilian Development Bank (BNDES) support programs (Prosoft, Innovative MPME, Finance, Card), Brazilian Funding Authority for Studies and Projects' (FINEP) Inovacred Expresso Program (Sabatini-Marques et al., 2015a); (4) Use of own resources – e.g., company profit being used; (5) Loans from commercial banks (these loans generally have high interest rates); (6) Revenue reinvestments – e.g., reinvestment to the company by partners.

Given that a company can receive either one type or multiple types of these funding at a time, respondents were given the option to indicate multiple sources of funding received over the last 4 years. In the original survey, the responses were recorded on a 4-point Likert scale: 1 – Not used at all; 2 – Rarely used; 3 – Used; 4 – Frequently used. A preliminary analysis, however, shows that many of the categories received very few responses (e.g., only 1% of the companies used investment funds frequently). As a result, the

responses were recoded into a binary exposure measure (1 – Used and 0 – Not used) in order to increase the degrees of freedom for the estimation of their impacts on performance outcome, while controlling for other confounding effects as discussed later.

Based on the literature (Gunday et al. 2011; Jung et al., 2016; Ferreira et al., 2017; Yigitcanlar et al., 2017b), this research identified a total of eight performance outcomes that a company might experience due to the exposure measures. These included the ability of the company to: (1) Invest more than competitors; (2) Become more competitive nationally; (3) Become more competitive internationally; (4) Access finance from the private market; (5) Generate interest from investment funds; (6) Gain market share; (7) Increase the number of employees; (8) Invest more in RDI. Respondents were requested to indicate which of the above performance outcomes they experienced over the last 4 years on a binary scale (1 – Yes, 0 – No).

In addition to collecting the exposures and outcomes data, this research also collected a range of contextual and company characteristics data, and used it as controlling factors while assessing the impacts of the exposure measures on outcomes. The controlling factors were status of financial support from public institutes, sources of received funding (e.g., BNDES, FINEP), company specialisation, company size, company age, professional networking (membership to ABES is used as an indicator of professional networking and information support opportunities as an added advantage), and geographical location of the company within Brazil. Previous research shows that these factors have an autonomous effect on company performance (Van Hemert et al., 2013; Conte and Vivarelli, 2014; Ferreira et al., 2017).

Table 1 outlines these characteristics of the companies. The classification of company size adopted by the BNDES is used and defined according to the annual turnover of the company to frame the conditions of its lines and financing programs. The company size data was originally collected into five categories: (1) Microenterprise (up to R\$2.4 million in revenue<sup>2</sup>); (2) Small enterprise (R\$2.4–16 million in revenue); (3) Medium enterprise (R\$16–90 million in revenue); (4) Medium to large enterprise (R\$90–300 million in revenue); (5) Large enterprise (over R\$300 million in revenue). These were recoded into microenterprise, small, and medium/large companies (the last three original categories were merged together due to fewer responses).

The geographical location of company data was collected using five categories: (1) Midwest and Northern Matrix (2% of the sample); (2) Northeast Matrix (2% of the sample); (3) São Paulo Matrix

Table 1. Descriptive statistics of the samples

Variables	Frequency	%
<i>Outcomes:</i> <sup>1</sup>		
Invest more than competitors	38	20.21
Become more competitive nationally	98	52.13
Become more competitive internationally	22	11.7
It was easier to access financing in the private market	21	11.17
Generated interest from investment funds	27	14.36
Gained market share	90	47.87
Increased number of employees	80	42.55
Investing more in research, development and innovation (RDI)	95	50.53
<i>Exposures:</i> <sup>1</sup>		
Used new members (new to market) fund	37	19.68
Used investment fund	15	7.98
Used loans from public institutions	64	34.04
Used own resources	166	88.30
Used loans from commercial banks	111	59.04
Revenue reinvestment	146	77.66
<i>Controlling factors:</i>		
Status of financial support from public institutions over the last 4 years		
I am not aware of the available programs	35	20.96
I did not try to receive financial support	60	35.93
I tried but could not access the resources	48	28.74
I used the support of BNDES/FINEP	29	17.37
I used financial support through regional development banks/agencies	22	13.17
Sources of received public funding <sup>1</sup>		
None	131	69.68
Direct support from FINEP	8	4.26
BNDES direct support in the Prosoft program	9	4.79
BNDES indirect support in the Innovative MPME program	11	5.85
BNDES indirect support in the BNDES Finance program	2	1.06
BNDES Card	41	21.81
Indirect support from FINEP on the Inovacred/Inovacred Express program	5	2.66
Company specialisation <sup>1</sup>		
Provision of IT services	100	53.19
Outsourcing services	33	17.55
Custom software development	68	36.17
Development of enterprise resource planning software	36	19.15
Software product development (other)	108	57.45
Consulting	77	40.96
Distribution/reseller – national software	17	9.04
Distribution/reseller – imported software	23	12.23
Value added reseller (VAR)	12	6.38
Integration	39	20.74
Support, training and installation	85	45.21
Others	20	10.64
Company size		
Microenterprises (up to R\$2.4M revenue/year)	110	58.51
Small enterprises (R\$2.4M–R\$16M revenue/year)	60	31.91

Table 1. (Continued)

Variables	Frequency	%
Medium/large enterprises (R\$16M+ revenue/year)	18	9.57
Company age		
0–4 years	39	20.74
5–9 years	43	22.87
10–14 years	28	14.89
15–19 years	23	12.23
20–24 years	26	13.83
25+ years	29	15.43
Geographical location		
São Paulo Region	49	26.20
South Region	110	58.82
North, Northeast, Midwest, Southeast Regions	28	14.97
Professional networking		
Yes, ABES member	66	36.26
No, not member	95	52.20
Other	21	11.54
N	188	100

<sup>1</sup>Companies had the option to select multiple options.

