

Is academic spinoff financing a matter of business and growth models? The Spanish case

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Declarations

-Funding

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-Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

-Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Is academic spinoff financing a matter of business and growth models? The Spanish case

Purpose. This study investigates the relationship between the development of academic spinoffs (ASOs) and the type of financing involved, by considering three research questions: How do ASOs differ in terms of financing? To what extent and for what reasons do ASOs differ in their financing? How do business and growth models dictate the selection of different sorts of financing arrangement?

Design/Methodology/approach. The study employs a grounded-theory, qualitative approach based on 39 Spanish ASOs.

Findings. There is a heterogeneity of ASO financing, and the selection of financial resources is related to the business and growth model of the ASO. Furthermore, there are some critical junctures for financing within each group of ASOs.

Research limitations/implications. The study advances the understanding of the determinants of ASOs, specifically with respect to financing, business models, and growth orientation. The Spanish context used here may not permit the global generalisation of the results; nevertheless, this study is a response to calls to consider the effect of regional context on ASOs.

Practical implications. Knowing the heterogeneity of ASOs in terms of financing and how business and growth models determines the selection of distinct financing sources help financial planning, investment decisions and the design of programs and policies, which can be relevant for both ASOs and their stakeholders (investors, universities, and governments).

Originality/value. This study provides a comprehensive view of ASO financing, confirming a heterogeneity, not only in terms of financing but also in some critical junctures that presage a change from one type of financing to another.

Keywords. Academic spinoff; financing; business model; growth orientation; entrepreneurship

Paper type. Research paper

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L26, M13, O32, G32

1 Introduction

Previous research has revealed the significance of academic spinoffs (ASOs) in terms of economic impact, technology transfer to industry, and contribution to employment (e.g., Block *et al.*, 2017; Cantner and Goethner, 2011; Meoli *et al.*, 2013). The literature on ASOs has also considered the work of such firms to be socially important thanks to their ability to commercialise products that might otherwise have remained undeveloped, and to provide social gains in addition to private yields (e.g., Fini *et al.*, 2018; Meoli *et al.*, 2019). Despite the considerable economic and social importance of ASOs (Hossinger *et al.*, 2020), the existing research is mostly focused on other types of entrepreneurship ventures. Studies that specifically target ASOs are less common (Mathisen and Rasmussen, 2019).

Previous authors have identified funding as a key factor (Sansone *et al.*, 2021), stressing the essential importance of the amount and type of financing for the creation, development, and success of the commercialization of the academic spinoff (ASO) (Mustar *et al.*, 2006; François and Philippart, 2019; Vinig and Van Rijsbergen, 2010). Despite the broad stream of research on entrepreneurship financing (OECD, 2015), ASOs have particular financial needs. Many researchers have pointed out that venture capital (VC) is a particularly appropriate form of financial intervention for supporting the creation and growth of high-tech company (Gubitta *et al.*, 2016). Likewise, much of the research on ASOs has also been oriented towards highlighting the role of debt financing (Moore, 1994), subsidies or public funds (Huggins, 2008), or business angels (BA) (Mosey and Wright, 2007). Given also that the private funds invested by individual business founders at the start are not generally sufficient to finance the development of the ASO (Wright *et al.*, 2006) and, by and large, debt financing is not an option due to the lack of collateral, there are generally two further possible sources of funding: public funds and equity investments (mainly, VC and/or BA) (Bock *et al.*, 2018). At the same time, ASOs are highly heterogeneous (Hossinger *et al.*, 2020), and previous literature has provided a more comprehensive understanding of their diversity, proposing business models and growth orientation as dimensions that differentiate between them (Mustar *et al.*, 2006).

Despite the relevance of financing for ASOs to go on to become established firms and to address their growth challenges, there is a lack of consensus among researchers regarding when, how, and why ASOs make use of such a wide range of sources of finance. In this vein, an understanding of the nature of ASOs may be a useful point to begin the selection of the sort of financial resources required. Different patterns of financing might be required by different business models, such as consultancies or

service-oriented, product-orientated, software-oriented, or technological asset-orientated models (Druilhe and Garnsey, 2004; Mustar *et al.*, 2006; Stankiewicz, 1994), and different types of growth orientation, e.g., growth and lifestyle models (European Commission, 2002). ASOs are heterogeneous firms with distinct financing needs depending on the business models and the growth orientation adopted (Mathisen and Rasmussen, 2019). Their financing has not, however, been previously related to the business and growth models pursued. Furthermore, most research on ASOs has been developed in the USA or the UK (Rodríguez-Gulías *et al.*, 2016), and although some European countries began to see more attention just over a decade ago (e.g., Wright *et al.*, 2007), countries such as Spain are lagging behind in the creation of ASOs compared to other European countries (OECD, 2014).

The aim of the present work is to investigate how business and growth models determine the financing of ASOs at the university level in Spain. Consequently, and taking account of the ideas expressed above, the following research questions are posed: How do ASOs differ in terms of financing? To what extent and for what reasons do ASOs differ in their financing? How do business and growth models dictate the selection of different sorts of financing arrangement? To guide this research, a business model perspective is applied (Mustar *et al.*, 2006). In this view, this study draws specifically on studies that differentiate between ASOs according to the activities they undertake (e.g., Druilhe and Garnsey, 2004; Stankiewicz, 1994) and based upon the growth orientation established by these firms (e.g., Tiler *et al.*, 1993). The research questions have been addressed considering an ASO, based on the definition of François and Philippart (2019), as the creation of a firm by a person or people from a university, grounded on a technology and/or knowledge generated within that university. To answer these research questions, a methodology that is qualitative in nature is used. This methodology permits to obtain primary and secondary data corresponding to the emergence of ASOs in Spanish universities and referring to the nature and evolution of their activity and financial structure. To this end, an in-depth study of 39 ASOs is organised.

This paper contributes to the entrepreneurship research in several ways. It enriches the literature on the analysis of ASOs development considering the type of financing involved, taking into account the link between financing, business model and growth model of ASOs, and confirming the heterogeneity of ASO financing. The research also corroborates that business/growth models have an essential role in the selection of ASO funding. Finally, it considers the influence of regional context on ASO financing, so its

findings may also be useful for countries with a similar technology transfer model and a comparable experience in terms of ASOs development.

The remainder of the paper proceeds as follows. First, the theoretical framework is outlined and the methodology is presented. The results and findings are then analysed and discussed. Finally, contributions are summarised, and limitations and possible future lines of enquiry are addressed.

2 The influence of business and growth models on the financing of ASOs

Previous research has differentiated several essential factors related to ASOs (Sansone *et al.*, 2021): personal factors (e.g., Hayter, 2011); organisational factors (e.g., Rizzo and Ramaciotti, 2014); cultural factors (e.g., Feldman and Desrochers, 2004); policy and ecosystem (e.g., Audretsch *et al.*, 2015) factors; governance factors (Meoli *et al.*, 2019); and also financial factors, such as industry (e.g., O'Shea *et al.*, 2005) and public funding (Ramaciotti and Rizzo, 2014). In this sense, some academics continue to highlight that insufficient financial resources can constrain the development of ASOs, whereas access to suitable levels of financial support can constitute both a driver to promote ASOs and an element in the success of their sustainable development (Hossinger *et al.*, 2020).

