

The determinants of the internationalization speed of Portuguese university spin-offs: An empirical investigation

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Abstract The speed of internationalization of firms has attracted considerable research in the last few decades. However, with regard to a particular type of firm, university spin-offs (USOs), this line of research is still incipient. A majority of the studies on USOs highlights their main features but does not focus on internationalization. Based on the responses from 111 Portuguese USOs, of which 78 are exporters, econometric estimations indicate that: (1) the internationalization speed of USOs is critically dependent on support from technology transfer offices; (2) in line with the “learning advantages of newness” perspective, younger Portuguese USOs reveal higher levels of entrepreneurial spirit and entrepreneurial capabilities, being in a better position to internationalize earlier than older USOs; (3) USOs that operate in microelectronics/robotics internationalize faster and earlier than USOs operating in ICT/software/digital media; and (4) in contrast with the literature on born globals/international new ventures, greater involvement in R&D activities slows down the early internationalization process of USOs.

Summary Highlights *Contributions:* This study adds empirical evidence to the research on the determinants of internationalization speed of university spin-offs (USOs).

Research questions/purpose: To provide a quantitative assessment of the determinants of the internationalization speed of USOs.

Results/findings: (1) The internationalization speed of USOs is critically dependent on the support of technology transfer offices (TTOs); (2) younger USOs tend to be in a better position to internationalize earlier than older USOs; and (3) high R&D intensive USOs are generally laggards in terms of internationalization.

Theoretical implications and recommendations: This study extends the arguments from a broad-based international entrepreneurship perspective to emphasize the role that TTOs play on early internationalization.

Practical implications and recommendations: Entrepreneurs should consider the potential that TTOs have for an earlier internationalization of USOs. Public authorities should stimulate the contact between USOs and the available S&T infrastructure, by promoting events and activities that put these two groups interacting with each other.

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Abstracto La velocidad de internacionalización de las empresas ha sido considerablemente estudiada en las últimas décadas. Sin embargo, con respecto a un determinado tipo de empresa, las Spin-off Universitarias, esta línea de investigación es aún incipiente. La mayoría de los estudios sobre las Spin-off destaca sus principales características, pero no se centra en la cuestión de la internacionalización. Con base en las respuestas de 111 Spin-off portuguesas, 78 de las cuales son exportadoras, las estimaciones econométricas indican que: 1) La velocidad de internacionalización de las Spin-off es críticamente dependiente del apoyo de las Oficinas de Transferencia de Tecnología;; 2) de acuerdo con la perspectiva de “learning advantages of newness” (ventajas de aprendizaje de lo nuevo), las más jóvenes Spin-off portuguesas revelan mayores niveles de espíritu y capacidad emprendedores, al estar en una mejor posición para una temprana internacionalización en oposición a las Spin-off más antiguas; 3) Las Spin-off que operan en Microelectrónica/Robótica se internacionalizan más rápido y anticipadamente que las Spin-off que operan en TIC/Software/Medios Digitales y 4), en contraste con la literatura sobre las empresas Born Globals/International new ventures, mientras mayor es la participación en las actividades de I&D, más lento es el proceso de internacionalización adelantada de las Spin-off.

Keywords University spin-offs · Internationalization speed · Determinants · Portugal

JEL Classification O32 · M13 · M21 · F23

Introduction

University spin-offs (USOs), new firms founded to exploit and commercialize the results of scientific and technological research generated in a university (Shane 2004),¹ are known for having high rates of innovation and a high survival rate in comparison to other firms in the same industry (Pettersen and Tobiassen 2012). They are also very competitive, helping countries and regions to foster economic growth (Müller 2010). Evidence based mainly on developed countries shows that an increasing number of USOs have succeeded in internationalizing early and rapidly (Styles and Genua 2008), leading policymakers worldwide to set up science and technology (S&T) infrastructures to optimize the potential of these firms in the internationalization process (Rasmussen 2005). It is, therefore, important to evaluate empirically the determinants of the USOs’ speed of internationalization so that appropriate and consistent policies can be implemented.

A majority of the studies on USOs highlights their main features but does not focus on internationalization (e.g., Pettersen and Tobiassen 2012; Ortín-Ángel and Vendrell-Herrero 2014), whereas studies on the internationalization of firms do not take account of USOs (e.g., Jones and Coviello 2005; Oviatt and McDougall 2005; Autio et al. 2011; Zucchella and Siano 2014). Furthermore, given that some evidence indicates that there

¹ The definition of USOs is far from consensual. Some authors (e.g., Ortín-Ángel and Vendrell-Herrero 2014, p. 101) define USOs as “those new technology-based firms created with the support of a university by some of its members.” We follow Shane (2004) who defines a USO as a new legal entity (company) whose core business is based on the exploitation and commercialization of the results of scientific and technological research generated in the academic parent organization (i.e., university).

is a link between the firms' speed of internationalization and performance (Oviatt and McDougall 2005; Casillas and Moreno-Menéndez 2014; Zhou and Wu 2014), it is fundamental to understand which determinants lead to faster internationalization.

This paper intends to address the abovementioned issues and, thus, fill the existing gap in the literature on the determinants of the internationalization speed of USOs.

It provides contributions at both the theoretical and empirical levels. At the theoretical level, it bridges the literature on technology transfer and commercialization, international business, and international entrepreneurship. At the empirical level, it explores a rather neglected domain—the drivers of internationalization of a specific type of firm, university spin-offs (USOs), in a rather unexplored context, Portugal.

In order to achieve this goal, multivariate estimation techniques are employed, in line with existing studies on the determinants of (the speed of) the internationalization of firms (e.g., Luo et al. 2005; Acedo and Jones 2007; Osarenkhoe 2009; Zucchella et al. 2007; Musteen et al. 2010). The study focuses on a sample taken from a population of about 300 Portuguese USOs, created in the last 10 years, and associated with organizations belonging to the University Technology Enterprise Network (UTEN), a component of the UT Austin|Portugal Program.² The information required to analyze the internationalization process of Portuguese USOs was gathered from their founders based on a two-page questionnaire. The respondents totaled 111 firms, of which 78 were exporters.

The study is structured as follows. The next section reviews the relevant literature on USOs and the speed of internationalization of firms, so as to identify the main gap in the literature to be empirically explored. “**Methodology**” briefly describes the methodology and data gathering procedures undertaken. The empirical results are presented in “**Empirical results**.” Finally, the “**Discussion and conclusions**” present the study's main results, implications, and limitations.

Literature review on USOs and the speed of internationalization of firms

The internationalization of a firm involves cross-border geographic expansion and is one of the most important paths for firm growth (Lu and Beamish 2001). It is closely connected to the concept of international entrepreneurship, which according to Peiris et al. (2012, p. 296), entails “the cognitive and behavioural processes associated with the creation and exchange of value through the identification and exploitation of opportunities that cross national borders.”