(26% of the sample); (4) Southeast (without São Paulo) Matrix (11% of the sample); (5) South Matrix (59% of the sample). Given the limited sample from the Midwest and Northern Matrix and Northeast Matrix, these two categories were merged together with Southeast (without São Paulo) Matrix in order to increase the degrees of freedom for analysis.

### 3.3. Analysis techniques

The objective of this research is to analyse eight company performance outcomes. Given that the outcomes are measured in a binary way (whether a company has experienced certain outcomes or not), binary logit or binary probit models are the candidate analytical methods. However, such a univariate model does not take into account the interrelationships between the outcome variables, if any (Golob and Regan, 2002; Kamruzzaman and Hine, 2013). As a result, the tetrachoric correlation analysis was conducted first to examine the level of associations between the outcome variables (Table 2). Tetrachoric correlation analysis takes into account the binary nature of the outcome variables (OECD, 2009). Table 2 shows that many of the outcome variables are significantly correlated with each other. For example, companies that experienced more investment in RDI also experienced growth in employment.

When outcome variables are correlated, research has highlighted that a more appropriate analytical strategy is to apply multivariate probit models that

can take into account the correlated nature of the binary dependent variables (Golob and Regan, 2002; Piya et al., 2013; Radas et al., 2015). In a multivariate probit model, the outcome variables are simultaneously regressed against the explanatory variables. As a result, multivariate probit models were estimated<sup>3</sup> as the main analytical method in this research in order to examine whether different funding sources have any/differential impacts on company performances. The models were estimated in Stata (version 15) using a custom programme (mvpobit) for multivariate probit regression analysis which is based on simulated maximum likelihood estimation (Cappellari and Jenkins, 2003). All models were estimated using 250 draws to ensure consistent estimates which also sufficiently met the minimum number of draws required – i.e., the number of draws should be more than the square root of sample sizes (data was collected from 188 companies in this research).

This research analyses the impacts of six exposure variables on the outcomes variables, also controlling for 39 potential confounders as listed in Table 1. If all these 45 independent variables are entered into the multivariable probit model, it would be susceptible to over-specification given the sample sizes (188) used in this research (Wilson et al., 2006). Model over-specification typically results in producing numerically unstable estimates and is characterised by unrealistically large estimated coefficients and/or estimated standard errors (Bursac et al., 2008). In addition, modelling exercises often seek to build a

Table 2. Tetrachoric correlations among the outcome variables

	Invest more than competitors	Become more competitive nationally	Become more competitive internationally	Easier to access financing in the private market	Generated interest from investment funds	Gained market share	Increased number of employees	Investing more in RDI
Invest more than competitors	1.00							
Become more competitive nationally	0.34***	1.00						
Become more competitive internationally	0.22	0.31*	1.00					
Easier to access financing in the private market	0.16	0.00	0.07	1.00				
Generated interest from investment funds	0.26*	0.11	0.37**	0.11	1.00			
Gained market share	0.27**	0.60***	-0.10	0.07	0.12	1.00		
Increased number of employees	0.41***	0.61***	-0.03	0.21	0.21	0.54***	1.00	
Investing more in RDI	0.13	0.55***	0.20	0.03	0.38***	0.18	0.48***	1.00

\*\*\* $P < 0.01$ , \*\* $P < 0.05$ , \* $P < 0.1$ .

parsimonious model by minimising the number of variables but without compromising the true outcome experience of the data. Hosmer et al. (2013, p. 90) stated that ‘the rationale for minimizing the number of variables in the model is that the resultant model is more likely to be numerically stable and is more easily adopted for use’.

Several methods exist in the literature to overcome the over-specification problem in a model (Wilson et al., 2006; Bursac et al., 2008). This research applied the purposeful selection method as laid out by Hosmer et al. (2013). Briefly, a bivariable binary probit model was estimated separately for each of the exposure and controlling factors on the outcomes to identify factors that have a significant association with the outcomes (Appendix B). Only factors that were found to be significant at the  $P < 0.1$  level were entered (forced entry) into the final multivariate probit model (Bursac et al., 2008).

The multicollinearity among the selected explanatory factors was tested using ordinary least squares (OLS) regression model. A similar technique has been applied in previous research (Piya et al., 2013). Eight OLS models were estimated, one for each of the outcome variables. The statistically significant factors associated with each outcome variable, as identified in the univariable probit model estimation, were entered into the OLS model. The variance inflation factor (VIF) test showed that none of the variables had a multicollinearity problem (all variables had a VIF of less than 10). This research also conducted sensitivity tests in order to assess the robustness of the estimated coefficients from the multivariate probit model by estimating univariate probit models for each of the eight outcome variables. The sensitivity test results are shown in Appendix C.

## 4. Results

### 4.1. Descriptive analysis

Table 1 reveals that the most common outcomes of the companies surveyed were to ‘become competitive nationally’ followed by ‘more investment in RDI’, ‘gaining market share’, and ‘growth in employment’. About 50% of the companies experienced these outcomes, and about 20% of the companies invested more than their counterparts.

As expected, 88% of the companies used their own resources as the main source of funding, and 78% reinvested their revenues, which is consistent with common wisdom. About 60% of the companies relied on loans from commercial banks as the main source of funding. A major government support (34%) came



in the form of loans from public institutions. Twenty percentage of the companies received funding support in the form of a new members fund and only 8% received investment funds. This is also consistent with the findings related to the sources of received public funding, as 70% of the companies received no public funding. There were only seven-reported venture capital funds use (3.7%), and no reported crowd-funding use by the surveyed companies.