Likewise, the literature has categorised and analysed alternative external sources of finance for SMEs and entrepreneurs in some depth, which complement limited internal funds. These external sources are characterised by distinct levels of risk/return: “low level”, such as “asset-based finance” (factoring, leasing, etc.) or “alternative debt” (corporate bonds, etc); “medium level” or “hybrid instruments”, such as subordinated loans/bonds, participating loans, etc.; “high level” or “equity instruments”, such as private equity, venture capital, business angels, etc. (OECD, 2015). For ASOs, the financial resources often include capital, loans, subsidies and reserved profits (Mustar *et al.*, 2006). Some authors have highlighted the central role of venture capital to facilitate the emergence of ASOs (e.g., O'Shea *et al.*, 2008), while others have pointed to the importance of obtaining finance through research grants to reduce the risk of R&D projects, through non-repayable financing (e.g., Klette and Moen, 2012). More recently, two internal financial instruments used by universities have received increasing amounts of attention as key determinants of academic technology transfer into markets, namely proof-of-concept programs and university seed funds (Munari *et al.*, 2018).

At the same time, previous literature has also classified ASOs based on the participation (or not) of external partners in terms of social capital (Lockett and Wright, 2005). Thus, according to this

classification, it is usual to distinguish between ASOs backed by external equity and ASOs that are not. What differentiates the two groups is the receipt of financing from large firms or financial intermediaries, such as crowdfunding, BA, or VC.

Based on this classification, some research has shown that firms that manage to obtain their own financing from external partners usually generate a product or technology that they sell through licenses and/or agreements (Stankiewicz, 1994), and therefore, this sort of firms need large amounts of financial resources during their lifecycle (Druilhe and Garnsey, 2004). These ASOs are considered to have both a high potential and a high risk (e.g., Munari *et al.* 2015), because they were designed to exploit their research results commercially to the maximum (Munari, *et al.*, 2011) and perhaps aim to capture a global market. These firms attract interest in financing their equity with external capital because they can generate a significant return for investors and require important inputs, both in terms of management experience and funding (European Commission, 2002). In exchange for the considerable risk of investing in small and immature businesses, external partners often obtain significant control over the firm's decision-making and a greater stake in its ownership (Gubitta *et al.*, 2016). Consequently, some other ASOs avoid using external funding altogether because of their wish to preserve control over the firm. These ASOs that are not backed by external equity usually engage in activities that consist of providing services and consulting (Munari and Toschi 2011), which allows them to generate resources, either in the short term before the planned activity becomes profitable, or with a longer-term time perspective (Heirman and Clarysse, 2004). Normally, ASOs that make the most of the skills of the main researchers by extending their research activities (Stankiewicz, 1994) do not require significant technological development, are not patent-based (Druilhe and Garnsey, 2004), and are consequently much less likely to raise external equity (e.g., Zerbinati *et al.*, 2012). This type of ASOs tends to have a low growth orientation because their main objective is the survival of the firm, through which the founders are able to make a living (European Commission, 2002).

Many of these characteristics are intrinsic to the business and growth model of the company in question. Despite the increasing relevance of these factors and their investigation separately, previous research has not addressed business and growth models in conjunction with the financing of ASOs. This research argues that the heterogeneity of the business model and the means of addressing the dilemma of growth are two fundamental aspects, related to the nature of the ASO, which can contribute to the

understanding of why ASOs select external or non-external equity financing (Heirman and Clarysse, 2004). The relevance of each of these aspects is presented in more detail below.

First, business models have received increasing interest during recent years both in theory and in practice, specifically because they are linked to defending and augmenting competitive advantage (Johnson *et al.*, 2008). Accordingly, great relevance is attached to the business model concept for both practice and academic research (Wirtz *et al.*, 2016). Business models define the way in which a firm transmits value to clients, persuades them to remunerate for value, and turns these financial rewards into net income (Teece, 2010). In the academic literature on ASOs in particular, one growing field of research is concerned with business models (e.g., Clausen and Rasmussen, 2013). Studies in this area are essentially focused on the activities undertaken by ASOs, the influence of the founding entrepreneur, or the characteristics of their markets (Bigdeli *et al.*, 2016). Despite ASOs being endowed with particular configurations of resources and business models (e.g., Hossinger *et al.*, 2020), and although different business models may lead to differences in financial resources (Heirman and Clarysse, 2004), the impact of business models on ASO financing is clearly under-researched.

As indicated above, previous studies have differentiated between distinct types of ASOs according to the main business models under which businesses can operate: consulting (or service-oriented), product-oriented, software-oriented, and technological asset-oriented modes (Druilhe and Garnsey, 2004; Mustar *et al.*, 2006; Stankiewicz, 1994). Previous research has highlighted clear differences between service and product-orientated ASOs (e.g., Pirnay *et al.*, 2003) and has identified technology asset-orientated ASOs as a prevalent form in the emerging phase of a new technology firm (Bower, 2003). Some studies have also classified ASOs depending on the market in which they operate - the product market or market for technologies (Pries and Guild, 2007). Likewise, other authors have differentiated between several types of business activity depending on the proximity to the knowledge and experience of the researcher in the business activity and the required resources: (1) consultancy and research services to clients, (2) resource-development technologies to be protected by intellectual property rights, which can be used to grant licenses or sold to customers, (3) software, to reach licensing agreements and require production with considerably lower costs of scale than those of physical products, (4) products based on research results, and (5) establishment of infrastructure for products based on research activities (Druilhe and Garnsey, 2004). These models are not necessarily mutually exclusive and ASOs can switch from one model to another over time, or pursue various models at the same time

(Stankiewicz, 1994) or in parallel (Clausen and Rasmussen, 2013). Thus, ASOs can evolve by taking part in a distinct type of business activity (Druilhe and Garnsey, 2004), and each mode involves a distinct set of skills, a dissimilar form of management and financing, distinctive connections with the scholarly source of knowledge, and a different means of infrastructural assistance (Stankiewicz, 1994). Nevertheless, ASOs may also benefit from complementary business models and exploit synergies (Niskanen *et al.*, 2017), and also in terms of funding. In short, ASOs are heterogeneous firms with distinct financing needs depending on the business model/s adopted (Mathisen and Rasmussen, 2019).

Second, previous studies have differentiated two broad models to approach growth. The growth model, which includes projects with the aim of capturing a global market, and the lifestyle model, which is characterised by limited ambitions for future growth (European Commission, 2002). Belonging to one model or another depends on the reasonable outcome of a specific technology commercialisation, given the inputs supplied to it. Growth model projects often involve considerable inputs in terms of management and financial knowledge, and are expected to generate remarkable performance, while lifestyle projects are conceived to provide an acceptable standard of living for their founders and their relatives, and can revitalise local economies. It is also common to consider a third model, known as the prospector model, which includes ASOs that are oriented moderately towards growth (Degroof, 2002; Tiler *et al.*, 1993). Likewise, previous literature that compares ASOs with new technology-based firms (NTBFs) in terms of growth has noted inconsistent findings. Whereas some studies have confirmed that ASOs have higher growth (e.g., Yague-Perales and March-Chorda, 2012), others showed lower growth (e.g., Wennberg *et al.*, 2011). These rather mixed findings show that ASOs are highly heterogeneous in terms of the growth model pursued, and the level of growth orientation might have a considerable effect on the source of financing used. In fact, even if it is a topic not explicitly studied, previous literature seems to indicate some theoretical rationale between growth orientation and the type of business financing used. On the one hand, ASOs based on a lifestyle model grow very slowly over time or do not grow at all (Roberts, 1991). Therefore, they usually tend to resort basically to self-financing in order to conserve the ownership and generate income for the founder and its family (Lumpin and Dess, 1996). On the other hand, growth-oriented ASOs seem to be inclined to use external funding, as they usually need to make large investments to boost their growth before they have obtained operating cash flows from their activity. As debt is very difficult to pay back with internally generated sources, external equity is

presented as a suitable financing source to drive growth in this sort of ASOs (Huyghebaert and Van de Gucht, 2007).

