

# A chip off the old block: Case studies of university influence on academic spin-offs

Thiago Renault<sup>1</sup>, José Manoel Carvalho de Mello<sup>2,\*</sup>,  
Marcus Vinicius de Araújo Fonseca<sup>3</sup> and Sérgio Yates<sup>3</sup>

<sup>1</sup>Innovation Agency, Fluminense Federal University, Rua Miguel de Frias, 9, Icaraí, Niterói, RJ, Brasil <sup>2</sup>Innovation Agency, Production Engineering Program, Fluminense Federal University Niterói, 24220-900, Brazil <sup>3</sup>Production Engineering Program, Federal University of Rio de Janeiro, Rio de Janeiro, 21941-972, Brazil.

\*Corresponding author. Email: josemanoel.carvalhodemello@gmail.com

## Abstract

Spin-offs are an important aspect of the process of technology transfer from academia to the business sector. A key issue in the study of the spin-off formation process is the influence of the parent research organization on the profile of the spin-offs that are created. Following this direction, our study seeks to analyze how the previous academic trajectory of the founding team affects the business model and performance of academic spin-offs. We performed our analysis drawing on a resource-based view and a business model perspective. Our findings show that the spin-offs inherit their initial resource base from the academic environment and that the business model adopted by these companies is influenced by their initial resource base.

**Key words:** entrepreneurial universities; academic spin-offs; resource-based view; business model.

## Introduction

With the advent of the new economic paradigm known as the Knowledge Society, universities have acquired increasing importance as key agents in the production and dissemination of knowledge, the main input for socio-economic development. In this context, universities are undergoing organizational changes and new activities are being introduced into the academic routine. Initially universities were focused only on teaching activities. Only in the mid-19th century did the incorporation of a second academic mission begin: research. In the mid-20th century the incorporation of the third mission began: that of acting proactively in the promotion of economic and social development. With the introduction of the third academic mission a new concept of entrepreneurial universities (Etzkowitz 2002) emerged which is characterized by systematic support for technology transfer and business creation. The companies created in the academic environment have been referred to in the professional literature as academic spin-offs (Fryges and Wright 2014; Mustar et al. 2006; Wright et al. 2008).

The process of technology transfer from academia to the business environment is very complex and follows a systemic profile, with the participation of multiple actors (Bozeman 2000; Wright 2014). The interactions among these actors form innovation systems (Nelson 1993) and impact on the socio-economic development process in the regions where these systems are in place (Kim and Nelson 2000). It is important to emphasize the learning process necessary for the implementation and systematization of the innovation

process (Lundvall 1992). This learning takes place along the historical trajectory of the actors and involves mutual knowledge transfer (Rasmussen 2011).

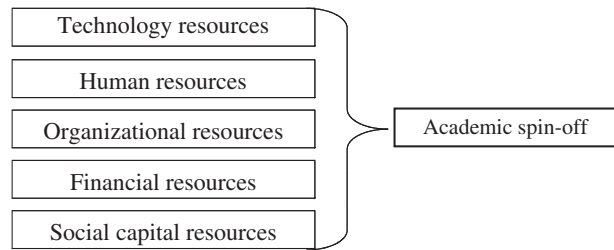
According to Etzkowitz (2002) the innovation process occurs in a context of interaction between different institutional spheres: government, academic and business, which he refers to as the triple helix. In the overlaps of these institutional spheres hybrid actors emerge that play an important role in the innovation process. The creation of academic spin-offs occurs in these hybrid environments (Zahra et al. 2014).

The influence of entrepreneurial universities on the profile of spin-offs that are created is an important issue that needs to be investigated and our analysis follows this direction. Our main research question was: how the previous academic careers of people involved in the creation of spin-off companies affect their resource base and the business model adopted by these enterprises during the process of creation and their early development.

The remainder of this paper is as follows: Section 2 presents the theoretical framework used in our analysis. Section 3 presents the methodology used for data collection and analysis, Section 4 presents the case studies, Section 5 presents our conclusions and discusses the policy implications.