Exports and foreign direct investment (FDI) are the two main options/modes for firms to serve foreign markets (Oberhofer and Pfaffermayr 2012).³ FDI involves higher fixed costs than exporting, requiring, in general, higher levels of commitment by firms in terms of both human and financial resources (Demirbas et al. 2013). Some theoretical (e.g., Helpman et al. 2004) and empirical (e.g., Girma et al. 2005; Oberhofer and Pfaffermayr 2012) contributions document that only the most productive firms find it profitable to meet the higher costs associated with FDI. Firm features such as size and

² For more information, see <http://utenportugal.org/>, last accessed in September 2012.

³ International sourcing, international joint ventures, and international cooperation are other less explored dimensions of firm internationalization (Kalinic and Forza 2012).

business/industry experience are positively associated with FDI internationalization modes (Arnold and Hussinger 2010). It is thus unsurprising that a vast majority of the studies focusing on the internationalization of new technology-based firms (e.g., Li et al. 2012; Kahiya 2013; Pinkwart and Proksch 2014; Sleuwaegen and Onkelinx 2014) analyzes exports and not FDI.⁴

Regardless of the mode of internationalization, firms are unquestionably internationalizing in greater numbers and faster than ever before (Axinn and Matthyssens 2002; Pettersen and Tobiassen 2012; Cannone and Ughetto 2014). Since internationalization is a dynamic process, it is surprising that few papers have considered time analysis as a critical element (Casillas and Acedo 2013; Chetty et al. 2014; Zhou and Wu 2014). Time is a central issue in a firm's internationalization, and speed is the most relevant time-based dimension in its development (Prashantham and Young 2011). Early internationalization is, according to Zhou and Wu (2014, p. 134), "a result of entrepreneurial spirit and entrepreneurial capability," and the "earliness of internationalization" might be considered an indicator for international entrepreneurial behavior.

The literature suggests that a high speed of internationalization has an impact on the firm's performance (Vermeulen and Barkema 2002; Wagner 2004; Rialp et al. 2005a; Zhou and Wu 2014) and that some determinants related to its entrepreneurs (Kalinic and Forza 2012), business relations and networks (Chetty et al. 2014), as well as macro-level factors (Casillas and Acedo 2013), impact on the speed of internationalization. However, the internationalization process of USOs has largely been ignored in the literature. The few existing studies are qualitative in nature, encompassing only a few firms and focusing on the determinants and process of internationalization of such firms (Johnson 2008; Styles and Genua 2008; York and Ahn 2012). In a more recent study, Pettersen and Tobiassen (2012) examine the networks of USOs in three main stages: idea conception, technology development, and growth and internationalization. As such, it includes a time analysis but does not address the speed of internationalization explicitly.

In order to understand which determinants influence the internationalization speed of USOs, it is important to put forward some key hypotheses relating their characteristics and context with the speed of internationalization in line with international entrepreneurship literature. Such determinants can be grouped into three main categories: entrepreneur-specific factors (e.g., Acedo and Jones 2007; Kalinic and Forza 2012; Casillas and Acedo 2013; Chetty et al. 2014), business-related factors (Zucchella et al. 2007; Kalinic and Forza 2012; Casillas and Acedo 2013; Chetty et al. 2014), and contextual factors (Luo et al. 2005; Li et al. 2012; Casillas and Acedo 2013).

With regard to *entrepreneur-specific factors*, some studies (e.g., Acedo and Jones 2007; Osarenkhoe 2009; Musteen et al. 2010) contend that the entrepreneurs' previous international experience increases the firms' speed of internationalization. The entrepreneurial process depends on the entrepreneurs' motivation and previous experience as it can compensate for initial organizational inexperience (Cooper and Dunkelberg 1986) and has a strong impact on technology-based firms (Coeurderroy and Murray 2008). D'Este et al. (2012) argue that a higher level of previous interaction with the industry leads entrepreneurs to explore opportunities and facilitates their understanding of market conditions and business processes. Moreover, experience within the same industry will make spin-offs more successful because their organizational procedures

⁴ This study adopts the same focus considering the internationalization of USOs in terms of exports.

and accumulated knowledge will be better designed for success (Dahl and Reichstein 2007; Bjørnåli and Aspelund 2012). Entrepreneurs with prior experience in the same industry as their current firm can accumulate industry-specific know-how, which allows them to become acquainted with their customers and to develop more appropriate market niches at national and international levels (Westhead et al. 2001; Cannone and Ughetto 2014). Zhou and Wu (2014) call such pre-founding experiences “congenital knowledge” and argue that it may enable the firm to more effectively leverage the new knowledge it encounters upon initial foreign market entry, giving early international ventures the advantage of learning capabilities in international markets. Therefore, we propose that:

Hypothesis 1 The entrepreneurs’ previous experience in the same industry increases the speed of internationalization of USOs.

Technology-based ventures, in particular USOs, are more frequently founded and managed by entrepreneurial teams rather than single entrepreneurs, and one of the main factors that may affect the growth of new business ventures is the quality of their entrepreneurial–managerial group (Visintin and Pittino 2014). Although the educational level of founders plays an important role in the firms’ speed of internationalization (Acedo and Casillas 2007), in the case of USOs, given that the founders are, in general, highly qualified (Williams and Figueiredo 2011; Pinkwart and Proksch 2014), their educational level may not be as relevant as the type of education/qualifications. In particular, USO dynamics are intimately linked to the ability to effectively integrate technological features and a business strategy aimed at the full exploitation of technology as a core resource for competitive advantage (Hamel and Prahalad 1994). Such integration often requires heterogeneous skills among founding team members (Visintin and Pittino 2014), encompassing a combination of technology and business/management-related qualifications (Cannone and Ughetto 2014). According to some authors (e.g., Antoncic and Prodan 2008; Martín-Rojas et al. 2013), the majority of successful, new technology-based ventures are founded and developed by a group of people whose technological skills play a pivotal role. Others, however (e.g., Vohora et al. 2004; D’Este et al. 2012; van Burg and van Oorschot 2013), highlight that difficulties in the development of spin-offs and the exploitation of entrepreneurial opportunities are closely related to the lack of certain types of skills/educational training, namely those associated with business/management, in particular with the commercialization of products. In order to assess the type and level of integration of distinct skills, we propose that:

Hypothesis 2 The type and integration of the founders’ qualifications/human capital influences the USOs’ speed of internationalization.

Hypothesis 2a: USOs whose founder(s) has (have) technology-related degrees internationalize faster.

Hypothesis 2b: USOs whose founder(s) has (have) business/management degrees internationalize faster.

Hypothesis 2c: USOs whose founder(s) combines technology-related and business/management degrees internationalize faster.

The resource-based view considers that every firm is unique regarding its human resources and that these may compensate for an initial lack of (financial) capital in the development of a new international venture (Hauser et al. 2012). Accordingly, it can be argued that the ability of a new venture to enter and develop in foreign markets depends on its capacities, competencies, and resources and only if a new venture possesses enough in-house resources will it be able to internationalize in an early stage of operation (McDougall et al. 2003). According to some authors (e.g., Pinkwart and Proksch 2014), the size of a firm's founding team is a reasonable indicator of its capacities, competencies, and resources, particularly in the case of a new technology venture.