In short, this study argues that the type of financing depends on business variables related to the business and growth models. The following proposition thus arises: *Business and growth models explain the type of financing used by ASOs.*

3 Material and methods

In this research the context is limited to Spain. Previous study on ASOs has also been based on specific national contexts, in order to reduce the impact of contextual variables such as legislation or the university system itself (e.g., Meoli *et al.*, 2019; Prokop, 2019; Sansone *et al.*, 2021).

This study employs a qualitative methodology based on an analysis of cases, using a variety of information sources. In order to build a comprehensive framework for the research objectives, this work develops a methodological proposal based on a systematic approach, combining analysis of the literature with a case study on the basis of two fundamental aspects: firstly, to understand the financial structure of the companies and the evolution of the use of different sources of funding, and secondly to allow the classification of the ASOs according to their type of financing, business model, and orientation towards growth. This systematic combination of two approaches, which makes direct use of empirical advances obtained from the case studies and the analysis of theory throughout the research process (Dubois and Gadde, 2002, 2014), broadens the understanding of the reality of these ASOs.

The qualitative methodology attends different characteristics of the research. On the one hand, despite the importance for the development of entrepreneurial activities in academic contexts and their relevance for university knowledge transfer (Galati, *et al.*, 2020), ASOs have received little attention (Fuller and Pickernell, 2018). Gummesson (2017) states that when the object of the research has received only scant attention in the scientific literature, the use of a case study is appropriate. Case studies enable the advance of theoretical knowledge “by utilizing in-depth insights of empirical phenomena and their contexts” (Dubois and Gadde, 2002, p. 555). Similarly, Yin (2014) considers qualitative methods to be the most appropriate for obtaining in-depth information on new phenomena, as in this case.

Further, the complexity of information related to the funding, business model and growth orientation, requires a qualitative analysis. According to Gummesson (2006) “addressing the complex reality of management issues, qualitative methodology supported by modern natural sciences is superior to quantitative methodology emanating from traditional natural sciences” (p.171).

Finally, although in recent years quantitative methodology has been predominantly used for ASO research, earlier studies used mostly a qualitative approach. The increased availability of specialist databases may have been the reason for a shift to quantitative methodologies (Hossinger *et al.*, 2020), but in the specific case of Spain, there are no such databases (Fernández-López *et al.*, 2019). In addition, the population of interest in Spanish universities comprises a small number of companies. Therefore, similarly to other ASOs research (Parmentola and Ferretti, 2018), the objectives of this study have been addressed through the use of a qualitative methodology that has allowed primary data to be obtained from a sample of Spanish ASOs.

In qualitative research, the sample is selected to serve the purpose of the research rather than to be statistically representative of a population (Carter *et al.*, 2007). The in-depth method of empirical analysis was based on a large sample of ASOs connected with a wide range of Spanish universities, and a judgment-based method of sampling was used. The Technology Transfer Offices of 45 Spanish universities were contacted to ask for cases of ASOs considered best practice in each university, according to performance and economic output. This method of sampling, in which the companies are identified by consulting TTOs, has been used in other research on ASOs, in the Spanish and other similar contexts (Diáñez-González *et al.*, 2020; Fernández-López *et al.*, 2019).

From an initial sample of 70 ASOs, responses from 39 cases across 20 different Spanish universities were obtained. The sample allows consideration of a wide heterogeneity of ASOs, in terms of home university, size, and activity, among other characteristics. Table I shows the home university and type of activity of the 39 ASOs sampled.

Table I Home universities and ASO activity

University	Spinoff activity
Autonomous University of Madrid	Development and commercialization of biotechnological products in the field of gastroenterology.
Complutense University of Madrid	Development of assisted reproduction techniques, molecular and genetic, applied to different animal species.
Complutense University of Madrid	Development of biosensors for the detection of biomarkers for disease identification.
Complutense University of Madrid	Development of products with high potential value from the waste produced in different industries.
Jaume I University	Development of geospatial technologies and map design.
Jaume I University	Development of applications to cover the evaluation processes of different skills such as emotional perception, understanding and management.
Polytechnic University of Madrid	Development and commercialization of biometric voice technologies for the security and telecommunication sector.
Polytechnic University of Madrid	Development of programs and applications to cover management, classification, and word processing needs (automatic translation, web content search ...).
Polytechnic University of Valencia	Food, processes and equipment design for the agri-food sector.
Polytechnic University of Valencia	Development of virtualization technologies for embedded and critical real-time systems.
Polytechnic University of Valencia	Training and consulting services in the management of the safety of hydraulic dams.
Public University of Navarra	Development of laboratory technology equipment for technical support to researchers in various areas (nanotechnology, chemistry, biotechnology, physics ...).
Public University of Navarra	Traffic analysis services, IT systems and network monitoring technology.

University of A Coruña	Cardiovascular genetic services for the prognosis and detection of diseases.
University of Barcelona	Development of Mind Tracking solutions that determine cognitive processing profiles for clinical and commercial uses.
University of Burgos	Development of sustainable integration systems for agriculture, livestock, water ...and native algae production systems.
University of Cadiz	Technical assistance services for the design of thermal equipment and processes, energy audits and energy software development.
University of Castilla-La Mancha	Sanitary and biotechnological services for wildlife and extensive livestock.
University of Castilla-La Mancha	Consulting service specialized in information and data quality.
University of Cordoba	Research and provision of services in the field of animal production and genetics.
University of Granada	Consulting service on evaluation and scientific communication, management of academic accreditation processes.
University of Granada	Development of educational software for mobile devices.
University of Granada	Research in the synthesis of polymeric and hybrid nanostructured materials.
University of Granada	Development of applications to increase the value of products through nanomaterials.
University of Granada	Development of embedded devices for various industrial sectors (automotive, avionics, aerospace or scientific). Development of intelligent video surveillance systems.
University of Huelva	Development of new supplements for animal feed based on microalgae.
University of Leon	Development of technology and drugs in the molecular health sector specially against strokes.
University of Leon	Research and development of biological services and products in the veterinary sector.
University of Malaga	Product development engineering and strategic innovation consulting (e.g. water use).
University of Malaga	Development of preventive surveillance tools in order to improve safety management and avoid emergency situations.
University of Malaga	Development of biomedical techniques for skin regeneration.
University of Murcia	Research and development of products and services in the field of chronobiology (circadian counselling, sleep analysis...).
University of Murcia	Business consulting and development of operations optimization software.
University of Murcia	Research in adaptive optics. Development of visual evaluation products and optical solutions.
University of Oviedo	Development of drugs from biosynthesis, genetic engineering and biocatalysis.
University of Valencia	Genetic analysis services addressed to the diagnostic and prevention of diseases.
University of Zaragoza	Development of marketable products from BI technology (brain-computer interfaces).
University of Zaragoza	Exploitation of the research results of complex networks and data analytics.
University of Zaragoza	Design and manufacture of specific hardware for the implementation of wireless sensory networks in the monitoring of environmental parameters.
University of Zaragoza	Development and commercialization of products within the field of nanoscience.

Primary data were obtained through personal interviews with members of the founders of the ASOs concerned. A semi-structured interview was designed for data collection, with both open and closed questions grouped into three blocks. In the first block of questions, contact data were collected, together with general information about the ASO (e.g., university, years of company life, % of the university's share in the company's capital). The second block comprised open-ended questions on the origin of the company and the evolution of its activity (e.g., recognition and description of the development phases of the ASO). In the third block information was collected on the sources of financing, combining closed questions on the types of financing with open questions on the impact of each source on business development.

These interviews were conducted via a web form and by telephone between July 2018 and April 2019. Each semi-structured interview lasted about 90 minutes and was conducted by the research group. Following an event-driven process, in which the interviewee was asked to reconstruct the history of the ASO and to describe the main events that took place, to identify critical decisions on funding sources, business models, and growth orientation were sought.