## Theoretical framework

We consider those companies created by professors and students to commercially exploit the results of research activity carried out in



**Figure 1.** Resources present in process of creation and development of academic spin-offs (ASO)

Source: Authors' adaptation, based on Landry et al. (2006) and Brush et al. (2001)

the academic environment to be spin-offs. In an extensive review of the literature Mustar et al. (2006) identify three streams that analyze the process of creation and development of spin-offs:

- The institutional approach where the authors analyze relationships between parent research organizations and the profile of spin-offs created.
- The resource-based view where the authors analyze the creation and development of spin-offs from the point of view of their resource base.
- The business model approach where the authors analyze the process by which the spin-offs create and capture value in the market.

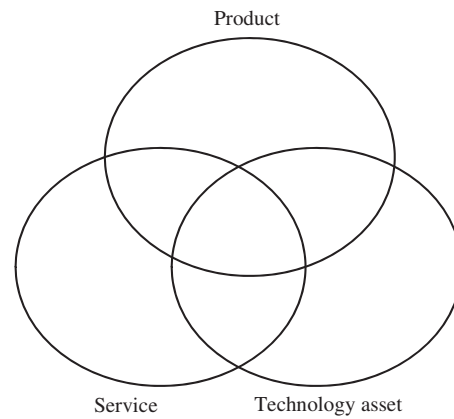
The analysis proposed in this paper involves the three streams identified in the specialized literature.

The institutional perspective is based on the recognition that spin-offs are typically embedded in a parent organization, although the way in which they are embedded may vary. The parent organization has its own culture, incentive systems, rules and procedures and this culture affects the resource endowments from the parent organization to the spin-offs (Moray and Clarysse 2005). As noted by Vohora et al. (2004), academic spin-offs emanate from environments that typically lack commercial resources and influence the profile of the spin-offs.

The resource-based view is centered on the analysis of resources employed in the process of creation and the early development of new enterprises. Authors who pursue this conceptual approach define resources very broadly, encompassing all tangible and intangible assets and skills linked to the firms in a 'semi-permanent' way. Brush et al. (2001) analyze the creation and early development of companies from the resource-based view and propose a categorization that involves six resources: technological, human, social capital, financial, physical and organizational. Landry et al. (2006) used a very similar resource categorization to analyze the propensity of Canadian researchers to create spin-offs.

The conceptual model we propose for our research uses a resource taxonomy based in the work of Brush et al. (2001) and Landry et al. (2006) (see Fig. 1).

The technological resources category refers to the basic skills and technologies specific to each company. The technology-based spin-offs show differences in their degree of innovation and technological scope and the nature and intensity of their R&D activities and positioning in the product development cycle (Clarysse et al. 2011). Human resources are analyzed on the basis of the attributes of the founding team and their collaborators, in both technical and managerial terms. These resources are usually measured in terms of: the size of



**Figure 2.** Business models adopted by technology based spin-offs

the founding team, the background of the entrepreneurs, and their technical and managerial experience. The organizational resources category refers to: possession or access to facilities and distribution networks, technical support, customer base, strategic suppliers, and management and certification systems, among other factors.

Financial resources relate to the amount and nature of the funding required for the setting up and development of the new venture. The social capital resources are defined by Brush et al. (2001) as the inter-relations between the entrepreneurs, the new venture and the environment in which they are inserted.

Stankiewicz (1994) pioneered the analysis of business models adopted by spin-offs, using a classification based on activities that they perform: service-oriented firms, product-oriented firms, and intellectual asset-oriented firms. Service-oriented firms offer consulting and R&D services and product-oriented firms seek scalability for a product with a clear value potential. Intellectual asset-oriented firms try to reach the market through different channels, normally incorporating their technology in the products and services of other companies. Chesbrough and Rosenbloom (2002) define a business model as: the orchestrating of value proposition, market segmentation, positioning in the value chain, and cost of infrastructure to produce and offer products and services. The business model is formed from the allocation of the different technological, human, organizational, financial and social capital resources available, in order to generate and capture value in specific market segments.