About 57% of the companies classified themselves as other types of software product developers. A similar proportion of companies also provide IT services, followed by support services (45%), consulting (41%), and custom software developer (36%). Most of the companies (59%) distinguished themselves as a small business. Only 10% of the companies are large in size. Additionally, as expected, a majority of the companies (44%) are relatively younger in age (less than 9 years). About 60% of the software companies are located in the Midwest (São Paulo) and South of Brazil (States of Paraná, Santa Catarina, Rio Grande do Sul). The majority of these companies are based in São Paulo – around 26% of the surveyed companies are located in this city. Furthermore, many of the top ranked Brazilian universities are located in this region, with their staff being involved in RDI activities – practicing academic entrepreneurship (Meyer, 2003). Due to supremacy of São Paulo, it is treated as a separate region in the analysis – other regions are North, Northeast, Midwest, South (excluding São Paulo), and Southeast regions. About half of the surveyed companies were not a member of ABES.

## 4.2. Regression analysis

Table 3 outlines the results obtained from the multivariate probit regression models. The overall model was found to be statistically significant with Wald  $\chi^2$  of 183.41. Although univariable probit models identified that five of the independent variables have a statistically significant association with performance outcome 1 (invest more than the competitors) (Appendix B), Table 3, however, shows that none of these factors remained statistically significant in the final multivariate probit model. The sensitivity test results as presented in Appendix C also confirm this finding. In addition, the results from the sensitivity tests were found to be comparable for the other explanatory factors as discussed below.

### 4.2.1. Impacts of sources of funding

Outcome 2 in Table 3 presents that companies that received loans from commercial banks become less competitive nationally compared to those companies

that did not use loans from commercial banks. These companies were also found to have a reduced probability of becoming competitive internationally (Outcome 3). However, their probability of accessing loans from private market increased (Outcome 4).

Unlike loans from commercial banks, companies that used new members fund had a higher probability of generating interest from investment funds (Outcome 5). Outcome 5 shows that companies that used investment funds had a higher probability of generating interest from investment funds. Although these findings suggest that there is a strong link between the companies that used new members funds and that used investment funds, the  $\chi^2$  test, however, confirmed that no such correlation existed within the data. Outcome 5 shows that companies that received direct support from FINEP and indirect support from BNDES had a significantly higher probability of generating interest from investment funds. These findings suggest that both FINEP and BNDES supports have a strong impact on company performance. Companies that were able to reinvest their revenues increased their probability of: becoming more competitive nationally (Outcome 2), gaining market share (Outcome 6); and growing the number of employees within their organisation (Outcome 7). Companies that were not aware of the financial support schemes from public institutes reduced their probability of investment on RDI (Outcome 8).

### 4.2.2. Impacts of company specialisation

Companies that were oriented with other types of software product development increased their probability of becoming competitive internationally (Outcome 3). These companies were also found to have a higher probability of generating interest from investment fund (Outcome 5). Companies that specialised in development of enterprise resource planning software had an increased probability of accessing finance from the private sector (Outcome 4), increasing the number of employees (Outcome 7), and investing more in RDI (Outcome 8). However, the companies that relied on distribution/resell had a reduced probability of investing on RDI (Outcome 8). In contrast, companies that were oriented to custom software development had a higher probability of investing on RDI.

### 4.2.3. Impacts of company size

Small-sized enterprises (R\$2.4–16 million in revenue) were found to have an increased probability of becoming competitive nationally compared to micro-enterprises (Outcome 2). Small-sized enterprises were

Table 3. Multivariate probit regression model results (coefficients)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
<i>Sources of funding</i>								
Used new members fund: yes (ref: no)		-0.30			0.67*			
Used investment fund: yes (ref: no)			0.41		1.97***			
Used loans from public institute: yes (ref: no)		-0.38		-0.28				-0.05
Used own resources: yes (ref: no)		-0.54***	-0.74**	0.90**			-0.16	-0.19
Used loans from commercial bank: yes (ref: no)		0.40*			-0.48		0.54**	0.41
Revenue reinvested: yes (ref: no)						0.59***		
<i>Status of financial support from public institutes</i>								
I am not aware: yes (ref: no)				-0.54	-0.75			-0.64**
I did not try: yes (ref: no)								-0.21
I used support of BNDES/FINEP: yes (ref: no)		0.65**	0.35	0.39	0.70			0.93**
I used support from banks/agencies: yes (ref: no)					0.47			0.59
<i>Sources of received fund</i>								
None: yes (ref: no)				-0.24	1.36**		-0.49	0.59
Direct support from FINEP: yes (ref: no)			1.07*		1.72**		-0.62	
BNDES direct support in the Prosoft program: yes (ref: no)	0.53		0.41					
BNDES indirect support in the Innovative MPME program: yes (ref: no)	0.43			0.82	1.80***	0.84*		0.36
BNDES Card: yes (ref: no)				-0.06			-0.18	
<i>Company specialisation</i>								
Provision of IT services: yes (ref: no)								
Outsourcing services: yes (ref: no)	-0.52		-0.90					
Custom software development: yes (ref: no)								0.49**
Development of enterprise resource planning software: yes (ref: no)				0.91***			0.67***	0.67***