Given the importance of integrating multiple sources to achieve more convincing and accurate results and conclusions in this type of qualitative approach (Yin, 2014), secondary data on ASOs was also collected to support and complete the information extracted from the case studies. The primary data were combined with information extracted from secondary sources, specifically from the Sistema de Análisis de Balances Ibéricos (SABI²) database and the 39 ASO websites (Table II), in order to enrich the information and provide results to link aspects of the ASO companies that had not previously been studied together. This combination of different sources is recommended for a more complete view of a complex reality (Järvensivu and Törnroos, 2010). Moreover, working with distinct sources is an essential requirement in the use of qualitative methodology (Gummesson, 2017; Yin, 2014). In this sense, access to the SABI database allowed us to obtain the following information for the sample: tax identification number, activity code, age, number of employees, total assets, equity, long-term liabilities, short-term liabilities, and sales. Access to the websites helped us to contrast the information derived from the discursive analysis, especially with regard to the milestones detected in the financial evolution of the ASOs.

Having compiled all the information, its classification was carried out using codes, with the aim of analyse the collected data and thus draw conclusions with regard to the propositions set out in the previous sections (Heinonen and Medberg, 2018). Atlas.ti v. 9.0.7 was used for the data analysis, and this allowed the categorisation of the ASOs according to the different types of financing, business, and growth models, as well as the establishment of relationships between these aspects. This software also made it possible to identify critical junctures in the history of the ASOs from the text of the open-ended responses.

² <https://www.bvdinfo.com>

Table II Overview of data sources and codes

Spinoff ³	Primary Data Sources	Code	Secondary Data Sources	Code
1	Personal Interview / Exchange of information with CEO	IN-P-1	Website (January 2019)	WS-1
2	Telephone Interview/ Exchange of information with CEO	IN-T-1	Website (December 2018)	WS-2
3	Telephone Interview/ Exchange of information with CEO	IN-T-2	Website (March 2019)	WS-3
4	Telephone Interview/ Exchange of information with Project Manager	IN-T-3	Website (March 2019)	WS-4
5	Telephone Interview/ Exchange of information with CEO	IN-T-4	Website (January 2019)	WS-5
6	Telephone Interview/ Exchange of information with CEO	IN-T-5	Website (January 2019)	WS-6
7	Telephone Interview/ Exchange of information with CEO	IN-T-6	Website (March 2019)	WS-7
8	Telephone Interview/ Exchange of information with CEO	IN-T-7	Website (March 2019)	WS-8
9	Telephone Interview/ Exchange of information with CFO	IN-T-8	Website (December 2018)	WS-9
10	Telephone Interview/ Exchange of information with CEO	IN-T-9	Website (April 2019)	WS-10
11	Telephone Interview/ Exchange of information with CEO	IN-T-10	Website (December 2018)	WS-11
12	Telephone Interview/ Exchange of information with CEO	IN-T-11	Website (March 2019)	WS-12
13	Telephone Interview/ Exchange of information with CEO	IN-T-12	Website (March 2019)	WS-13
14	Telephone Interview/ Exchange of information with CEO	IN-T-13	Website (February 2019)	WS-14
15	Telephone Interview/ Exchange of information with CEO	IN-T-14	Website (February 2019)	WS-15
16	Telephone Interview/ Exchange of information with CEO	IN-T-15	Website (January 2019)	WS-16
17	Web Form Interview / Exchange of information with CTO	IN-W-1	Website (February 2019)	WS-17
18	Web Form Interview / Exchange of information with CEO	IN-W-2	Website (February 2019)	WS-18
19	Web Form Interview / Exchange of information with CEO	IN-W-3	Website (December 2018)	WS-19
20	Web Form Interview / Exchange of information with CTO	IN-W-4	Website (January 2019)	WS-20
21	Web Form Interview / Exchange of information with COO	IN-W-5	Website (February 2019)	WS-21
22	Web Form Interview / Exchange of information with CEO	IN-W-6	Website (January 2019)	WS-22
23	Web Form Interview / Exchange of information with CEO	IN-W-7	Website (April 2019)	WS-23
24	Web Form Interview / Exchange of information with CEO	IN-W-8	Website (February 2019)	WS-24
25	Web Form Interview / Exchange of information with CTO	IN-W-9	Website (January 2019)	WS-25
26	Web Form Interview / Exchange of information with CEO	IN-W-10	Website (January 2019)	WS-26
27	Web Form Interview / Exchange of information with I+D+i Project Manager	IN-W-11	Website (March 2019)	WS-27
28	Web Form Interview / Exchange of information with Strategic Assistant to the CEO	IN-W-12	Website (January 2019)	WS-28
29	Web Form Interview / Exchange of information with R&D Manager	IN-W-13	Website (January 2019)	WS-29
30	Web Form Interview / Exchange of information with Financial Department	IN-W-14	Website (January 2019)	WS-30
31	Web Form Interview / Exchange of information with CEO	IN-W-15	Website (March 2019)	WS-31
32	Web Form Interview / Exchange of information with administrator	IN-W-16	Website (March 2019)	WS-32
33	Web Form Interview / Exchange of information with partner Web Form Interview / Exchange of information with administrative	IN-W-17	Website (February 2019)	WS-33
34	Web Form Interview / Exchange of information with Sales & Business Development Manager	IN-W-18	Website (March 2019)	WS-34
35	Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with researcher	IN-W-19	Website (March 2019)	WS-35
36	Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with researcher	IN-W-20	Website (February 2019)	WS-36
37	Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with researcher	IN-W-21	Website (February 2019)	WS-37
38	Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with researcher	IN-W-22	Website (December 2018)	WS-38
39	Web Form Interview / Exchange of information with CEO Web Form Interview / Exchange of information with CFO	IN-W-23	Website (January 2019)	WS-39
Databases 1-39			SABI Database	DB-1

4 Findings

The findings of this study confirm the heterogeneity of the ASOs in terms of their financial structure, providing evidence that ASOs make financial decisions conditioned by two key aspects: business model (product-oriented, software-oriented, technology development, and service-oriented) and growth orientation (growth, prospector, or lifestyle). The relevance of these factors is presented below, referring to the classification of Lockett and Wright (2005) in differentiating between ASOs backed by external equity (VC and BA) and those without financing from external partners. Those main results are

³ The numbering of spinoffs has been carried out randomly, not coinciding with the order established in the Table 1, that includes information about the activity and the home university of the spinoffs participating in the study.

presented in sub-headings 4.1 and 4.2. Complimentary, in sub-heading 4.3, the results identify critical junctures that shed lights on the changes in the type of financing in each category of ASOs.

4.1 ASOs using external equity

Based on the business model, the ASOs that use equity are essentially product-oriented and software firms. Normally, the type of activity that defines the business model determines the reasons that explain firms' decisions to incorporate external equity. Thus it is possible to identify ASOs dedicated to the development of products in health or biotechnology sectors (IN-T-11, IN-W-7, IN-W-11, IN-W-12, IN-T-10, IN-T-11, IN-W-22, IN-W-23, IN-T-3, IN-W-3, IN-T-7), and those based on software development (IN-T-1, IN-W-4). The findings of this study also show that growth is an important feature of the company's business vision. In the case of companies with a growth model, the presence of this aspect is key to the business strategy. Prospector companies also see growth as an important factor, and although this is not the priority of this type of company, it nevertheless conditions their decision-making. The incorporation of external equity is one aspect that makes this growth possible. Table III shows the business and growth models of ASOs using external equity. It is important to note that these ASOs may also have other financial sources, although equity financing is considered to be the main funding.