Analyzing new ventures located in the UK, Bürgel (2000) concludes that the founding team size influences the ability to internationalize because more resources are available. More recently, Pinkwart and Proksch (2014), studying 44 German high-tech start-ups, assumed that larger founding teams were more likely to internationalize as they could handle the different tasks of the internationalization process more easily but failed to empirically corroborate their hypothesis. Despite the lack of clear-cut results regarding the impact of team size on the speed of internationalization, we propose that:

Hypothesis 3 USOs with a higher number of founders tend to internationalize faster than their smaller counterparts.

Regarding *business-related factors*, the importance of knowledge intensity and innovation cannot be neglected. Knowledge intensity refers to the extent to which the production process of the firm involves specialized and unique knowledge or technology that may provide a competitive advantage (Autio et al. 2000; Mukherjee et al. 2013), being associated with the deployment and development of research and development (R&D) activities (Bernstein and Nadiri 1983).

Several studies show that innovation, especially technological innovation, has a positive impact on the tendency to export, being closely associated to accelerated internationalization (Luo et al. 2005; Shrader and Siegel 2007; Osarenkhoe 2009; Ramos et al. 2011). According to Autio et al. (2000), knowledge intensity is associated with faster international growth. Moreover, Prashantham and Young (2011) underline that market and technological knowledge accumulation, measured as the value of a firm's R&D expenditures in terms of its turnover, helps to boost internationalization and its scope. Dahlstrand (1997a) argues that spin-offs benefit from having initially developed more products than non-spin-off firms due to technology transfer. USOs benefit from inventive work and are therefore more likely to have ready-developed products at an early stage, which can contribute to faster international growth. Focusing on small high-tech "born global" firms, Li et al. (2012) found that high R&D intensity fosters internal innovative capabilities which drive the firms' early internationalization.

Several studies mention and explain the development of USOs by assessing their patent portfolio and strategies (Dahlstrand 1997a; Shane and Stuart 2002; Di Gregorio and Shane 2003; Clarysse and Moray 2004; Genua and Nesta 2006; Clarysse et al. 2007; Salvador 2010; Krabel et al. 2012). The decision to patent is often linked to a belief in the benefits they provide, specially protection, leverage possibilities, and

sources of income (Owen-Smith and Powell 2003) as well as the conviction that patents reinforce the ability of new firms to protect their technology from imitators, to attract investments, and grow (Shane and Stuart 2002). Shane and Stuart (2002) also argue that the strength of a new firm's technological endowments at founding is a predictor of its performance, since these firms do not have complementary assets. Moreover, some authors (e.g., Knockaert et al. 2006) highlight the importance of a strong and protected technology base for the firms' development. Since patents seem to constitute a critical competitive advantage for firms, enabling them to become strategically more flexible, it may be argued that, in line with Gassmann and Keupp (2007), patent protection is associated to the early internationalization of firms. Therefore:

Hypothesis 4 High knowledge-intensive and innovative USOs internationalize faster than other USOs.

Hypothesis 4a: High knowledge-intensive USOs (i.e., with a high R&D-turnover ratio) internationalize faster.

Hypothesis 4b: USOs with a higher innovation rate (registered patents) tend to internationalize faster.

The exploitation and commercialization of the results of scientific and technological research generated in the academic parent organization by USOs might be led by an academic (or a team of academics) or an individual (or team of individuals) external to academia. USOs led mainly by academics tend to benefit from more qualified, innovative, and research-oriented personnel that can foster the firm's development (Dahlstrand 1997b). However, USOs led mainly by individuals external to academia (i.e., who have come from incumbent or even deceased firms) may be more successful due to their previous business experience, particularly that related to marketing, distribution channels, and international experience and are therefore better prepared to deal with obstacles and explore international market opportunities (Dahlstrand 1997b; Politis et al. 2012). Hence, we hypothesize that:

Hypothesis 5 USOs whose main driver/leader comes from industry internationalize faster than those led by academics.

Due to globalization and competition from large firms benefiting from scale advantages, small, technology-based firms grow in niche markets (Aspelund and Moen 2004). Niche firms tend to differentiate themselves and their products from their competitors, entering faster and easier into new markets and industries (Osarenkhoe 2009). Based on qualitative research, Kalinic and Forza (2012) show that the strategic focus of SMEs, entailing a combination of niche-focused and global, highly proactive international strategies developed in geographically spread-out lead markets around the world from inception, is the key determinant for rapid internationalization. Based on 144 Italian SMEs, Zucchella et al. (2007, p. 268) found a positive link between early internationalization and niche positioning, arguing that "focalization is a reflection of entrepreneurial orientation and strategic decisions." Additionally, Ribeiro et al. (2012) underline the importance of a firm's globally oriented strategy arguing that customized

products and client-oriented strategies will foster faster internationalization. Consequently:

Hypothesis 6 Global market orientation and niche positioning is positively related to faster internationalization.

Hypothesis 6a: USOs with a global market strategy (encompassing several foreign markets) tend to internationalize faster.

Hypothesis 6b: Niche positioning positively influences the speed of internationalization of USOs.

Finally, a firm's general demographic traits, such as size and age, may contribute to explaining differences in the speed of internationalization of USOs.

Traditional literature indicates that a firm's internationalization is determined by its organizational factors and resources which may put small firms at a disadvantage (Li et al. 2012). Accordingly, small firm size reduces market power which internationalizing firms require to overcome entry barriers (Singh et al. 2010), and the higher levels of foreign market knowledge larger firms possess foster international sales growth and speed of entry (Yli-Renko et al. 2002). However, Li et al. (2012, p. 542) contend that "a small firm size is a double-edged sword," limiting resources but increasing flexibility and agility. Indeed, in this perspective, small size facilitates early internationalization because it increases operational flexibility and speed. Moreover, a simple organizational structure facilitates rapid internal communication and responses, enhancing the firm's ability to speed up the pace of internationalization and react quickly and efficiently to both market and technological changes (Pla-Barber and Escribá-Esteve 2006). Following this line of reasoning:

Hypothesis 7 Smaller USOs tend to internationalize faster/earlier.

Two theoretical approaches help to rationalize the relation between firm age and speed of internationalization: the international entrepreneurship approach (Autio et al. 2000; Oviatt and McDougall 1994; McDougall and Oviatt 1996; Rialp et al. 2005b), and the process theorizing of internationalization that draws on both the behavioral theory of the firm (Cyert and March 1963) and the stage model approach (Johanson and Vahlne 1977). The process theorizing of internationalization emphasizes the 'virtuousness' of firm experience (i.e., years in business) for internationalization, as the accumulation of foreign market knowledge should enable firms to overcome uncertainty when they incrementally increase their international commitment (Johanson and Vahlne 1990). By contrast, the international entrepreneurship approach has put forward the concept of "learning advantages of newness," according to which "new ventures tend to possess fewer deeply embedded routines (from domestic operations), face fewer inertial constraints (past-dependent cognitive biases), and thus are in a forward-looking position to explore new opportunities in international markets" (Zhou and Wu 2014, p. 134). Moreover, the international entrepreneurial orientation of young firms tends to be positively related to unique product development and to fostering global technological competence (Knight and Cavusgil 2004). Early

internationalization is thus a result of that entrepreneurial spirit and entrepreneurial capability (Oviatt and McDougall 2005).