Table 3. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
Software product development (other): yes (ref: no)		0.24	0.66*		1.00***			
Consulting: yes (ref: no)	-0.10				-0.01			
Distribution/reseller – imported software: yes (ref: no)								-1.26***
Company size (ref: microenterprise)								
Small	0.11	0.86***	0.44	0.37		0.47**		
Medium/large					1.18**			
Company age (ref: 0–4 years)								
5–9 years								0.39
10–14 years		0.53*		0.21		0.31		0.36
20–24 years				0.05	-0.12	-0.29		0.47
More than 25 years		0.58**		0.47		0.49*		0.72**
Professional networking (ref: non-member)								
ABES member								
Other		0.73**						
Company location (ref: São Paulo Region)								
North, Northeast, Midwest, Southeast regions								1.19***
South region (excluding São Paulo)			-0.66*	0.43	0.07			0.36
Constant	-0.84***	0.51	-1.02	-2.86**	-5.55***	-1.06**	-0.83	-1.91*
N								181
Wald chi <sup>2</sup>								185.41***
Log likelihood								-587.33

\* $P < 0.1$ , \*\* $P < 0.05$ , \*\*\* $P < 0.01$ , \*\*\*\* variation in sample sizes is due to exclusion of missing cases.

also found to have an increased probability of increasing the number of employees (Outcome 7). However, medium/large enterprises (R\$16–300 million in revenue) had a higher probability of generating interest from investment funds over microenterprises (up to R\$2.4 million in revenue).

#### 4.2.4. Impacts of company age

Middle-aged companies (aged 10–14 years) became more competitive nationally compared to companies aged between 0 and 4 years (Outcome 2). Matured companies had a higher probability of becoming competitive nationally (Outcome 2), growing the number of employees (Outcome 7), and investing on RDI (Outcome 8), when compared to new companies aged between 0 and 4 years.

#### 4.2.5. Impacts of professional networking

In general, the ABES membership status of companies – an indicator of added advantage for professional networking and information support – has no significant effect on the company performance in any of the models. Only significant association was found with other types of membership status and national competitiveness. Outcome 2 in Table 3 shows that companies that had other membership status (e.g., not affiliated at present but showing interest) had a higher probability to become competitive nationally. However, the causal mechanism of this relationship is difficult to discern – perhaps their willingness to become a member motivated them to perform better.

#### 4.2.6. Impacts of geographical location

Two statistically significant impacts of geographical location on company performance were identified in Outcomes 3 and 8. Table 3 shows that companies that were located in the North, Northeast, Midwest, and Southeast regions had an increased probability of investing on RDI compared to companies located in São Paulo Region.<sup>4</sup> In contrast, Table 3 shows that companies that were located in the South Region of Brazil had a reduced probability to become competitive internationally compared to those companies that were located in the São Paulo Region. Apart from these two differences, there are no significant differences observed in any of the performance measures among the companies located across the three regions compared. This finding is also supported by the literature indicating the regional disparities in the country – in favour of the São Paulo Region.

For instance, the poor performance of the South Region and a better performance of software companies located in the São Paulo Region can be justified

as São Paulo: (1) Being the financial centre of the country (Suzigan and Albuquerque, 2008); (2) Hosting most of venture capitalists of the country<sup>5</sup>; (3) Offering a vibrant business climate for entrepreneurs (Endeavor Brazil, 2017); (4) Being attractive to high-tech/software companies (Egusa and Carter, 2017); (5) Receiving 40% of the public funds (Endeavor Brazil, 2017); (6) Housing the highest ranked universities of the country (Chiarini et al., 2013); (7) Being home to a large knowledge worker talent-base (FAPESP, 2016). Furthermore, in general the primary focus of companies located in the South Region is the domestic market rather than international (Magalhães et al., 2015; Galina et al., 2016).

## 5. Discussion and conclusion

As the literature indicates, innovative entrepreneurs are an important driver of economic growth through the development of new business models, application of new technologies, and creation of new jobs (Schumpeter, 1951). Innovative entrepreneurial companies – particularly start-ups and young SMEs – tend to heavily rely on obtaining adequate access to capital from public and private sources, as access to finance is often necessary for the creation, survival, and growth of innovative new ventures (Massa and Testa, 2008). Countries that are aiming to transform their economies into a knowledge-based one, or in other words innovation economy, have started to develop national and regional innovation systems – with incentive and support mechanisms attached to increase innovation capabilities of their companies (Castellacci and Natera, 2013; Laitinen et al., 2016; Pancholi et al., 2017).

This trend is also evident in the Latin American emerging economies. In the region, while some countries still base their economy solely on the extraction of natural resources (Guatemala, Venezuela), most have progressed to achieve economies based on efficiency and large businesses (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Panama, Peru). Despite Brazil and Mexico being the most important patent producers of the region and introducing national innovation systems and incentivised companies, no Latin American country has yet reached the third stage of the competitive development – an economy based on innovation (Ketelhöhn and Ogliastrì, 2013). Additionally, in Brazil the dominant share of patents are at the hands of transnational companies (TNCs) – most of them are from the United States, Western Europe, and Japan. Besides this, the strategies of Brazilian owned companies are not directly translated into patents, and successful ones are generally acquired by TNCs –

reducing Brazilian owned company patenting activities (Hiratuka, 2008; Chiarini et al., 2017).

Traditionally, one of the main weaknesses of the Brazilian innovation system is that the country does not have a consistent long-term strategic agenda that gives coherence to the public policies implemented by different institutions and that guides scientific research and private agents in their efforts for innovation (Mazzucato and Penna, 2016). In recent years, however, Brazil has exhibited the signs of progress to move towards an innovation economy (Santos et al., 2014). As stated by Chiarini et al. (2013, p. 14), however ‘only four states can be classified as highly productive (“scientific quartet”, formed by São Paulo, Rio de Janeiro, Rio Grande do Sul, Minas Gerais) and they form the epicenter of Brazilian science’. This points to a regional disparity issue in Brazil, which is a common characteristic of most of the emerging (and even developed) economies.