Table III ASOs using equity financing from external partners

ASO	Type of financing (Equity from external partners)	Business Model classification (Druilhe and Garnsey 2004)	Evidence of a reached critical juncture	Growth orientation (European commission 2002; Degroof 2002)
IN-T-1	VC	Software	Successfully tested	Growth
IN-T-3	VC	Product	Patented	Growth
IN-T-7	VC	Software	Successfully tested	Growth
IN-W-23	VC	Product	Patented	Growth
IN-W-4	BA	Software	Successfully tested	Prospector
IN-W-7	BA	Product	Patented	Prospector
IN-W-11	BA	Product	n/a	Growth
IN-W-12	BA	Product	n/a	Prospector
IN-W-14	BA	Product	Patented	Growth
IN-T-10	BA	Product	Patented	Growth
IN-T-11	BA	Product	Patented	Growth
IN-W-22	BA	Product	Patented	Prospector
IN-W-3	Crowdfunding	Software	Successfully tested	Growth

References in this table to patented product and successfully tested software correspond to the evidence on the critical junctures presented in sub-heading 4.3. n/a: not available.

The following are the characteristic elements of the business and growth models that explain to a greater extent the incorporation of external equity, differentiating between those companies that develop products and software.

Firstly, for ASOs with a product development business model, mostly in the health and biotechnology sectors, the introduction of equity is required due to a clear need for funds, long product development processes, and high levels of associated uncertainty. This sort of ASOs demands a large investment to cover product development over long periods in high-risk conditions. In these cases, the evolution of their financing is marked by the research development and results generated, which determine the commercialisation of the product. Thus, the funding provided by external partners is generally associated with product development and growth in the market: *"In this phase of commercialisation and growth, through the development of new products, to reach more clients, we needed more funds since we had to deal with the acquisition of machinery and the hiring of qualified personnel."* (IN-T-11).

Secondly, ASOs with a software development business model usually require rapid growth in a short period of time, and therefore need to incorporate external equity. The exploitation of the product is normally carried out in a global market and the periods of amortisation are short. Therefore, their high growth orientation plays an important role.

Furthermore, the growth of an ASO depends on the degree of adjustment between the adopted business model and the financial resources received. Given that significant amounts of financial resources are needed for the creation of products, it is not surprising that these sorts of ASOs often require the support of VC. In this vein, the ASOs financed with VC in this study confirm their clear ambition to grow, and quickly (IN-T-1). In this regard, VC also facilitates establishment in new locations (IN-T-1). The choice to incorporate VC is related to the different advantages associated with this type of equity financing, such as access to more funding, a greater involvement of partners when sharing common objectives, the achievement of greater and better national and international contacts, and/or the involvement of more experienced professionals.

"With the venture capital we get much more funding. We think that it is the best thing for the technological firms since not only the investment is achieved, but also the involvement of the partners. Not only are you adding money, but you also incorporate indirectly professionals in the company that help you achieve your goal" (IN-T-1).

Likewise, the choice of VC is also associated with the disadvantages of other alternative sources of financing (*IN-T-1*), such as excessive bureaucracy and/or complexity in the application (e.g., European projects), high financing costs (e.g., bank financing interests), or mandatory reimbursement (e.g., national R&D funds). Even so, just a small number of ASOs choose this type of financing. The main reasons for this are the conditions attached to VC and the desire of the academic founders to maintain corporate control.

"Until now we have not liked the idea of venture capital because the conditions are more complex, we have to agree on exit clauses and many of them have unfavourable conditions for the founding partners due to their lower capital contributions." (*IN-T-10*).

Due to the difficulties associated with the incorporation of VC and their limited presence in the Spanish academic entrepreneurial ecosystem, a greater number of ASOs with high financial needs obtain external equity from BAs. The interviewed ASOs financed by BAs, both those with a product and a software business model, have a high growth orientation. All are classified as prospector ASOs or growth ASOs, but to a lesser extent than those financed by VC (Table III). Some are already in a state of growth and others are in the process of achieving it, which can take a few years. Therefore, this type of ASOs needs the support of patient investors, such as BAs, who can wait years to recover the investment and obtain benefits (*IN-T-11*).

"This type of investor is a middle way between self-financing by founding partners (few resources) and large funds (very slow process and little flexibility). BA is ideal for supporting a small business to grow at the beginning of its life." (*IN-W-4*).

Furthermore, some ASOs involve BAs gradually, in several rounds as the company grows, connected with increases in capital.

"In relation to private financing we have always had business angels and we have incorporated them little by little: the first contribution as seed capital, the second for the qualitative leap from ASO to startup (a more structured company) and the third for strategic growth with a view to international expansion." (*IN-W-12*).

4.2 ASOs not using equity financing from external partners

ASOs that do not use equity financing from external partners base their financial models on access to public research funds (R&D) (*IN-W-2, IN-W-16, IN-W-20, IN-P-1, IN-T-6, IN-W-18, IN-T-13*) or on their own traditional funding, with or without debt (*IN-W-13, IN-W-8, IN-W-6, IN-T-4, IN-W-15,*

IN-T-2, IN-W-10, IN-T-15, IN-W-5, IN-W-1, IN-T-5, IN-T-9, IN-T-12, IN-W-21, IN-W-9, IN-T-14, IN-W-17, IN-T-8, IN-W-19). In some cases, the firms used R&D and traditional funding at the same time, then R&D is the main source of financing, and the incorporation of own funds, subsidies or bank debt are used to support the long periods of time until they receive the funding from the R&D call.

Companies that do not base their financing on external equity can also explain their financing choices by looking at their business and growth models. The results show that ASOs that do not have equity financing from external partners are characterised by technology development or serviced-oriented business models and lower levels of growth orientation (mainly prospector or lifestyle ASOs), even if some ASOs based on technology development integrate a vision of growth in their strategy. Similarly, the choice between R&D funding or their own traditional sources is also related to these factors.

4.2.1. ASOs using R&D funding

Table IV shows the business model and the growth orientation of the ASOs not using equity financing from external partners but using R&D funds.

Table IV ASOs not using equity financing from external partners but from R&D funds

ASO	Type of financing (No equity from external partners)	Business Model classification (Druihe and Garnsey 2004)	Growth orientation (European commission 2002; Degroof 2002)
IN-W-2	R&D*	Technology development	Growth
IN-W-16	R&D	Consultancy and product	Prospector
IN-W-20	R&D	Technology development	Lifestyle
IN-P-1	R&D	Technology development	Growth
IN-T-6	R&D	Technology development	Growth
IN-W-18	R&D	Technology development	Prospector
IN-T-13	R&D	Technology development	Lifestyle

*All ASOs with this type of financing have achieved the critical juncture defined in the sub-heading 4.3, regarding the success of a competitive project in an R&D fund call.

ASOs that, in addition to their own traditional funding, make use of finance obtained from public research projects have a technology-oriented business model (technology development) with a high growth orientation.

These tend to be engineering ASOs focused on the development of technological solutions for a specific sector, which implies the manufacture of highly complex and cutting-edge technology, for which this sort of ASOs requires a large initial investment. Their growth orientation is high, although this type of ASOs does not necessarily have the objective of achieving mass-market penetration (they rely on the quality of their clients rather than the number of them). These ASOs generally have international exposure, and

usually operate in sectors in which the prestige generated by access to public funds helps them to position themselves and generate the trust of clients (international organisations, international security...).

"In these markets it is always important to have R&D projects and funds because they give credibility in the eyes of clients and investors." (IN-T-6).

Nevertheless, despite their international presence, these ASOs do not usually allocate much funding to marketing or commercial actions (IN-W-20); instead, one client leads to another.

"In the case of our company, the most relevant agents are the clients, since they are the ones who, through recommendations, transfer us to other clients. We hardly need marketing; we work through contacts." (IN-P-1).