Following the international entrepreneurial approach, we hypothesize that:

Hypothesis 8 Younger USOs tend to internationalize faster/earlier.

A firm's past economic performance tends to impact on its pace of internationalization by providing indicators on the acquisition of innovative capabilities and resources to pursue its goals (Vermeulen and Barkema 2002; Wagner 2004). According to Zhou and Du (2014), past firm performance affects the availability of slack resources. High past firm performance was found to be positively associated with international entrepreneurship (Zahra and Garvis 2000), with Li et al. (2012) emphasizing the need for firms to have a certain level of financial stability before going international.

Although financially less stable firms might be easily driven to internationalize early due to less resources (Li et al. 2012), they are usually negatively affected in their export potential and earliness (Smolarski and Kut 2011). Therefore, we hypothesize that:

Hypothesis 9 USOs that have experienced high past performance tend to internationalize faster.

Generally speaking, *contextual factors*, including S&T support mechanisms, perceived obstacles, university characteristics, regional factors and sector differences, may also constitute important drivers of firm internationalization and its speed. In particular, for USOs, the existence of support mechanisms such as incubators and technology transfer offices (TTOs) can contribute to their competitiveness by helping them to establish collaborations with third party organizations (Colombo et al. 2012). Indeed, the use of TTOs by researchers is positively linked to the commercialization of academic research (O'Shea et al. 2005; Bourellos et al. 2012). Moreover, the performance of incubated firms can be improved by the efficiency and the quality of the facilities provided by a support mechanism (Salvador 2010). Thus, the performance of firms that make use of technology transfer support mechanisms is likely to be higher than that of other firms (Caldera and Debande 2010). Since USOs operate mainly in technology-based industries, competitive dynamics, shortened product life cycles, and client demands lead them to accelerate their learning efforts (Prashantham and Young 2011). Assuming that S&T support mechanisms and infrastructures improve USOs' learning efforts, it might be expected that they also play a pivot role in increasing the speed of internationalization. Hence, we hypothesize that:

Hypothesis 10 USOs that have received support from TTOs internationalize faster than other USOs.

TTOs and other S&T infrastructures (e.g., science parks and incubators) provide distinct types of support mechanisms for USOs, namely: access to resources (most notably, skilled labor force), network and business advice, financial and capital advice/support, and intellectual property rights support. Musteen et al. (2010) posit that networks affect the timing of the internationalization effort by facilitating the

identification of opportunities, providing information and creating ties between firms. Networks allow firms to gain access to resources, to improve their strategic positions, to learn new skills, or to gain legitimacy (Osarenkhoe 2009; Ibeh and Kasem 2011; D'Este et al. 2012). For USOs, linkages between universities and industry can contribute to industrial change through the transfer of tacit and codified knowledge (Etzkowitz 1998; Wright et al. 2008; Pettersen and Tobiassen 2012). Additionally, strategic-related research suggests that resources and capabilities accumulated inside a firm affect the success or failure of its strategic choices (Chang and Rhee 2011). Finally, protection of intellectual property rights is closely linked to technology commercialization and firm performance (Goldfarb and Henrekson 2003; Boehm and Hogan 2014), thus any support and/or advice in this regard is likely to impact on the firms' speed of internationalization. Therefore:

Hypothesis 11 USOs that assign greater importance to S&T support mechanisms tend to internationalize faster than other USOs.

Hypothesis 11a: USOs that attribute high importance to S&T support mechanisms for access to resources tend to internationalize faster.

Hypothesis 11b: USOs that attribute high importance to S&T support mechanisms for network and business advice tend to internationalize faster.

Hypothesis 11c: USOs that attribute high importance to S&T support mechanisms for advice and support to access funding tend to internationalize faster.

Hypothesis 11d: USOs that attribute high importance to S&T support mechanisms for intellectual property rights (IPR) support tend to internationalize faster.

Firms in general and USOs in particular face several obstacles that hinder their business development and thus their internationalization process. Given their specificities, the USOs' business development and learning capabilities greatly benefit from a context characterized by strong university-firm relations, which enhances the probability of successful technology transfer and commercialization (Boehm and Hogan 2014). In this line of reasoning, weak university-industry linkages might constitute an important obstacle to the USOs' international endeavors, slowing down their entry into new foreign markets.

Other obstacles, in particular those related to financial, managerial, infrastructural, institutional, or regulatory factors, can also play a role in explaining the process and speed of internationalization (Kahiya 2013; Teixeira and Barros 2014). Several studies highlight that the regulatory environment, including transparency, bureaucracy, and legal protection, impact on the decision to internationalize and its pace (Coeurderroy and Murray 2008; He and Cui 2012). Some authors state that financial and legal constraints, such as bank paperwork and bureaucracies, constrain firm growth (Beck et al. 2005; Freeman and Reid 2006). Government policy shapes the institutional environment in which entrepreneurial decisions are made and the evolution of the firm (Lim et al. 2010). Coeurderroy and Murray (2008) state that political risks increase costs for domestic firms and influence the internationalization of firms.

Hence, having to deal with these obstacles may have an impact on the pace of internationalization:

- Hypothesis 12 The self-reported importance attributed by USOs to given obstacles they have faced in establishing the firm and developing their business activity is likely to impact on their speed of internationalization.
- Hypothesis 12a: Weak university-industry relations are considered by USOs an important obstacle to their establishment and business development, affecting their internationalization speed.
- Hypothesis 12b: Labor market rigidities and the existence of a confusing and non-integrated policy and regulatory framework are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed.
- Hypothesis 12c: Financial constraints are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed.
- Hypothesis 12d: Internal managerial handicaps are considered by USOs an important obstacle to their establishment and business development, affecting their internationalization speed.
- Hypothesis 12e: The available physical infrastructures and distance to markets and suppliers are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed.

The university-related context, namely overall university characteristics, reflected in the university's pool of scientific (articles indexed) and applied (patent accumulated) knowledge produced, as well as the existence of world renowned scientific centers may influence the establishment and the (international) development of USOs, in general (Genua and Nesta 2006), and the process and pace of internationalization, in particular (Gassmann and Keupp 2007). Pazos et al. (2012) claim that there is a positive relationship between (applied) research generated in the university and the creation of USOs. Indeed, a rich pool of patents may serve as an entry ticket to commercialization networks that allow university entrepreneurs to develop higher impact intellectual property produced at universities and facilitate the development of their own firms (Goldfarb and Henrekson 2003; Owen-Smith and Powell 2003). Likewise, increased research productivity in terms of published articles generates a larger and more diverse "pool" of new scientific findings that may possibly be patented (Owen-Smith and Powell 2003). Lastly, the university's prestige or reputation makes it easier for researchers from more eminent universities to start companies to exploit their inventions than researchers from less renowned universities (Di Gregorio and Shane 2003). More specifically, potential investors may favor firms with access to experienced and high status researchers since having well-known universities is often considered a sign of firm quality (Shane and Stuart 2002). Besides, universities that are more intellectually eminent are more likely to engender more USOs because intellectual eminence allows schools to produce new technologies of real or perceived higher quality (Shane and Stuart 2002; Fini et al. 2011).