In earlier research we used the classification proposed by Stankiewicz (1994), but when we began an analysis of the cases studies we realized that in practice the three business models present overlapping areas and that the same company often adopts multiple business models simultaneously (see Fig. 2).

During the early stage of a spin-off company more than one business model may be used simultaneously. Hence, Fig. 2 shows areas of overlap, where business models emerge in which products are offered along with services, products and services are offered through technological assets, and there are some business models that offer all three at the same time. In our study we analyze the influence of the parent organization in the evolution of the spin-off's resource base and business model.

## Methodology and data collection

We took a qualitative approach to data collection for this study. A longitudinal case study was chosen (Eisenhardt 1989; Yin 1994) to

analyze the evolution of five technology-based academic spin-offs generated at the Coordination of Post-Graduate Engineering Programs (COPPE) at the Federal University of Rio de Janeiro (UFRJ). These spin-offs were supported by the business incubator and were set up by graduate students in partnership with professors and researcher scholars.

We decided to analyze these five companies because they were all created under the same conditions, in similar business environments. All of the spin-offs were connected to academic research projects carried out at COPPE.

We started the data collection in 2006, interviewing two of the business incubator staff, the director and the operational manager, following a semi-structured questionnaire. In this phase, we analyzed the background of the business incubator, the operational model and each of the 46 companies supported since it began its activities. We realized that in the 1990s companies were created under completely different conditions to those in the mid-2000s. These differences were related to the Brazilian business and public policy environment and also to the capabilities developed by the business incubator to support the creation of innovative companies. In order to perform a homogeneous analysis we decided to select the five most recently created companies (at that time, in 2006) and follow them over a six-year period, until 2012.

Our research was based on document analysis, multiple interviews and informal conversations with the founders of the companies. We started with data collection from secondary sources such as the websites of these companies and obtained additional information from the business incubator website and other specialized media. After this, we gained access to the business plan that each of these companies submitted for the business incubator selection process. We also analyzed their fund raising proposals, so that we could identify the critical resources that they needed. We organized the primary data collection on an annual basis, considering qualitative data on resource development and allocation and the business model adopted by these companies.

In order to illustrate the context of the case studies, we provide a brief description of COPPE/UFRJ focusing mainly on its research environment, its track record of interaction with the business sector and the infrastructure in place to support technology transfer and the creation of innovative companies.

## **Influence of the parent research organization on academic spin-offs**

The presentation of data on these case studies is organized into four subsections. Section 4.1 presents an overview of the COPPE program at UFRJ in order to contextualize the case studies as spin-offs from a university where the research activities and interaction with the market are already well established. We then present a brief description of the five spin-offs studied, with an emphasis on the past history of the teams within the academic environment, the opportunity recognition process and the decision to create the company. In Section 4.3 we present an analysis of the resource base in the creation and early development of the business. In Section 4.4 we present an analysis of the business model adopted by these companies.

### **4.1 Context**

The UFRJ is the largest federal university in Brazil. Scientific activities are a major part of the university routine with more than 100 graduate programs (Masters and Doctoral programs) and 11,248

enrolled students of which over 4,000 are from the technological areas (UFRJ 2014). COPPE is the largest academic unit at the university offering 12 different graduate engineering programs, all of them with high rankings in the national ratings published by the Ministry of Education (CAPES 2014). It has the largest infrastructure for teaching and research in engineering in Latin America, with some 2,800 graduate students (1,600 MSc and 1,200 PhD) and 350 employees (325 full-time researchers) working in 116 research laboratories. In 2013, over 500 students received advanced degrees from COPPE. Since it was founded in 1963 COPPE has awarded degrees in engineering to some 12,000 MSc and PhD students (COPPE 2014).