Access to public funding is common practice for ASOs, due to the tendency to request such funds when managing university research projects. In general, firms that access public funds through R&D projects show some aversion to loss of control (IN-P-1, IN-T-6). For this reason, these ASOs might renounce alternative sources of equity financing, such as BA or VC. Furthermore, having public funding they have no need for the incorporation of external agents who often attach conditions to business decisions (IN-W-20).

This type of financing implies different consequences. On the one hand, it enhances business development, as the amounts of financing are usually large, much of which is non-recoverable.

"If the project is good and funding is achieved, it is the best financing instrument because you receive large amounts of funds (hundreds of thousands of euros) without having to make any of your own capital contribution." (IN-P-1).

On the other hand, there is a consequent lack of knowledge and an increased distance with respect to the private financial sector, derived from the tradition of developing projects in public environments. Likewise, the process of managing public financing slows down growth, because the application and grant-awarding processes are often prolonged over time, in addition to the period required for receiving the funds in the first place.

"It is true that maintaining financing based on R&D projects and public grants is complicated, due to the fact that it takes a long time to develop projects that may not be chosen and for which, in this case, no financing is received. It is a risk spending so much human capital effort." (IN-P-1).

In addition, usually these ASOs also use bank financing to obtain financial resources until the R&D funds become available. This provides the necessary liquidity to the ASOs to face the daily working capital needs and cover the delayed payments of clients over time (*IN-P-1*).

4.2.2. ASOs using only traditional financing

Finally, it is also possible to discern a group of ASOs whose financial structure consists essentially of traditional equity financing: equity provided by founding members, self-financing, and subsidies. Only in some cases, and the very marginally, do these ASOs complement traditional equity with bank debt. Table V shows the business model and the growth orientation of the ASOs only using their own funds, subsidies, and bank financing.

Table V ASOs not using equity financing from external partners, but only using traditional financing (own funds, subsidies, bank)

ASO	Type of financing (No equity from external partners)	Business Model classification (Druihe and Garnsey 2004)	Growth orientation (European commission 2002; Degroof 2002)
IN-W-6	Own funds	Services	Lifestyle
IN-T-4	Own funds, subsidies	Services	Lifestyle
IN-W-15	Own funds	Product	Prospector
IN-T-2	Own funds	Services	Prospector
IN-W-10	Own funds	Services	Prospector
IN-T-15	Own funds	Services	Prospector
IN-W-5	Own funds	Services	Lifestyle
IN-W-1	Own funds, subsidies	Services	Prospector
IN-T-5	Own funds	Services	Prospector
IN-T-9	Own funds	Services	Prospector
IN-T-12	Own funds, subsidies	Services	Lifestyle
IN-W-21	Own funds	Services	Prospector
IN-W-9	Own funds, subsidies	Services	Prospector
IN-T-14	Own funds	Services	Lifestyle
IN-W-17	Own funds, subsidies	Services	Lifestyle
IN-W-13	Own funds, subsidies, bank	Services	Prospector
IN-W-8	Own funds, subsidies, bank	Services	Prospector
IN-T-8	Own funds, subsidies	Product	Lifestyle
INT-W-19	Own funds	Services	Lifestyle

All the ASOs presented in this table has had a previous development phase financed by the university's research unit, but have reached the critical juncture defined in sub-heading 4.3 and are now using own funds and other traditional financing.

These ASOs usually focus on a business model based on consultancy and research services or products grounded on research results and focused on a small niche market. In these cases, the ASO

activity is a means of obtaining extraordinary personal remuneration rather than a way of generating profits to capitalise the firm.

In terms of growth orientation, these ASOs have very limited ambition (prospector or lifestyle models), and generally focus on regional or national markets (*IN-T-14, IN-W-5*). Many of these ASOs maintain their research groups and have no wish to stop being "scientists", opting instead for controlled growth from the research group.

"We are fine as we are right now and we do not wish to grow much more in the short term because we want to be able to develop all the work the people that currently work at the firm. We are reluctant to include external people because that would imply more problems. We do not need so much growth, this is not our goal. Our current situation is idyllic." (*IN-T-14*).

This orientation towards low growth, a clear aversion to loss of control, and a lack of incentive to finance the development phase from the very beginning as these ASOs maintain their own research group, all allow these ASOs to cover their expenses to a large extent, using the financial resources of the researchers themselves and/or the funds from self-financing generated by sales (*IN-T-2, IN-W-17, IN-T-14*).

"The main criterion is that there is no need to access another financing source, in addition to retaining control of the firm." (*IN-W-6*). *"We do not contemplate external investors because we do not want to put the business in other hands, we do not want to lose control."* (*IN-T-12*).

4.3. Critical junctures in ASO funding

In addition to the results described above, that respond to the research purpose, the discursive analysis of the open-ended questions and the secondary data obtained from the ASOs websites have allowed us to identify some milestones or critical junctures in the financial evolution of firms with similar business and growth models. These complementary results are presented in more detail below.

Firstly, ASOs with a business model based on a product incorporate external financing throughout the life of the firm. To cope with the long periods of R&D phases, each time a new product is developed, ASOs with this type of business model normally access public financing through both national and international R&D funds. *"R&D funds have been very important to us throughout the process, as we are constantly developing R&D in parallel to the commercialization of the products we generate"* (*IN-T-11*). Even so, these ASOs normally access equity when there is a research result that is patented and then commercialised. Thus, equity financing can appear each and every time the firm has a new patent that

allows the production and sale of the product on the global market. *“In 2018 we patented our product and also added the participation of external investment partners.” (IN-T-11).*

This shows that companies with a product-based business model focus their financing on R&D throughout the development phase, and once the product has been patented and the commercialisation phase has begun, these ASOs integrate external equity financing, normally in the form of VC. In such cases, the patent and the subsequent start of the commercialisation is considered a critical juncture for the financing of this group of ASOs (IN-T-3, IN-W-23, IN-W-7, IN-W-14, IN-T-10, IN-T-11, IN-W-22).

Secondly, in respect of ASOs with a software business model, there is an initial phase based on traditional funds, which facilitates the hiring of personnel and causes an acceleration of commercialisation. Equity is incorporated when these ASOs reach the scaling-up milestone, which usually occurs after the development and successful testing of the software. In this respect, the evolution of the financing structure is determined by market penetration. *“The initial phase, research and business constitution, is financed with the company's own contributions and with subsidies from the Xunta de Galicia to develop specific aspects (e.g., software development, research in a specific technology...). After testing the software and signing contracts with important companies, two large venture capital funds came in and provided millions of euros” (IN-T-7).*

Given the high costs of the software development phase, these ASOs can even integrate external equity from the very beginning to finance *different lines of research of the projects, i.e., R&D (IN-T-3)*. This can be in the form of VC, *“our source of financing has always been the venture capital” (IN-T-1)* or BA, when the required amount of capital is too high for family and friends, but at the same time is too low for VC funds and too risky for banks (IN-W-4). In these companies, successful software testing leading to its commercialisation entails a greater commitment and incorporation of these external equity funds. Therefore, in this group of ASOs the critical juncture that determines the change of funding is the successful testing of the software leading to commercialisation (IN-T-1, IN-T-7, IN-W-4, IN-W-3).

Thirdly, in ASOs with a technological development, external funds provide the capacity for the evolution and improvement of the technology and the patenting of the results. Hence, their activity is conditioned by access to financing, and when it arrives, *“the machinery starts”*. These external funds are usually obtained through public calls, which companies can access through competitive projects. Therefore, the success of the competitive project in an R&D fund call is the critical juncture that

determines the financing of this type of ASOs (IN-W-2, IN-W-16, IN-W-20, IN-P-1, IN-T-6, IN-W-18, IN-T-13). *“The degree of development of the competitive project is the milestone that leads to the change of funding source”* (IN-P-1).