Therefore, overall university characteristics may influence the pace of internationalization:

Hypothesis 13 The characteristics of the host university influence the USOs' speed of internationalization.

Hypothesis 13a: USOs that are associated with universities with a higher pool of advanced applied/commercialized knowledge (i.e., accumulated patents) tend to internationalize faster than other USOs.

Hypothesis 13b: USOs that are associated with universities with a higher pool of scientific knowledge (i.e., scientific publications) tend to internationalize faster than other USOs.

Hypothesis 13c: USOs that are associated with universities with a higher proportion of centers of research excellence tend to internationalize faster than other USOs.

There is a lack of research on the role of regions and local networks based in regional industry settings in the internationalization process of small firms (Giblin and Ryan 2012; Zhou and Wu 2014). However, a region's characteristics and infrastructure is considered a key factor in determining spin-off activity and performance (O'Shea et al. 2008). Several authors claim that the environment, including the entrepreneurial, and venture and social capital, reduce the obstacles to starting a new firm (Feldman 2001). Indeed, some regional environments foster the competitiveness and export growth of innovative firms (Rialp et al. 2005a). In other words, regions matter due to the need of innovative firms to acquire new knowledge from external resources that are mostly concentrated in regions characterized by a strong basis/cluster of internationalized local firms, which may help new ventures to engage in activities abroad as 'client followers' (Bell 1995). Being part of a local network can generate benefits for the cluster actors, such as labor pooling and "knowledge spillovers," which describe the transmission of sticky, non-articulated, tacit forms of knowledge between firms (Tödtling et al. 2008; Andersson et al. 2013). Notwithstanding the pertinence of these theoretical arguments, empirical support for the influence of regions (and the associated local networks and industry cluster embeddedness) is scarce. Al-Laham and Souitaris (2008), studying 853 German biotechnology firms for the period 1995–2004, found that local clusters foster the internationalization of new ventures by increasing their awareness of international opportunities, and by offering grounds to learn from the experience of internationally connected firms. More recently, Andersson et al. (2013) analyzed four French medium-tech firms and concluded that location influences the internationalization and network dynamics of the studied firms. Thus, we formulate the hypothesis that:

Hypothesis 14 The region in which the USOs are located influences their speed of internationalization.

Firms in different sectors face different competitive challenges, which often demand distinct attitudes regarding internationalization, thus achieving different levels and patterns of internationalization (Zahra and Garvis 2000). To date, only a small number of studies have examined the relationship of the speed of internationalization across different industry sectors (Taylor and Jack 2013). Zhou and Wu (2014) found that the sector failed have any significant influence on the earliness of the internationalization of firms located in the Zhejiang (China) province, whereas Madsen (2013) found evidence that industry/sector affiliation is linked to the early and rapid international development of firms. Based on a sample of 278 small US firms in technology-intensive industries, Li et al. (2012) also found that industry affiliation matters, particularly firms in biotech and semiconductor sectors which emerged as the fastest to go international.

Given that several studies focusing on USOs have shown that there are significant sectorial differences (Owen-Smith and Powell 2003; Stephen et al. 2007; Müller 2010; Krabel et al. 2012), and assuming that, in line with Li et al. (2012) and Madsen (2013), the sectors' endogenous factors can lead to differences in the USO's speed of internationalization, we contend that:

Hypothesis 15 The sector/industry to which the USOs belong influences their speed of internationalization.

Methodology

Many of the studies that address the issue of the speed of firms' internationalization have applied multivariate econometric techniques, using hypothesis testing as a procedure of analysis (e.g., Chetty et al. 2014; Zhou and Wu 2014). Following procedures from existing studies (e.g., Acedo and Jones. 2007; Ripollés-Meliá et al. 2007; Osarenkhoe 2009; Zuchella et al., 2009; Hauser et al. 2012), we designed (and implemented) a questionnaire targeting all Portuguese USOs. The questionnaire is composed of five parts: (1) the description of the firm, (2) support mechanism questions related to TTOs and obstacles faced by the firms, (3) firm data such as the date of foundation, and the beginning of internationalization (exports and foreign subsidiary establishment); (4) turnover, R&D and patents; and (5) firm's human capital, including the number of founders and collaborators (in full time equivalent), their educational level and past industry experience.

Based on the literature review performed (cf. "Literature review on USOs and the speed of internationalization of firms"), the econometric specification to be estimated comprises three main groups of determinants: (1) those related to entrepreneurs or the team of founders (size, education, and industry experience of the founding team); (2) those related to the USO (main driver/push factor of creation, innovation, internationalization, market strategies, and demographic traits); and (3) contextual factors (TTO support and self-reported importance of a given set of S&T support mechanisms, self-reported importance of some given obstacles to the establishment and development of

the firm, university characteristics, region, and sector). The general econometric specification that is used to test the hypotheses put forward stands as follows:

Internationalization speed_{*i*}

$$\begin{aligned}
 &= \hat{\beta}_1 + \hat{\beta}_2 \text{Experience}_i + \hat{\beta}_3 \text{Type of Education}_i + \hat{\beta}_4 \text{Number of founders}_i \\
 &+ \hat{\beta}_5 \text{Innovation}_i + \hat{\beta}_6 \text{Driver of creation}_i + \hat{\beta}_7 \text{Strategy}_i + \hat{\beta}_8 \text{Size}_i + \hat{\beta}_9 \text{Age}_i \\
 &+ \hat{\beta}_{10} \text{Past Performance}_i + \hat{\beta}_{11} \text{S\&T support}_i + \hat{\beta}_{12} \text{Obstacles}_i \\
 &+ \hat{\beta}_{13} \text{University characteristics}_i + \hat{\beta}_{14} \text{Region}_i + \hat{\beta}_{15} \text{Sector}_i + e_i
 \end{aligned}$$

Where, *i* is the subscript for each USO and *e_i* is the sample error term (bold represents vector-variables).

The speed of internationalization is the dependent variable. It is usually measured by the time lag between the founding of the firm and the firm's first international operations (e.g., exports or FDI) (Autio et al. 2000; Luo et al. 2005; Acedo and Casillas 2007; Osarenkhoe 2009; Zucchella et al. 2007; Coeurderroy and Murray 2008; Ramos et al. 2011). An alternative proxy, labeled "precocity of internationalization" by Zucchella et al. (2007), consists in identifying the firms which started exporting within the first 3 years of business (Madsen and Servais 1997; Zucchella et al. 2007). Thus, the first proxy is a continuous variable computed as the difference (in years) between the firm's founding date and the date of its first exports, whereas the second proxy is a dummy variable which assumes the value 1 when the firm is an early exporter (that is, started exporting within the first three years of business) and 0 otherwise. This latter proxy is closer to the concept of international new venture, a firm that reports international activities within the three years after its year of foundation (Madsen 2013).

The consideration of these two alternative proxies for the speed of internationalization required the use of two distinct econometric estimation methods: ordinary least squares (OLS), in the first case, and logistic regressions, in the second.⁵

Despite the use of two distinct proxies for the speed of internationalization, we are assuming, like others before us (e.g., Zhou and Wu 2014; Ramos et al. 2011; Musteen et al. 2010), a one-dimensional view of the internationalization process, taking time as the only relevant dimension. As Chetty et al. (2014) correctly pointed out, such an operational approach discards two key dimensions of the firms' internationalization process, previously highlighted by Zahra and George (2002): its extent (commitment to internationalization, i.e., level of resources available) and its breath or scope (range of locations where the firm develops its business).