There is a foundation at COPPE which is known as COPPETEC and currently manages 657 projects involving 7640 collaborators with total revenues of about US\$220 million (COPPETEC 2014). The COPPE Business Incubator was founded in 1994 and, since that time, has assisted in the creation of over 50 companies offering innovative products and services with high technological content. The incubator has more than 1,900 m<sup>2</sup> in facilities, with a capacity for 24 incubation modules each using 30 m<sup>2</sup>. There are 20 companies under incubation. The operational model used in the incubation process involves providing physical infrastructure and consulting services in the fields of marketing, finance, accounting, law and design.

The UFRJ technology transfer office was set up after the business incubator. In 2001, the Intellectual Property and Technology Transfer Division was added to the UFRJ, and in 2007 was replaced by the UFRJ Innovation Agency. The agency currently has a portfolio of around 270 patents, of which eight are licensed (UFRJ 2014). Implementation of a technology park at the university began in 2003 and it came into operation in 2008, following an initial investment of approximately US\$50 million. The technology park covers about 350,000 m<sup>2</sup> and is home to 20 companies that together employ about 200 technicians and researchers (UFRJ 2014). In the period 2008–2012, several companies announced intentions to invest in the technology park, including: Petrobras, Schlumberger, Halliburton, FMC Technologies, Siemens, BG Group, and General Electric. The UFRJ campus also hosts research centers such as CENPES, belonging to the state-owned oil and gas company Petrobras, CEPTEL, owned by the national electricity company Eletrobrás, and CETEM, which conducts mineral research. The university, therefore, has a rich ecosystem that goes beyond teaching departments, maintaining space for the interaction of multiple actors from different institutional spheres (Etzkowitz 2002).

### **4.2 Academic spin-offs at COPPE / UFRJ: From academia to market**

We now present an overview of the previous academic trajectory of each team involved in the creation of the five spin-offs studied. Our goal is to briefly present the process by which entrepreneurial teams recognize the opportunity and acquire/develop the resources used in the creation of the spin-off. We named each of the five spin-offs with a character from the Greek alphabet: Alpha, Beta, Gamma, Delta, and Kappa.

Alpha was set up in 2004 as a consultancy in the polymers segment. The idea arose as a result of the work of two PhD students and a professor at the Macromolecules Institute (IMA/UFRJ). At the time, these entrepreneurs noticed that companies had a recurring need for consulting services regarding polymers and that there was no specific supplier of such services. So the IMA researchers

organized themselves to cater to this niche market, which mainly involved those researchers in the research group led by the professor who helped to set up the company. There was no specific research that led to the development of a product. These were highly specialized technical services, delivered as the need arose to a variety of regular clients. The research activities of this group were quite intensive. In the period 1991–2003 they handled some 15 research projects funded by the major government funding agencies and private companies. During this period, the professor and the two PhD students acquired important technical expertise in the polymers segment, which turned out to be the primary resource for the creation of the company. The company offers consulting services related to special pastes and adhesives with applications in the construction, electrical, oil and industrial sectors.

Beta was founded in 2004 by three doctoral students from the Power Electronics Laboratory in the Electrical Engineering Graduate Program. During their PhD studies these students participated in R&D projects contracted by a specific Brazilian electricity power company and they had developed a device to convert single-phase power into three-phase power. This converter is very convenient for rural areas, where the network is single-phase and there is a need for occasional use of three-phase power. Through this R&D project, the entrepreneurs acquired technical expertise in the field of power electronics, which enabled them to put together a wide range of services. Beta has serviced many customers that are major companies in the electricity and engineering sectors, such as: Light, Ampla, ONS (Operator of the National Grid), and Quentech/Siemens.