During the project preparation, the ASO is usually financed by the research group or by its own funds, and once the project is successful in the call for proposals, these ASOs integrate R&D funds, enabling the development and commercialisation of the technology.

“The ASO arose from a very good research group that had been doing research for 10 years... As we were doing well, we saw the opportunity to create a company. As the technology matured, we had access to public calls for proposals and the growth was financed by European projects”. (IN-T-6).

The access to external finance occurs at the beginning of the company's life and facilitates the generation of results that are the basis of subsequent commercial exploitation. Even so, because ASOs with a technology development business model usually develop several R&D projects throughout their life cycle, the application for R&D funds often continues and constitutes the main type of financing throughout the progress and growth of the company (IN-T-6, IN-P-1, IN-W-2, IN-W-20).

Lastly, ASOs that develop products or services within the research group tend not to need finance from the very beginning. Most traditional ASOs are born when the research group has already generated intellectual property/goodwill or has developed a service, and the ASO simply commercialises the research results (e.g., IN-T-4). Sometimes, even once established, the research group tends to continue to carry out R&D activity; in this case the ASO is a commercial unit (IN-W-8, IN-T-14, IN-W-17 or IN-W-21). When services are developed, those focus on the exploitation of know-how that does not require a production process. In this sense, the critical juncture that determines the change of financing is the development of an intangible asset by the research group at the university. The development phase is financed by the research unit, and once these ASOs obtain results that can be commercialised, they constitute the company based on its own financing (IN-W-21, IN-W-1, IN-T-12, IN-W-6, IN-T-8, IN-T-14), subsidies (IN-T-9, IN-T-8), and income derived from sales (IN-W-6, IN-T-8, IN-T-14). The business model of this kind of ASOs has usually a low-cost structure (e.g., IN-W-5), so these ASOs do not need to incorporate external capital or apply for complex public grants. *“The initial source was the own financing of the nine partners (...) The initial investment required is not so large because we had been doing research for many years before creating the company, so we did not have a large research phase, we were able to start commercializing and obtaining income almost directly”* (IN-T-5).

5 Discussion

This study examined the influence of business model and growth orientation on the financing of ASOs, a topic overlooked in previous analyses of the determinants of ASOs (Sansone *et al.*, 2021), entrepreneurship funding (OECD, 2015), or even in the heterogeneity of university spin-offs (Hossinger *et al.*, 2020). The results provide a clearer understanding that ASOs are heterogeneous firms with distinct financing needs, which should be addressed properly to foster the creation, development, and commercialisation of university technologies (Munari *et al.*, 2018). This research explored this using a qualitative methodology based mainly on primary data obtained from personal interviews corresponding to 39 ASOs arising from 20 Spanish universities. This work found firstly that ASOs are heterogeneous in terms of their financial structure, as well as with respect to the diversity of the financial resources used. Secondly, product- and software-oriented firms, which are highly or moderately oriented towards growth, are external equity-backed (VC- or BA-backed); Technology development firms, which are mainly highly or moderately oriented towards growth, are funded by public grants based on R&D projects; Service-oriented firms, which follow a prospector or a lifestyle orientation, are normally financed by their own funds, subsidies, and/or debt. Thirdly, ASOs included in each category make similar decisions with regard to their financing before and after certain common critical junctures. Product-oriented ASOs are financed by R&D funds until the research result is patented; after this juncture, these ASOs are backed by external equity. Software-oriented firms receive funds from families and subsidies before development and software testing; after this juncture, and provided the test is successful and the project involves a scaling-up phase, these ASOs incorporate external equity financing. Technology development ASOs move from their own traditional funds to R&D funding when they manage to develop a successful competitive project. Finally, before service-oriented ASOs generate intellectual property/goodwill or develop a service, their expenses are covered by the financing of the research group; after this juncture these ASOs are normally financed by their own funds, subsidies, or even bank debt.

The results of this research provide a missing link in the existing literature. First, previous research has confirmed that among the factors that affect ASOs, financing is a crucial determinant (e.g., O'Shea *et al.*, 2005). This study suggests that not all types of funding are appropriate for all ASOs, but that differences in the business and growth models of ASOs mean that there are differences between them in terms of the most appropriate funding to support their formation, further development, and survival. This research confirms that different business models are related to a diverse use and integration of

financial resources, as anticipated by previous research (Heirman and Clarysse, 2004), and that there is a manifest high heterogeneity in terms of growth models that affect the ASOs' choice of funding sources, which helps to understand the previous mixed results regarding the link between ASOs and growth (e.g., Yague-Perales and March-Chorda, 2012; Wennberg *et al.*, 2011).

Secondly, some studies have analysed the new approaches to SME and entrepreneurship financing, highlighting that some particular types of funding such as equity finance or alternative debt instruments are especially relevant for new and innovative ventures (e.g., OECD, 2015). Likewise, other research has confirmed that there are genetic differences between academic and non-academic spin-offs that justify the clear distinctions between the financing adopted by each (Roininen and Ylinenpää, 2009; Colombo and Piva, 2012). The present research confirms that ASOs, in terms of financing, are not only distinct from other entrepreneurial ventures, but different from each other. Consequently, not all ASOs behave in the same way in terms of funding. In this vein, prior literature affirms that ASOs only have two alternatives sources of financing, namely R&D public funds and equity investments, since the lack of collateral makes it impossible to access debt financing (Bock *et al.*, 2018; Grilli and Murtinu, 2015). However, this research refines the former affirmation, proposing that rather than referring to ASOs in general terms, it might be more appropriate to distinguish between different groups. In this sense, the results of this study show that some ASOs with technology development and services business models complement their funding with bank debt. This study also answers the call of Hogan *et al.* (2017) to provide evidence on the reasons why external equity financing is more commonly used than debt in high-tech ventures, specifically in high-tech ASOs, using business and growth models to better understand this choice. Likewise, these results complement previous work in other contexts, which suggests that companies engaged in biotech activity need primary funding from research grants to make R&D possible (Bialek-Jaworska and Gabryelczyk, 2016). This study shows that biotech ASOs rely on R&D funding before patenting their research results, but once these ASOs reach the former juncture, they prefer to turn to external equity.

Thirdly, this work adds to existing research on the critical junctures that ASOs must overcome in order to grow (Vohora *et al.* 2004; van Geenhuizen and Soetanto, 2009). In particular, this study extends previous research in which particular critical junctures are identified to explain the changes in the type of financing selected in each category of ASO, considering business model and growth orientation. In this sense, these results are in line with previous studies that show how patenting has a positive effect

on the growth of university ASOs and how this favourable influence is a sign of the need for funding from venture capitalists and business angels (Rodríguez-Gulías *et al.*, 2016). The findings of this research are also in line with other results confirming that telecom, medical, and patenting high-tech firms are more likely to receive VC financing (Hellmann and Puri, 2000). R&D funds are also usually considered an essential financial source for ASOs (Huynh, 2016). The results of this work complement those described by others (e.g., Fernández-López *et al.*, 2019; Ramaciotti and Rizzo; 2015), which confirm that the generation of ASOs is dependent on public research funding, especially for the specific case of technology development ASOs. The results of this study also agree with previous findings that distinguish between technology and non-technology based ASOs (Meoli and Vismara, 2016), because the latter are set to carry contract research and consultancy, having very low capital requirements once they develop intellectual property/goodwill or a service (Meoli *et al.*, 2019). Therefore, the findings of this research contribute to the general idea that ASOs are highly heterogeneous not only in terms of financing but also regarding the critical junctures that presage their move from one type of financing to another.