The proxies related to the determinants of the speed of internationalization (i.e., the model's independent variables) are described in Table 1, together with the study's main hypotheses.

In order to test the hypotheses put forward, the USOs associated with UTEN members were selected as the target "population." The UTEN, a component of the

⁵ Recall that when the dependent variable is binary, conventional estimation techniques (e.g., OLS regressions) are not a valid option. First, the assumptions needed for hypothesis testing in conventional regression analysis are necessarily violated—it is unreasonable to assume, for instance, that the distribution of errors is normal. Second, in conventional regression analysis, predicted values cannot be interpreted as probabilities—they are not constrained to fall in the interval between 0 and 1.

Table 1 Main hypotheses and proxies for the relevant variables

Group determinant	Variable	Hypothesis	Proxy for the relevant variable	Source (questionnaire question number and description)
Dependent variable	Speed of internationalization		Time lag between the founding date and the time of the firm's first exports ^a	Q2: Firm's founding date and year of firm's first exports and foreign direct investment
	Earlier exporter		Dummy variable that assumes the value of 1 when the firm is an earlier exporter (that is, started exporting within the first 3 years of business) and 0 otherwise	
Specific entrepreneurial factors	Experience	H1: The entrepreneurs' previous experience in the same industry increases the speed of internationalization of USOs	Same-industry experience (dummy: 1, yes; 0, no)	Q.10: Do some of the founders have prior experience in the industry?
	Education	H2: The type and integration of the founders' qualifications/human capital influences the USOs' speed of internationalization	The founder(s) has (have) technology-related degree (dummy: 1, yes; 0, no) The founder(s) has(have) business/management degrees (dummy: 1, yes; 0, no) The founder(s) combines engineering and economics/managerial degrees (dummy: 1, yes; 0, no)	Q.10: The founder(s) has (have) degrees or advanced specialized qualifications in: (1) technology-related areas, (2) business/management, and (3) other scientific areas (please specify)
	Number of founders	H3: USOs with a higher number of founders tend to internationalize faster than their smaller counterparts	Number of founders in FTE (in ln)	Q.10: Human capital of the firm (number of founders and number of employees)
	Innovation	H4: High knowledge-intensive and innovative USOs internationalize faster than other USOs	R&D intensity (2011)–R&D/sales ratio	Q.9/2: Value (in thousands of €) of research and development (R&D) activities
Business-related factors		H4b: USOs with a higher innovation rate (registered)	The firm possesses active patents by 2012	Q.8: Company data (sales in thousands of €) Q.9: Number of active patents

Table 1 (continued)

Group determinant	Variable	Hypothesis		Proxy for the relevant variable	Source (questionnaire question number and description)
	Main driver/leader	H5: USOs whose main driver/leader comes from industry internationalize faster than those led by academics	patents) tend to internationalize faster	USOs whose main push came from firms/industry (1) or academia (0) (dummy)	Q. 1: Source of creation of the firm—main push for the creation of the firm: industry versus academia
	Market strategies/ Focalization of strategies	H6: Global market orientation and niche positioning is positively related to faster internationalization	H6a: USOs with a global market strategy (encompassing several foreign markets) tend to internationalize faster H6b: Niche positioning positively influences the speed of internationalization of USOs	Firm's strategic focus in terms of market (dummy: 1, global-several markets; 0, domestic/one single market) Target market segment (dummy: 1, niche market; 0, mainstream markets)	Q. 3: Focus in terms of internationalization Q. 4: Target market
	Size	H7: Smaller USOs tend to internationalize faster/earlier		Number of employees plus founders in terms of FTE (in ln)	Q. 10: Human Capital of the firm (number of founders and number of employees) H8: Younger USOs tend to internationalize faster/earlier
	Age	H8: Younger USOs tend to internationalize faster/earlier		Number of years since founding (in ln)	Q. 8: Company data
	Past performance	H9: USOs that have experienced high past performance tend to internationalize faster		Past sales per collaborator in FTE	Q. 8: Company data
Contextual factors	Science and technology (S&T) support mechanisms	H11: USOs that assign greater importance to S&T support mechanisms tend to internationalize faster than other USOs	H11a: USOs that attribute high importance to S&T support mechanisms for access to resources tend to internationalize faster H11b: USOs that attribute high importance to S&T support	High relevance attributed to the given item (dummy, 1: if USO considered highly important (4 or 5) the support mechanism; 0, otherwise)	Q. 6: Importance of the support mechanisms associated with the SC&T (1, low importance ...5, high importance)

Table 1 (continued)

Group determinant	Variable	Hypothesis	Proxy for the relevant variable	Source (questionnaire question number and description)
			<p>mechanisms for network and business advice tend to internationalize faster</p> <p>H11c: USOs that attribute high importance to S&T support mechanisms for advice and support to access funding tend to internationalize faster</p> <p>H11d: USOs that attribute high importance to S&T support mechanisms for Intellectual Property Rights (IPR) support tend to internationalize faster</p>	
Obstacles		<p>H12: The self-reported importance attributed by USOs to given obstacles they have faced in establishing the firm and developing their business activity is likely to impact on their speed of internationalization</p>	<p>H12a: Weak university-industry relations are considered by USOs an important obstacle to their establishment and business development, affecting their internationalization speed</p> <p>H12b: Labor market rigidities and the existence of a confusing and non-integrated policy and regulatory framework are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed</p> <p>H12c: Financial constraints are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed</p>	<p>Q. 7: Importance attributed of the listed obstacles in the creation and development of the firm's business activities (1, low importance, ..., 5, high importance)</p>

Table 1 (continued)

Group determinant	Variable	Hypothesis		Proxy for the relevant variable	Source (questionnaire question number and description)
			<p>H1.2d: Internal managerial handicaps are considered by USOs an important obstacle to their establishment and business development, affecting their internationalization speed</p> <p>H1.2e: The available physical infrastructures and distance to markets and suppliers are considered by USOs important obstacles to their establishment and business development, affecting their internationalization speed</p>		
	Host University characteristics	H1.3: The characteristics of the host university influence the USOs' speed of internationalization		<p>International patent pool per 1,000 researchers (2010) (in ln)</p> <p>Scientific pool of knowledge (WOS publications per researcher) (2000–2007) (in ln)</p>	<p>Universities' Websites</p> <p>Universities' Websites</p>
			<p>H1.3b: USOs that are associated with universities with a higher pool of scientific knowledge (i.e., accumulated patents) tend to internationalize faster than other USOs</p> <p>H1.3c: USOs that are associated with universities with a higher proportion of centers of research excellence tend to internationalize faster than other USOs</p>	<p>Proportion of research units classified as "excellent" or "very good" by the FCT</p>	<p>Universities' Websites</p>

Table 1 (continued)