Gamma was founded in 2005 by three professors and two PhD students from the Membrane Separation Process Laboratory in the Chemical Engineering Program. The idea of commercially exploiting the results of the laboratory's research activities lay in the work of the group over the last three decades. The group had been studying membrane separation processes since the mid-1980s. This stream of research advanced during the 1990s, to the point of generating a commercially viable application in the 2000s. Throughout this time, around 30 projects were carried out, with financing from the major government funding agencies, domestic and international foundations and companies. From the year 2000, there was a growing concern in society over the sustainable use of water. The entrepreneurs saw an opportunity to commercially exploit the technology they had developed.

The company produces membranes for microfiltration and ultrafiltration in specific applications, including the production and assembly of microfiltration modules and systems. Gamma's customers are companies that want to reduce waste water such as: condominiums, shopping malls, service stations, and industrial firms in general.

Delta was founded in 2005 by a researcher and a professor at the Vibration Control Laboratory in the Civil Engineering Program. While they were still at the Structures Laboratory, three research projects carried out in the period 200–2005 showed a market opportunity for setting up a business. These were vibration control: on the Rio-Niterói bridge, at the Maracanã football stadium, and on electricity transmission towers. In all three cases, there were complex vibration problems that were mitigated by the solutions presented by the researchers.

Delta's work focuses primarily on providing services that include engineering consultancy for major works, construction and the industrial segment focused on solving vibration problems in structures and equipment. Among its clients are major companies such as:

Concer, Odebrecht, Andrade Gutierrez, Tecnosolo, Engevix, Technipp, and Queiroz Galvão.

Kappa operates in the computer technology segment with software based on image and sound pattern recognition. It was founded in 2004 by a professor, an MSc student at the UFRJ Electronic Computing Center, and three undergraduate students. The group led by this professor has been conducting research into the recognition of image patterns for recognizing texts, which is known as optical character recognition technology. The research group was approached by the local state traffic department (DETRAN/RJ) to develop a solution for automating the process of registering vehicle license plates from images.

They developed a system using video cameras that is able to register vehicle license plates and connect this information with databases, thus making it possible to identify vehicles with irregularities and automate that part of the annual vehicle licensing process. At the end of the project, the researchers realized that they had a technology that could have a variety of market applications. The company provides applications to control access to parking lots, condominiums and shopping centers.

### 4.3 Resource base of spin-offs at COPPE/UFRJ

We now analyze the resource base in the creation and early development of the spin-offs. The technological and human resources used in the process of spin-off creation were developed throughout the academic careers in publicly funded research projects. The human resources involved in the creation of the new ventures were professors and students who were previously involved in academic research projects, with social capital predominantly restricted to the academic environment.

Organizational resources inherited from the academic environment by spin-offs are calibrated for project management, focused in R&D projects. These resources usually combine project management and technological foresight management tools. Typically, the academic environment lacks experience related to: scalable production, distribution, and the provision of technical assistance services. These three skills related to organizational resources were reported by the five companies as the biggest bottleneck to growth.

Table 1 gives an overview of the resource base in each spin-off during its creation and early development. Using the resource-based view as a tool of analysis sheds some light on the influence of the academic environment on the profile of the spin-offs that were created. Our sample suggests that the founders' lack of business experience drives them to replicate the structure they are comfortable with, namely the lab. By the same token, they are inclined to provide the same kind of service as they did during their academic life. It is interesting to note that similar results regarding the founder's skills and the process of firm creation were found by other researchers in developed economies such as the UK (Clarysse et al. 2011) and Scandinavia (Rasmussen 2011).

### 4.4 Business model of spin-offs at COPPE/UFRJ

A pattern can be observed in the evolution of the business models adopted by the spin-off companies. This pattern was influenced by the common resource base available to the five companies studied. In all five cases studies the spin-offs remained small companies with revenues of less than US\$1 million per year and fewer than 50 employees. Only one company achieved an annual revenue over US\$1 million and more than 20 employees. At the end of the six-year