This study investigated the impact of funding sources on innovation with a special interest in Brazilian software companies. The paper focused on addressing a critical research question of ‘whether different sources of funding of innovation support have different levels of influence on various performance outcomes’. The findings underlined the critical importance of public innovation funding, and revealed that companies that: (1) Used public funds were more likely to become nationally competitive; (2) Used loans from commercial banks were less likely to become nationally and internationally competitive; (3) Reinvested revenues were more likely to gain market share, and help in increasing the number of employees; (4) Not aware of public funding schemes were less likely to invest on RDI. The overall findings suggest the positive impacts of innovation funds on software company performance.

### *5.1. Research implications*

This study is important as it provides new empirical evidence on the impacts of different sources of innovation funding on software company performances in the context of an emerging economy – Brazil. The findings of the study are significant and contribute to the existing RDI literature in the following ways.

Firstly, this study complements and builds on the findings of previous studies that have particular interests on understanding: (1) Which financial factors influence RDI performance of high-tech companies (e.g., Minola and Giorgino, 2008; Altomonte et al., 2016); (2) How RDI investment financing takes place in the emerging market context (e.g., Zhang et al., 2007; Alam et al., 2017); (3) How effective financial

support in stimulating RDI is (e.g., Kaufmann and Tödtling, 2002; Yigitcanlar et al., 2017b).

Secondly, the findings reiterated the crucial importance of public funding – in the form of both public funds and incentives – for supporting software companies’ RDI activities. They underlined the role of public funds in increasing competitiveness of companies – national level competitiveness in the case of Brazil. This can be encouraging evidence particularly for public authorities that are hesitant to allocate larger amounts of financial resources due to the higher risk of return from innovation business. Currently, however, public regional development banks’ loans are not widely being used by software companies – even though the interest rates are significantly lower than commercial banks. This might be related to development banks’ red tape and requested guarantees to access the credit (Crocco et al., 2014). This is an area that government bodies need to further focus on.

Thirdly, private funding of commercial bank loans was deemed to be necessary for companies to finance their activities. Their impact, however, on national or international competitiveness of companies was found to be negative. The potential reasons of this could be the high interest rates charged by commercial banks and them granting loans only for companies that could provide guarantees. Commercial banks average lending interest rate was 47.4% per annum in 2016, while the annual inflation rate was 6.29% for the same year. As stated by Crocco et al. (2014, p. 892), ‘the market-driven logic of “financial efficiency”, which constantly forces banks to look for higher returns and lower risks to allocate funds might not be the best alternative to achieve higher levels of growth and economic cohesion’.

Fourthly, in terms of venture capital funds, Brazil, is an emerging market and the ‘B’ in ‘BRICS countries’,<sup>6</sup> has received attention from international investors. Although there are many opportunities for international investors in this emerging market, the presence of significant risks kept them highly cautious. International venture capitalists were particularly active during the booming years of the Brazilian economy (between 2004 and 2012), but they stayed quiet in the following years. Therefore, despite such an interest (until 2012), a vibrant and sustainable venture capital ecosystem has not been established in the country (Andrea et al., 2014). Consequently, there were only limited reported venture capital funds use (3.7%) by the surveyed companies – within the last 4 years.

Fifthly, the findings have shown that companies with reinvested revenues were more likely to gain market share and increase their number of employees

– indicating healthy growth of the company. The study also highlighted the disadvantages of the companies that are not aware of public available funding schemes in the tough competition for innovation – as they were less likely to invest on RDI compare to other companies. This is to say; to stay in the game of innovation, companies need to be aware of the opportunities available to them. In many cases, however, public institutions in Brazil are also to blame for not promoting innovation, and not communicating and advertising the support opportunities adequately – as well as having various red tapes and bureaucratic hurdles (Sabatini-Marques et al., 2015a).

Lastly, the overall findings suggest the positive impacts of innovation funds on company performance, where public funds were the biggest trigger for Brazilian software companies to become nationally competitive. This means, as stated by Yigitcanlar et al. (2017b, p. 10), ‘Brazilian governments should further focus on the design, promotion and delivery methods of the support mechanisms, and consider particularly matching the strategic directions of different enterprises and the market. It is essential for national innovation incentive schemes. . .to be carefully designed as strategic, simple, straightforward, consistent, impactful, transparent, less bureaucratic, long-term, inclusive, and apolitical programs’. The findings disclosed in this study were not only relevant and useful to Brazil, but also to other emerging economies. For those countries, provided insights can serve as a base for developing a policy guide to construct targeted performance strategy concerning which funding scheme would be effective to foster which desired outcome.

### 5.2. Limitations and directions

The study has the following limitations: (1) The study focuses on one sector only – software companies; (2) The company participation figure (N = 188) and response rate of conducted survey (17.12%) are much lower than expected. Higher company engagement and higher response rates might have an impact on picking up some more venture capital funds used; (3) The study might have an unconscious bias, particularly at the design of the survey questionnaire – such as asking funding related questions targeting the last 4 years only; (4) Some of the indicators might not be fully representative of the coverage. For example, the use of professional association membership might not be the most suitable indicator to measure professional networking efforts of companies; (5) It is possible that the companies that received one type of public funding are likely to receive another type of funding as well. Although this research investigated the impacts of individual funding sources on company

performance, the joint effect of various funding schemes on company performance was not analysed; (6) Both the exposure and outcomes measures are qualitative in nature. Application of a quantitative approach would provide a more robust empirical foundation. For example, it is possible to calculate the elasticity between funding amounts and growth in terms of number of employees; (7) The paper investigates an emerging economy, and thus the insights generated may mainly apply to this context. Our prospective research will focus on addressing these limitations for more precisely determining the effects of innovation support on company performances in both developed and emerging economy contexts.