Group determinant	Variable	Hypothesis	Proxy for the relevant variable	Source (questionnaire question number and description)
	Region	H14: The region in which the USOs are located influences their speed of internationalization	Dummy variable which assumes the value 1 if the USO is located in the North region (NUTs II)	Questionnaire
	Sector (default: ICT/software/digital media)	H15: The sector/industry to which the USOs belong influences their speed of internationalization	Dummy variable: 1 if the USO operates in energy/environment/sustainability; bio/pharma or medical devices/diagnostics; microelectronics/robotics; agri-food; consultancy-related activities including training and other specialized services	Questionnaire

^a Originally, this variable was computed as the time lag between the firm's first exports and the founding of the firm. We decided to compute in a symmetric way relatively to the original proposal in order to have effectively the "speed of internationalization." In this way, firms that have higher scores/figures are more rapid in internationalization

Table 2 Distribution of USOs by TTO and university (reference year, 2012)

Associated university (population; % total)	UTEN partner associated to technology transfer	Population by 2012	% total
U. Minho (43; 14.4 %; no. research staff, 1,260)	Avepark/Spinpark	14	4.7
	TecMinho	29	9.7
U. Porto (64; 21.3 %; no. research staff, 2,469)	UPIN	3	1.0
	UPTEC	52	17.3
	INESC Porto	9	3
U. Aveiro (11; 3.7 %; no. research staff, 1,086)	UATEC	11	3.7
U. Beira Interior (26; 8.7 %; no. research staff, 924)	UBI-GAPPI	5	1.7
	Parkurbis	21	7
U. Coimbra (26; 8.7 %; no. research staff, 1,602)	OTIC-UC	5	1.7
	IPN	21	7
U. Nova Lisboa (49; 16.4 %; no. research staff, 1,695)	Gab. de Empreendedorismo (FCT-UNL)	20	6.7
	Madam Parque	29	9.7
U. Lisboa (2; 0.7 %; no. research staff, 1,910)	IMM	2	0.7
ISCTE (4; 1.3 %; no. research staff, 1,276)	INDEG	4	1.3
U. Técnica de Lisboa (36; 11.9 %; no. research staff, 1,841)	OTIC-UTL	1	0.3
	Inovisa	3	1.0
	TT@IST	4	1.3
	Taguspark	28	9.3
U. Algarve and U. Évora (37; 12.3 %; no. research staff, 829 and 661)	CRIA	31	10.3
	Uévora	3	1.0
	Sines Tecnopólo	3	1.0
U. Madeira (2; 0.6 %; no. research staff, 231)	GAPI Madeira	1	0.3
	TECMU Madeira	1	0.3
All		300	100.0

The number of researchers was collected from each university's annual report

UT Austin|Portugal Program, is a network of professional TTOs, focused on the commercialization and internationalization of Portuguese S&T. Its member institutions include universities, polytechnic institutes, associated R&D labs, university-linked incubators, and science parks.

This network is the only body that, at present, possesses a credible list of the USOs operating in Portugal. According to the most recent information, in 2012, there were 300 USOs associated with (12) Portuguese public universities (cf. Table 2).⁶

The University of Porto is the institution which has reported the highest number of USOs. This ranking is not particularly surprising given that it is the largest Portuguese university in terms of research staff and students, thus possessing a large potential pool of entrepreneurial talent. Other smaller universities present comparatively good

⁶ There are fourteen public universities in Portugal, of which twelve are members of the UTEN network, leaving out two relatively small universities: Azores and Trás-os-Montes (UTAD).

dynamics in terms of academic entrepreneurship, most notably the University of Minho, with 43 USOs, and the New University of Lisbon, with 49 USOs.

Each USO was contacted by email (in a first stage) and telephone (follow up) in the two following months. From the 300 USOs contacted via email and telephone, we obtained 111 answers (37.3 % response rate). Out of the total responses, 78 firms are exporters and 18 expect to export in the near future.

We estimated two sets of models (see Table 3), one set by OLS (models 1A–6A), using the number of years between the firm’s establishment and its first exports (proxy for the speed of internationalization) as the dependent variable. The other set was based on logistic regressions (models 1B–6B), where the dependent variable is a dummy which assumes the value 1 when the USO is an “early exporter” (i.e., started exporting within the first three years of business). In order to avoid multicollinearity problems, such as “age” and “past performance,” and the variables characterizing the USOs’ host universities (“patents per researcher,” “publications indexed in ISI per researcher,” and “research units rated very good/excellent”) are highly correlated (see Table 4 in the Appendix), we decided to estimate six models (for each proxy of the dependent variable). The first three models (models 1A–3A) correspond to estimations including age and patents per researcher (model 1A), publications indexed in ISI per researcher (model 2A), and research units rated very good/excellent (model 3A). The remaining three models (models 4A–6A) include past performance with each of the three university-related variables.

All the models present a reasonable goodness of fit. The OLS models present a better fit when age is included (as compared with those using past performance), as about 43 % of the variability in the speed of internationalization can be explained by the estimated model. In the logistics estimations, the non-rejection of the null hypothesis of the Hosmer and Lemeshow test (the model is fit) for the conventional significance levels indicates that the six estimated models are acceptable.

Empirical results

The vast majority of the respondent firms (70 %) are exporters. On average, these USOs took about 2.4 years to undertake their first exports.⁷ Half of the exporters (39 USOs) can be classified as early exporters (i.e., firms that started exporting within three years of business). In 67 % of the cases, at least one of the founders had past experience in the same industry where the USO operates. Regarding the founders’ skills, in about 76 % of the USOs, at least one of the founders has a technology-related background (in most cases related to engineering). Management-related skills or the combination of technology and management skills are less frequent—only one third (about 22 %) of the USOs has at least one founder with management-related (technology and management) skills.

Exporting USOs are small (ten individuals, including the founders, in full time equivalent) and young (6 years in business), with very low rate of (past) sales (less than 30 thousand Euros/year). The average size of the founding team is 1.9 (in full time equivalent).

⁷ Table 4 (in Appendix) presents the means and correlation coefficients of the relevant variables for the respondent USOs that export.

Table 3 Determinants of the speed of internationalization of Portuguese USOs (dependent variables: time lag between founding and firm's first exports and early exporters (dummy))