**Table 1.** Resource base for five academic spin-offs from COPPE/UFRJ

	Alfa	Beta	Gamma	Delta	Kappa
Technological	Technical expertise in consulting projects in polymers	Patented technology for conversion of single-phase into three-phase power	Technology for micro and nano-filtration systems	Technical expertise in solution of complex vibration problems in large structures	Registered software for visual identification of cars
Human	One professor and two PhD students	Three PhD students	Three professors and two PhD students	One professor and one PhD student	One professor and one MSc student
Organizational	Project management. Later: production, distribution and technical assistance	Project management	Project management	Project management	Project management. Later: production, distribution and technical assistance
Financial	Government grants, private companies consultancy services and venture capital	Government grants, private R&D contracts	Government grants, private company R&D contracts	Government grants, private company consultancy services	Government grants, private company R&D contracts
Social capital	Predominantly academic	Part academic, part private with electricity power companies	Predominantly academic	Part academic and part private with engineering companies	Predominantly academic

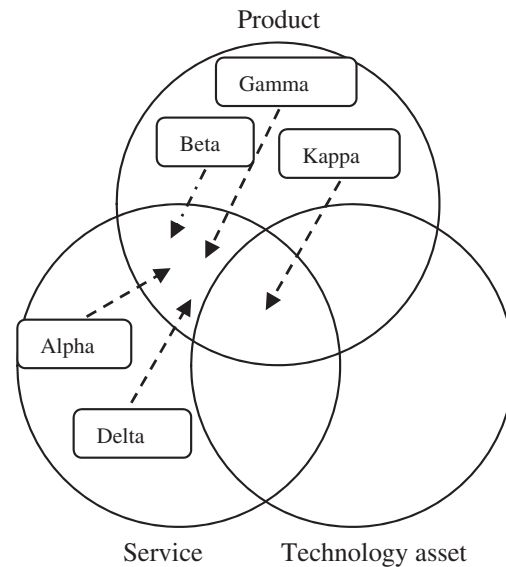
period of analysis, the five companies had very similar business models.

During the period of creation and early development of the spin-offs they were constantly making adjustments to make the operations more profitable and scalable. Four of the companies underwent structural change in their business models. Beta, Gamma and Kappa started their operations with the clear intention of adopting a business model focused on providing a product, but in none of the three cases did the strategy prove to be feasible. Although Alpha and Delta did not start their operations with this focus (providing products), at some point in their development they tried, unsuccessfully, to adopt a business model focused exclusively on supplying goods. The interviews showed that entrepreneurs realized that the adoption of a business model focused purely on the product requires resources and skills that are absent in the academic environment.

Entrepreneurs involved in the creation of companies said that the financial resources available for these businesses present profiles very similar to the type of funding available for research laboratories in the academic environment. There is a lack of investment in marketing, in the distribution networks and production facilities. The interviewers report that this type of financing stresses the abundant resources inherited from the academic environment: they are designed to develop new technologies but not to put products in the market.

Our analysis of the five companies showed that they sought hybrid business models focused above all on providing services. Fig. 3 shows the evolutionary dynamic of the five companies' business models.

It should be noted that all five companies, after an initial period of adjustment, adopted a hybrid business model focused on providing technical services and customization based on technological assets and skills inherited from the academic environment. In the five cases studied this was the natural choice of the entrepreneurial team seeking a competitive business model. The resource base inherited from the academic environment influenced the business model they adopted. On the other hand, we know that, as important as the influence of the resources endowment over the firm development is, the mindset and vision that constitute the entrepreneur's



**Figure 3.** Evolution of business models of companies studied



**Table 2.** Academic spin-offs at COPPE/UFRJ: Business models vs resources

Resources	Service-oriented firms	Intellectual property asset-oriented firms	Product-oriented firms
Technological resources	Technical skills combined with technologies that are employed in providing customized consulting and R&D services Limited concern over intellectual property	Technologies developed in R&D projects, transfer without direct intervention in production or marketing of final products or services High concern over intellectual property	Mature technology, tested in the market. Technology for product development, production and management High concern over intellectual property
Human resources	Technical profile: high proportion of MScs and PhDs among company employees Specific skills in project management	Technical profile: high proportion of MScs and PhDs among company employees Need for managerial and law skills	Technical, managerial and commercial profile. Low proportion of MScs and PhDs among company employees
Organizational resources	Software or methodologies for project management	Patent or registration of intellectual property Structure for license agreement and monitoring of sales	Distribution network, technical support, investment in brand, certification, production structure, etc.
Financial resources	Low investment, organic growth, slow and gradual	Public and private investment in R&D, exogenous growth	Public and private investment, growth potential scalability
Social capital resources	Academic	Academic and business	Predominantly business