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## Notes

1. ABES (Associação Brasileira das Empresas de Software) is the national professional body of the software sector, with around 1,900 members in 23 Brazilian states and the Federal district. Member companies generate over 120,000 jobs and an annual revenue of around US\$20 billion ([www.abessoftware.com.br](http://www.abessoftware.com.br)).
2. According to Thomson Reuters foreign exchange trading figures, US\$1 was on average equivalent to R\$3.2 in 2017.
3. Interpretation of the coefficients in probit regression is not as straightforward as the interpretations of coefficients in linear regression or logit regression. In probit regression, an increase in coefficient/probability of 0.4 for the ‘become competitive nationally’ outcome variable is attributed to a one-unit increase in a given predictor (e.g., revenue reinvested) is dependent on the values of the other predictors and the starting value of the given predictor (0 in this case). For example, if we hold all variables constant at zero, a unit change in revenue investment variable (from no reinvestment to reinvestment) is likely to increase the probability of becoming competitive nationally by (0.5 (model constant) + 0.4 (coefficient)) 0.9. An easy interpretation of the probit regression coefficient is that a positive coefficient means that an increase in the predictor leads to an increase in the predicted probability. A negative coefficient means that an increase in the predictor leads to a decrease in the predicted probability.
4. This is due to the 2006 Brazilian legislation – Decree 5906 – that is providing a greater support to these regions, guaranteeing a percentage of the budget of the sectorial funds of RDI. The companies of São Paulo and the south of the country seek partnerships with companies and research centres of these regions. Additionally, the north of the country hosts a Free Zone (in Manaus). The tax policy in this Free Zone is differentiated from the rest of the country, offering locational and RDI

benefits aiming at minimising investment costs at the Amazonian region. Furthermore, the incentives offered by the Federal government in these regions are also supported by state and municipal tax policies (see [http://www.suframa.gov.br/zfm\\_incentivos.cfm](http://www.suframa.gov.br/zfm_incentivos.cfm)).

5. This information is gathered through a direct conversation with the Associação Brasileira de Private Equity & Venture Capital officials ([www.abvcap.com.br](http://www.abvcap.com.br)).
6. BRICS is the acronym for an association of five major emerging national economies – namely Brazil, Russia, India, China, and South Africa.

**Tan Yigitcanlar** is an Associate Professor at the School of Civil Engineering and Built Environment, Queensland University of Technology, Brisbane, Australia. He also carries the Executive Director role at the World Capital Institute (WCI), and is an Adjunct Professor at the Smart Cities Lab (LabCHIS) of the Federal University of Santa Catarina, Florianópolis, Brazil. The main foci of his research cluster around three interrelated themes: Knowledge-based urban development; Sustainable urban development, and; Smart urban technologies and infrastructures.

**Jamile Sabatini-Marques** is a Postdoctoral Fellow at the Graduate Program on Knowledge Engineering and Management at the Federal University of Santa Catarina, Florianópolis, Brazil. She also carries the Director for Innovation and Incentives role at the Brazilian Association Software Companies (ABES), and is the Director of the Human Smart Cities Lab (LabCHIS) of the Federal University of Santa Catarina. Her research focuses on public sector innovation incentive programs for technology companies and clusters’ development and growth.

**Md Kamruzzaman** is an Associate Professor at the School of Urban Planning and Design, Monash University, Melbourne, Australia. His research interests include smart cities, autonomous vehicles, transport disadvantage, travel behaviour, planning and decision support systems, and geographic information systems application in planning.

**Francisco Camargo** is the President of the Brazilian Association Software Companies (ABES), São Paulo, Brazil. He has an engineering educational background, completed courses in the Harvard University, and has extensive expertise in the technology company entrepreneurship area. Previously, he worked as a Managing Director of international banks.

**Eduardo Moreira da Costa** is a Professor at the Graduate Program on Knowledge Engineering and Management at the Federal University of Santa Catarina, Florianópolis, Brazil, and founder of the Pi-Academy – a private company that promotes

innovation for large corporations. He is also the founding Executive Director of the Human Smart Cities Lab (LabCHIS) of the Federal University of Santa Catarina. His research focuses on the development of more humane, smart and sustainable cities.

**Giuseppe Ioppolo** is an Associate Professor at the Department of Economics, University of Messina, Italy. He is the Chair of the Research and Mobility Group – an international academic research network based in Italy. His research focuses on sustainability,

transport sector, environmental governance and management, industrial ecology, economic development, and innovation.

**Fernanda Elisa Demore Palandi** is a Postgraduate Researcher at the Knowledge Engineering and Management at the Federal University of Santa Catarina, Florianopolis, Brazil. She is also a Researcher at the Human Smart Cities Lab (LabCHIS) of the Federal University of Santa Catarina. Her research focuses on knowledge-based urban development.

## Appendix

### Appendix A. Survey questions and investigation areas

No	Question	Broad area	Specific area
1	In which technology areas does your company operate?	Characteristics	Company specialisation
2	How mature is your company – when was it established?	Characteristics	Company age
3	In which Brazilian major region is your company located?	Characteristics	Company geographic location
4	How big is your company – in terms of Brazilian Development Bank (BNDES) classification?	Characteristics	Company size
5	Is your company a member of the Brazilian Association of Software Companies (ABES)?	Characteristics	Company professional networking
6	What is the accumulated increase of your company's turnover during the last 4 years?	Performance	Financial performance
7	Which activity corresponds to the highest percentage of billing in your company?	Performance	Overall best performing area
8	Which activity corresponds to the highest percentage of billing in relation to international performance of your company?	Performance	Internationally best performing area
9	What performance outcomes has your company achieved during the last 4 years?	Performance	Performance outcomes
10	What were the main sources of funding for your company during the last 4 years?	Funding	Sources of funding
11	What were the major difficulties for your business to access loans from commercial banks?	Funding	Difficulties accessing private loans
12	What was the per annum interest rate last time when your company borrowed from a commercial bank?	Funding	Private loan interest rate
13	Has your company obtained any financial support from public institutions during the last 4 years?	Funding	Received public funding
14	What were the sources of received public funding, and which specific funding programs were they from?	Funding	Source of public funding
15	What kind of guarantees does your company has to provide when applying for loans/funds?	Funding	Required guarantees
16	What is the experience of your company with investment funds during the last 4 years?	Funding	Investment funds availability
17	What were the benefits of investment funds for your company?	Funding	Benefits from investment funds