Fourthly, the study of ASOs is a relatively recent issue in the Spanish context in comparison with other countries such as USA or UK (Rodríguez-Gulías *et al.* 2016). In fact, despite the number of this type of firms has augmented substantially so that 113 new ASOs were created annually in the period 2007-2016 (Red OTRI de Universidades, 2017), Spain is still behind other European countries in terms of creation of new technology-based firms (OECD 2014). Spanish universities play an essential role in the creation, development and survival of ASOs (Rodríguez-Gulías *et al.* 2016). Particularly, the Spanish university system is made up of 83 universities and the creation of ASOs is concentrated only in 60% of them (Red OTRI de Universidades, 2017). Likewise, not many studies are focused on Southern Europe due to the relative novelty of this sort of firm (Yagüe-Perales and March-Chordà 2012). Therefore, the results of this study must be considered in light of the influence of the regional context. The findings of this work qualify those of previous studies in the same context in emphasising the low-growth capacity of these firms (e.g., Teixeira and Grande, 2013), given that product-, software oriented and technology development ASOs tend to be growth-oriented. The findings of this research enable some light to be shed on the role of VC in increasing the growth of Spanish ASOs (Rodríguez-Gulías *et al.* 2018), in support of the link between the use of VC and growth orientation in product- and software-oriented firms. Nevertheless, the analysed data also confirm that only a relatively small number of ASOs integrate VC (Heirman and Clarysse, 2004; Wright *et al.*, 2007). The conditions generally attached to VC funds,

together with the desire of the founders to maintain corporate control, tend to deter most ASOs from using VC as an alternative source of equity finance (Shane, 2004). In general, there is still a lack of close collaboration between universities and entrepreneurial ventures in Southern European countries, and Spain is no exception to this (Fernández-López *et al.*, 2015). Even so, the Spanish context is characterised by the relevance of the public research system and the role of universities, as the industrial system of research is inclined to be less important than in other developed countries (Rodríguez-Gulías *et al.*, 2016). Furthermore, universities are key to the establishment and growth of firms in providing incubation and other complementary services (Red OTRI de Universidades, 2015). As the main characteristics of the Spanish context in terms of R&D investment and legislation and entrepreneurship policies are similar in other international contexts (e.g., other Mediterranean and Latin American countries) these regions could also benefit from the conclusions reached in this study.

6 Conclusions

The present study makes several significant theoretical contributions. Firstly, it sheds some light on the research into the heterogeneity of ASOs (Hossinger *et al.*, 2020); specifically, this research takes advantage of the business model and growth orientation to better evaluate and understand the different sources of finance used by different types of ASO. Secondly, this study attends to the requirements of recent literature on entrepreneurial finance, which highlights the attraction of studying not only the differences between ASOs and other entrepreneurial ventures (OECD, 2015), but also the differences between distinct types of ASO. Thirdly, this study also contributes to a growing field in the ASO literature concerned with the determinants of ASOs (Sansone *et al.*, 2021) and particularly with the business models (Clausen and Rasmussen, 2013). In this sense, decades ago, some researchers anticipated that different business models could be characterised by distinct sources of financing (Stankiewicz, 1994). Nevertheless, to our best knowledge no additional research has yet been undertaken to investigate this topic any further. Therefore, this study is the first attempt to examine whether the business/growth models have an essential role in the selection of financing. Fourthly, because some of the previous literature has used the Spanish university system to investigate ASOs, this work has developed findings extensible to countries with similar levels of experience (e.g., Rodríguez-Gulías *et al.*, 2018; Diáñez-González *et al.*, 2020). In this way, in addressing the Spanish case, this research also responds to calls to

take into account the effect of regional context on a firm's resources and their relationship with ASO growth (Rodríguez-Gulías *et al.*, 2016).

The findings of this study have direct practical implications for ASOs and stakeholders involved in academic entrepreneurship. Firstly, this study provides key information for the financial planning of ASOs based on the experiences of a great range of them. The case analysis has allowed to consider a wide heterogeneity of ASOs, which facilitates the extrapolation of the results obtained to other contexts. At the same time, given the selection process of the sample, based on the decisions of managers of entrepreneurship units and TTOs, who catalogued the ASOs as success stories of their respective universities, the financing choices of these ASOs can be taken as examples of good practice. In this sense, the classifications provided by this study can shed light on the financial decision-making process of new ASO ventures with similar business and growth models, because categorisations help to identify possible existing financing resources and their application to their own present and future financial needs. In short, this study provides valuable information for new ASOs to enable understanding of the financial reality and to recognise and define themselves in terms of business/growth models and financing.

Secondly, the results of this study also have practical implications for various stakeholders engaged in the process of creating and developing ASOs. In general, it allows a global vision of all the existing ASOs and their classification in terms of business/growth models and financing. This study shows the great diversity and heterogeneity of these companies, but it also makes it possible to see some homogeneity within each group of ASOs, which could be useful for the design of programmes (e.g., training, mentoring, consultancy, transfer of research results, financing networks), as promoted by both public and private institutions, to enhance the creation and growth of ASOs. In this respect, the University has a central role as a decisive stakeholder. In recent times, universities in Spain have developed new infrastructure and services to facilitate the transfer of research results through the creation of ASOs. Thus, universities play a mediating role in connecting ASOs with the actors of the entrepreneurial ecosystem, favouring access to financial resources. The fact that these university units have a good knowledge of the reality and diversity of ASOs in Spain can clearly help them to offer better financial support and consultancy services.

Along the same lines, the results are also useful for the development of policies to promote these objectives by governments. As noted above, ASOs have an important social and economic value, especially in contexts such as Spain's, where the R&D system is more closely linked to academia than to

industry. In this sense, the results are important for the development of policies that promote the creation, and above all the growth of these companies, based on specific financial needs. In line with other studies, the results demonstrate the importance of favouring the development of initiatives of external equity financing, specifically reinforcing the role of VC (Rodríguez-Gulías *et al.*, 2018), due to its low profile in the financial structure of ASOs and its importance in terms of growth. Finally, the results of this study also have practical implications in the field of ASO investment, since it gives investors an overview of the diversity of existing ASOs and the relationship between the financing used and certain key milestones in the life of each type of ASO. In this sense, it favours the recognition of specific ASO profiles. Thus, although the factors involved in an investment decision are numerous, the differential characteristics of the business and growth models can help investment decision making and favour the identification of those companies with a greater potential for external equity incorporation.

This study is not without some limitations; however, each of these provides new avenues of research for future work. On the one hand, the heterogeneous reality of ASOs implies that the classification according to the typology of business and growth models is not simple, because the characteristics of ASOs are not necessarily mutually exclusive and the business and growth models can vary throughout the life of the company. In this sense, future research could consider characteristics of various models simultaneously (Stankiewicz, 1994) or in parallel (Clausen and Rasmussen, 2013). On the other hand, the study analyses the experience of ASOs in the context of Spanish universities. In this sense, based on the singularity of each country's university system, the external context and the availability of financial resources, extrapolations to other contexts must be made with caution, taking these characteristics into account. Thus, the results of this study are more applicable to contexts similar to the Spanish one.

Future research could be used to verify the extent to which the conclusions of this article are transferrable to other contexts. The development of similar studies in other regions with distinct academic and socioeconomic conditions could help to determine whether the influence of business and growth models relate differently to ASO financing depending on the environment. In this sense, it is interesting to delve deeper into which aspects of the context shape the results the most. Likewise, it would be of interest to verify the role of universities in ASO access to different financial resources, and the extent to which universities play an efficient mediating role between ASOs and funders. Lastly, it would be of

great interest to deepen the evidence detected in terms of critical junctures, analysing from a longitudinal perspective the characteristics of the ASOs that determine their financial evolution over time.

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