cognitive decision process can be a real barrier to growth (Wright and Stigliani 2012).

## Analysis and conclusions

Our central research question aimed to examine the influence of the parent organization on the profile of spin-offs created with reference to the resource base and the business model adopted in the creation and early development of the new venture. The combined use of the resource-based view with the perspective of the business model adopted by the companies has revealed nuances that had not been explored in earlier work, especially for companies in emerging economies.

The starting point of the five case studies was quite homogeneous. The previous path of entrepreneurial teams in academia was centered on publicly funded laboratories engaged in R&D projects with participation from the business sector. In four of the five cases the opportunity for the creation of new business was triggered by the interaction of the business sector with academic research projects.

The academic environment at COPPE/UFRJ had an important influence on the resource base available for the spin-offs. Our data analysis shows the resource endowments from the parent research organization to the spin-offs created and its influence in the business model adopted by these spin-offs. The five companies analyzed were created using technological, human, organizational and social capital resources inherited from the parent research organization. Even the financial resources available were similar to those present in the academic environment. The spin-offs experienced great difficulty in developing organizational resources beyond those inherited. Those resources related to scalable production, distribution and technical assistance were identified as the most difficult for the companies to build or acquire.

Our analysis shows the strong influence of the resource base inherited by the spin-off and the business model adopted. In the five cases studied, the entrepreneurs were fully aware that it is very

difficult for a business to grow when it is focused on providing customized consulting services. These services are not scalable, because they involve highly specialized human resources that are not readily available in the market. In the five cases studied, the entrepreneurs were interested in growing their business and there was the notion that growth entailed adopting a business model focused on scalable products. However, none of the five companies was successful in adopting a business model focused on providing a product.

The resource base required for the adoption of a business model centered on supplying a product is quite different from that required for the provision of specialized services. For the business model focused on providing specialized services, the necessary resource base is very similar to that found in academia, centered on highly qualified human resources and cutting-edge technology. In contrast, the resources necessary for adopting a product-focused business model are not only quite distinct, but are unlikely to be found in academia. Table 2 summarizes the resource base required for the adoption of each of the business models.

The main resource gap for the adoption of a business model focused on offering products is in relation to the organizational resources. To supply products one must have the necessary specific production certification, a distribution network, technical assistance and other organizational resources that one does not find in academia and that are not covered by the system of funding available to the companies studied.

This analysis sheds some light on the discussion about the growth of academic technology-based spin-offs. In the context of the five companies studied, this growth involved the adoption of a business model focused on providing scalable products. Yet these companies had great difficulty in adopting this type of business model, since they did not have the necessary resources.

Policy-makers expect that academic spin-offs will grow into large employers and tax payers. Our analysis of the five companies studied showed that none of the cases were able to meet these expectations.

The growth of spin-offs is linked to the successful adoption of a scalable business model focused on providing products. In the

academic environment, few resources are calibrated for a product-providing business model. If policy-makers expect these companies to grow, they should address the issue of the development of the absent resources. The incentive systems for the creation of spin-offs set up in the context of our case studies encourages the creation of companies that are very similar to the university laboratories and that often compete for the same contracts. They soon have to follow separate routes, which discourages further collaboration between the new venture and its laboratory of origin. This segregation occurs because both organizations provide the same customized services, with a very similar value proposition.