Appendix B. Unadjusted (bivariable) probit regression model coefficients associated with different explanatory factors

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
<i>Sources of funding</i>								
Used new members fund: yes (ref: no)	0.17	-0.45*	-0.06	-0.46	0.48*	-0.32	-0.33	-0.14
Used investment fund: yes (ref: no)	0.23	0.03	0.64*	0.42	1.31***	-0.03	-0.07	0.08
Used loans from public institute: yes (ref: no)	0.33	0.03	0.18	0.57**	0.18	-0.04	0.22	0.40**
Used own resources: yes (ref: no)	0.08	-0.78**	0.16	0.13	-0.37	-0.06	-0.47*	-0.52*
Used loans from commercial bank: yes (ref: no)	0.20	-0.38**	-0.67***	0.60**	-0.37*	-0.12	0.09	0.16
Revenue reinvested: yes (ref: no)	0.17	0.54**	0.15	0.31	0.14	0.65***	0.86***	0.57**
<i>Status of financial support from public institutes</i>								
I am not aware: yes (ref: no)	-0.44	-0.11	-0.21	-0.78*	-0.95**	0.19	-0.17	-0.81***
I did not try: yes (ref: no)	0.16	-0.02	-0.01	0.04	-0.44*	0.02	0.09	-0.33*
I tried but could not access: yes (ref: no)	-0.29	-0.14	-0.09	-0.05	0.01	-0.07	-0.10	0.12
I used support of BNDES/FINEP: yes (ref: no)	0.41	-0.01	0.61**	0.65**	0.71***	0.11	0.38	0.57**
I used support from banks/agencies: yes (ref: no)	0.41	0.77**	0.32	0.13	0.69**	0.32	0.21	0.66**
<i>Sources of received fund</i>								
None: yes (ref: no)	-0.21	-0.21	-0.40	-0.68***	-0.40*	-0.11	-0.43**	-0.46**
Direct support from FINEP: yes (ref: no)	-0.32	-0.06	1.28***	0.07	1.14***	-0.65	-0.99*	-0.01

Appendix B. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
BNDES direct support in the Prosoft program: yes (ref: no)	0.74*	0.74	0.82*	0.48	0.68	0.20	0.34	0.44
BNDES indirect support in the Innovative MPME program: yes (ref: no)	0.77**	–	0.64	0.96**	1.30***	1.01**	0.57	0.94**
BNDES indirect support in the BNDES Finance program: yes (ref: no)	–	–0.05	1.21	–	–	0.05	–	–
BNDES Card: yes (ref: no)	0.28	0.05	0.03	0.62**	–0.13	0.26	0.52**	0.26
Indirect support from FINEP: yes (ref: no)	0.60	0.81	–	–	0.84	0.91	–0.07	0.24
<i>Company specialisation</i>								
Provision of IT services: yes (ref: no)	0.06	–0.17	–0.29	–0.13	–0.22	–0.37**	–0.19	–0.19
Outsourcing services: yes (ref: no)	–0.58*	–0.11	–0.78*	–0.39	–0.13	–0.07	0.27	0.12
Custom software development: yes (ref: no)	0.10	0.15	0.01	0.04	–0.30	–0.03	0.24	0.51***
Development of enterprise resource planning software: yes (ref: no)	0.20	0.11	–0.23	0.87***	–0.38	0.33	0.77***	0.33
Software product development (other): yes (ref: no)	0.17	0.42**	0.53**	–0.01	0.58**	–0.04	0.17	0.75***
Consulting: yes (ref: no)	–0.37*	0.10	–0.11	–0.07	–0.42*	–0.27	–0.04	–0.22
Distribution/reseller – national software	–0.38	–0.30	0.29	0.03	–0.54	–0.18	–0.04	–0.25

Appendix B. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
Distribution/reseller – imported software: yes (ref: no)	-0.32	0.01	0.48*	0.51*	-0.07	-0.01	-0.37	-0.74**
Value added reseller (VAR): yes (ref: no)	0.17	-0.06	-0.20	-0.18	0.10	0.05	0.43	-0.23
Integration: yes (ref: no)	0.12	-0.19	-0.29	0.26	0.05	-0.05	0.03	0.02
Support, training and installa- tion: yes (ref: no)	-0.25	0.03	-0.22	0.28	-0.21	-0.03	0.05	-0.15
Others: yes (ref: no)	-0.01	-0.20	0.17	0.20	0.25	0.34	-0.07	0.41
Company size (ref: microenterprise)								
Small	0.19	0.77***	0.43*	0.55**	-0.18	0.13	0.54***	0.12
Medium/large	0.69**	0.20	0.43	0.76**	0.66**	-0.04	0.09	-0.28
Company age (ref: 0–4 years)								
5–9 years	-0.35	0.21	-0.21	0.47	-0.26	0.02	0.18	0.52*
10–14 years	0.06	0.66**	-0.20	0.88*	-0.10	0.43	0.77**	0.52*
15–19 years	0.22	0.13	0.14	0.82	-0.89*	0.44	0.45	0.27
20–24 years	-0.46	0.49	0.40	0.93*	-0.20	-0.03	0.00	0.72**
More than 25 years	-0.08	0.79***	0.32	1.13**	-0.44	-0.06	0.63	0.74**
Professional networking (ref: non-member)								
ABES member	0.13	0.27	0.46*	0.15	0.22	0.17	0.29	-0.23
Other	-0.18	0.54*	-0.29	-0.06	0.32	0.23	0.27	0.39

Appendix B. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Outcome 1) Invest more than competitors	(Outcome 2) Become more competitive nationally	(Outcome 3) Become more competitive internationally	(Outcome 4) Easier to access financing in the private market	(Outcome 5) Generated interest from investment funds	(Outcome 6) Gained market share	(Outcome 7) Increased number of employees	(Outcome 8) Investing more in RDI
<i>Company location (ref: São Paulo Region)</i>								
North, Northeast, Midwest, Southeast regions	0.10	0.11	0.06	0.75**	0.62	0.14	-0.05	0.96***
South region (excluding São Paulo)	0.09	0.09	-0.47*	0.31	0.60*	0.25	-0.08	0.44**

\* $P < 0.1$ , \*\* $P < 0.05$ , \*\*\* $P < 0.01$ .

Appendix C. Adjusted (multivariable) probit regression model results

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Model 1) Invest more than competitors	(Model 2) Become more competitive nationally	(Model 3) Become more competitive internationally	(Model 4) Easier to access financing in the private market	(Model 5) Generated interest from investment funds	(Model 6) Gained market share	(Model 7) Increased number of employees	(Model 8) Investing more in RDI
<i>Sources of funding</i>								
Used new members fund: yes (ref: no)		-0.407			0.806**			
Used investment fund: yes (ref: no)			0.484		2.109***			
Used loans from public institute: yes (ref: no)				-0.160				-0.385
Used own resources: yes (ref: no)		-0.401					-0.0357	-0.219

Appendix C. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)	(Model 6)	(Model 7)	(Model 8)
Invest more than competitors		Become more competitive nationally	Become more competitive internationally	Easier to access financing in the private market	Generated interest from investment funds	Gained market share	Increased number of employees	Investing more in RDI
Used loans from commercial bank: yes (ref: no)		-0.571***	-0.699**	0.905**	-0.366			
Revenue reinvested: yes (ref: no)		0.500**				0.598***	0.684***	0.542**
<i>Status of financial support from public institutes</i>								
I am not aware: yes (ref: no)				-0.548	-0.809			-0.705**
I did not try: yes (ref: no)								-0.192
I used support of BNDES/FINEP: yes (ref: no)			0.485	0.375	0.968			0.963**
I used support from banks/agencies: yes (ref: no)		0.784**			0.651			0.506
<i>Sources of received fund</i>								
None: yes (ref: no)								
Direct support from FINEP: yes (ref: no)				-0.166	1.445**		-0.534	0.461
BNDES direct support in the Prosoft program: yes (ref: no)	0.703		1.072*		1.302*		-1.090	
BNDES indirect support in the Innovative MPME program: yes (ref: no)	0.596		0.256	0.692	1.813***	0.832*		0.586
BNDES Card: yes (ref: no)				-0.0196			-0.175	
<i>Company specialisation</i>								
Provision of IT services: yes (ref: no)						-0.272		
Outsourcing services: yes (ref: no)	-0.414		-0.956*					

Appendix C. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)	(Model 6)	(Model 7)	(Model 8)
Invest more than competitors								
Custom software development: yes (ref: no)								0.516**
Development of enterprise resource planning software: yes (ref: no)				0.890***			0.653**	
Software product development (other): yes (ref: no)		0.229	0.732**		0.971**			0.576**
Consulting: yes (ref: no)	-0.250				-0.0797			
Distribution/reseller – imported software: yes (ref: no)								-1.118***
Company size (ref: microenterprise)								
Small		0.808***	0.306	0.398			0.518**	
Medium/large	0.0893				1.202**			
Company age (ref: 0–4 years)								
5–9 years								0.651**
10–14 years		0.671**		0.179			0.406	0.527
20–24 years				0.0510	-0.354		-0.554*	0.742**
More than 25 years		0.581*		0.532			0.334	0.694**
Professional networking (ref: non-member)								
ABES member			0.250					
Other		0.891***						
Company location (ref: São Paulo Region)								
North, Northeast, Midwest, Southeast regions				0.397				1.233***



Appendix C. (Continued)

Explanatory variables	Outcome variables (company performance outcomes (CPO): 1 = yes, 0 = no)							
	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)	(Model 6)	(Model 7)	(Model 8)
Invest more than competitors		Become more competitive nationally	Become more competitive internationally	Easier to access financing in the private market	Generated interest from investment funds	Gained market share	Increased number of employees	Investing more in RDI
South region (excluding São Paulo)			-0.631*		-0.000479			0.439*
Constant	-0.796***	0.546	-1.246	-3.117***	-6.058***	-1.022**	-1.234	-1.678
N***	188	182	181	187	187	188	188	187
pseudo R <sup>2</sup>	0.053	0.206	0.271	0.235	0.402	0.058	0.157	0.249
LR chi <sup>2</sup>	10.10*	51.99***	34.06***	30.82***	62.08***	15.21***	40.16***	64.65***
Log likelihood	-89.58	-100.06	-45.88	-50.28	-46.16	-122.54	-108.14	-97.29

\*:  $P < 0.1$ , \*\*:  $P < 0.05$ , \*\*\*:  $P < 0.01$ , \*\*\*\*: variation in sample sizes is due to exclusion of missing cases.