## Funding

The authors would like to thank CNPq (grants 401009/2011-4 and 443119/2014-7) and FAPERJ (grants E-26/111.422/2011 and E-26/110.028/2012) for financial support.

## References

- Bozeman, B. (2000) 'Technology transfer and public policy: A review of research and theory'. *Research Policy*, 29: 627–55.
- Brush, C. G., Greene, P. G. and Hart, M. M. (2001) 'From initial idea to unique advantage: The entrepreneurial challenge of constructing a resource base'. *Academy of Management Executive*, 15(1): 64–78.
- CAPES. (2014) 'Avaliação Trienal 2013' <www.capes.gov.br> accessed 23 April 2014.
- Chesbrough, H. and Rosenbloom, R. S. (2002) 'The role of the business model in capturing value from innovation'. *Industrial and Corporate Change*, 11: 529–44.
- Clarysse, B., Wright, M. and Van de Velde, E. (2011) 'Entrepreneurial origin, technological knowledge, and the growth of spin-off companies'. *Journal of Management Studies*, 48: 1420–42.
- COPPE (2014) 'Coppe em Números' <http://www.coppe.ufrj.br> accessed 23 April 2014.
- COPPETEC (2014) 'Relatório de atividades 2013' <http://www.coppetec.coppe.ufrj.br/site/relatoriodegestao.php> accessed 23 April 2014.
- Eisenhardt, K. M. (1989) 'Building theories from case study research'. *Academy of Management Review*, 14: 532–50.
- Etzkowitz, H. (2002) *MIT and the Rise of Entrepreneurial Science*. London: Routledge.
- Fryges, H. and Wright, M. (2014) 'The origin of spin-offs: A typology of corporate and academic spin-offs'. *Small Business Economics*, 43: 245–59.
- Kim, L. and Nelson, R. (2000) *Technology, Learning, and Innovation: Experiences of Newly Industrialising Economies*. Cambridge, UK: CUP.
- Landry, R., Amara, N. and Rherrad, I. (2006) 'Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities'. *Research Policy*, 35: 1599–615.
- Lundvall, B. (1992) *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter.
- Moray, N. and Clarysse, B. (2005) 'Institutional change and resource endowments to science-based entrepreneurial firms'. *Research Policy*, 34: 1010–27.
- Mustar, P., Renault, M., Colombo, M. G., Piva, E. et al. (2006) 'Conceptualizing the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy'. *Research Policy*, 35: 289–308.
- Nelson, R. (1993) *National Innovation Systems: A Comparative Analysis*. Oxford, UK: OUP.
- Rasmussen, E. (2011) 'Understanding academic entrepreneurship: Exploring the emergence of university spin-off ventures using process theory'. *International Small Business Journal*, 29: 448–471.
- Stankiewicz, R. (1994) 'University firms: Spin-off companies from universities'. *Science and Public Policy*, 21: 99–107.
- UFRJ (2014) 'Relatório de Autoavaliação – Março 2013' <http://www.ufrj.br/docs/2013/UFRJ-CPA-2013.pdf> accessed 23 April 2014.
- Vohora, A., Wright, M. and Lockett, A. (2004) 'Critical junctures in the growth in university high-tech spinout companies'. *Research Policy*, 33: 147–75.
- Wright, M. (2014) 'Academic entrepreneurship, technology transfer and society: Where next?'. *Journal of Technology Transfer*, 39: 322–34.
- , Clarysse, B., Mustar, P. and Lockett, A. (2008) *Academic Entrepreneurship in Europe*. Cheltenham, UK: Edward Elgar.
- and Stigliani, I. (2012) 'Entrepreneurship and growth'. *International Small Business Journal*, 31: 3–22.
- Yin, R. (1994) *Case Study Research: Design and Methods*. Newbury Park, CA: Sage.
- Zahra, S. A., Wright, M. and Abdelgawad, S. G. (2014) 'Contextualization and the advancement of entrepreneurship research'. *International Small Business Journal*, 32: 479–500.