Group of determinants	Variables (hypotheses)	Time lag between founding and firm's first exports (OLS estimations)											
		Models with Age					Models with Past performance						
		Model 1A	Model 2A	Model 3A	Model 1	Model 2	Model 3	Model 4A	Model 5A	Model 6A	Model 4	Model 5	Model 6
Entrepreneurial specific factors	Same industry's experience (H1)	-0.015	-0.010	-0.025				0.012	0.032	0.011			
	Qualifications/human capital (H2)	0.402**	0.400**	0.418***				0.394**	0.402**	0.438**			
	Business/management (H2b)	0.327	0.331	0.396				0.464	0.505	0.610*			
	Technology and business/Management (H2c)	-0.362	-0.358	-0.414				-0.379	-0.407	-0.495			
Business related factors	Size of the founders' team (number of founders) (H3)	0.107	0.065	0.075				0.172	0.091	0.100			
	Knowledge intensity and innovation (H4a)	-0.257**	-0.245*	-0.230*				-0.336**	-0.337**	-0.309**			
	Patents (H4b)	-0.120	-0.153	-0.144				-0.188	-0.239	-0.228			
	Main driver emerged from industry (H5)	0.121	0.108	0.099				0.103	0.062	0.043			
	Global market (H6a)	0.209*	0.218*	0.226*				0.248*	0.257*	0.274*			
	Niche positioning (H6b)	-0.067	-0.069	-0.053				-0.127	-0.140	-0.114			
Size (H7)	0.024	0.026	0.030				-0.083	-0.096	-0.086				
Age (H8)	-0.609***	-0.612***	-0.610***										
Contextual factors	Past performance (H9)												
	Resorted to TTO support (H10)	0.164	0.190	0.184				-0.266*	-0.227	-0.203			
	Importance attributed to the support mechanism (H11)	-0.067	-0.079	-0.079				0.333**	0.393**	0.387**			
	Resource access (H11a)							-0.080	-0.113	-0.122			
	Network and business advice (H11b)	0.185	0.186	0.193				0.235	0.258	0.272			
	Financial access advice/support (H11c)	0.040	0.028	0.040				-0.031	-0.064	-0.052			
Importance attributed to the obstacles in firm's creation (H12a)	IPR support (H11d)	-0.300**	-0.276**	-0.275**				-0.211	-0.147	-0.143			
	Weak university-industry relations (H12a)	0.083	0.087	0.097				0.029	0.040	0.059			

Table 3 (continued)

Group of determinants	Time lag between founding and firm's first exports (OLS estimations)											
	Models with Age						Models with Past performance					
	Model 1A	Model 2A	Model 3A	Model 1	Model 2	Model 3	Model 4A	Model 5A	Model 6A	Model 4	Model 5	Model 6
and the development of business activity (H12)	-0.074	-0.078	-0.077				-0.169	-0.173	-0.166			
Labor market rigidities and confusing/nonintegrated policy and regulatory frame (H12b)												
Financial constraints (H12c)	-0.092	-0.105	-0.114				-0.049	-0.063	-0.084			
Internal managerial handicaps (H12d)	0.204	0.194	0.198				0.132	0.103	0.112			
Physical infrastructures and distance to markets and suppliers (H12e)	0.303***	0.304**	0.317***				0.225	0.216	0.230			
University characteristics (H13)	-0.006						-0.015					
Patents per researchers (H13a)												
Publications indexed in ISI per researchers (H13b)		-0.017						-0.010				
Research units with very good/excellent (H13c)												
Located in the North (H14)												
Region (H14)				0.039	-0.005	-0.023				0.255	0.158	0.129
Sector (default: ICT/Software/digital media) (H15)				0.226**	0.192*	0.182*				0.383**	0.318*	0.284
Energy/environment/sustainability				0.430***	0.403***	0.396***				0.431	0.360	0.341
Bio/pharma or medical devices/diagnostics				0.598	0.618	0.610				0.678***	0.729***	0.712***
Microelectronics/robotics												
Agri-food				-0.242	-0.260	-0.244				-0.484**	-0.535**	-0.510**

Table 3 (continued)

Group of determinants		Variables (hypotheses)											
		Time lag between founding and firm's first exports (OLS estimations)											
		Models with Age						Models with Past performance					
		Model 1A	Model 2A	Model 3A	Model 1	Model 2	Model 3	Model 4A	Model 5A	Model 6A	Model 4	Model 5	Model 6
Consultancy related activities including training and other specialized services					-0.224	-0.272	-0.265				-0.073	-0.164	-0.168
Number of observations/USOs	<i>N</i>					77	77				77	77	77
	Early exporters												
	Laggard exporters												
Goodness of fit	Adjusted <i>R</i> ²					0.432	0.426				0.431	0.431	0.175
	% correct												
	Hosmer-Lemeshow test (<i>p</i> value)												
Group of determinants		Early exporters (logistic estimations)											
		Models with Age						Models with Past performance					
		Model 1B	Model 2B	Model 3B	Model 7	Model 8	Model 9	Model 4B	Model 5B	Model 6B	Model 10	Model 11	Model 12
Entrepreneurial specific factors	0.095	0.420	0.639	0.639				-0.721	-0.359	-0.337			
	3.548	2.221	2.310	2.310				1.623	1.393	1.528			
	1.132	1.452	1.329	1.329				1.513	1.635	1.876			
	-2.311	-2.611	-2.377	-2.377				-0.720	-0.791	-0.962			
	5.622*	3.481	3.440	3.440				1.739	0.855	0.762			
Business related factors	-7.452*	-5.808**	-5.463**	-5.463**				-2.676***	-2.446**	-2.299**			
	1.348	0.095	0.010	0.010				-0.503	-0.861	-0.957			
	-2.527	-1.870	-2.132	-2.132				-1.287	-1.515	-1.543			

Table 3 (continued)

Group of determinants	Early exporters (logistic estimations)											
	Models with Age					Models with Past performance						
	Model 1B	Model 2B	Model 3B	Model 7	Model 8	Model 9	Model 4B	Model 5B	Model 6B	Model 10	Model 11	Model 12
Contextual factors	1.493	0.605	0.975				0.067	-0.019	0.157			
	-0.634	0.221	0.064				-0.189	-0.399	-0.367			
	-0.585	-0.707	-0.580				-0.908*	-1.138**	-1.084**			
	-16.342*	-12.877**	-13.159**									
	3.972	2.958*	3.037*				-0.783	-0.411	-0.182			
	-1.223	-1.289	-1.527				1.374	1.692*	1.858*			
	2.206	3.463*	3.339*				-1.277	-1.544*	-1.607*			
	-5.589**	-5.639**	-5.580				1.798	2.152**	2.150**			
	-2.594	-1.977	-1.817				-2.689**	-2.971**	-2.985**			
	-2.277	-0.667	-0.671				-0.370	0.266	0.376			
	4.742	3.485	3.949				-0.328	-0.002	0.017			
	-0.433	-0.887	-1.284				-0.143	-0.110	-0.032			
	3.920	2.029	2.265				-0.110	0.146	-0.023			
	3.288	2.264	2.586				0.440	-0.108	-0.052			
	-0.233*						-0.041	-0.287	-0.153			
	0.493						0.271					
									-0.005			
				1.867	0.320	0.170				1.717*	0.749	0.720
			2.898	1.262	0.834					2.335*	1.347	1.078
			5.192	4.032	3.679					2.398	1.521	1.303
			15.072**	12.862****	13.029***					5.531***	6.267***	5.959***
			-1.972	-1.187	-1.306					0.497	-0.033	-0.092
			-5.199	-6.007*	-5.964*					-0.260	-0.937	-1.101
				77	77					77	77	77

Table 3 (continued)

Group of determinants	Early exporters (logistic estimations)											
	Models with Age			Models with Past performance								
	Model 1B	Model 2B	Model 3B	Model 7	Model 8	Model 9	Model 4B	Model 5B	Model 6B	Model 10	Model 11	Model 12
Number of observations/ USOs						39 38				39 38	39 38	39 38
Goodness of fit					0.189	88.3 11.408 (0.180)				85.7 5.810 (0.668)	77.9 6.538 (0.587)	76.6 6.395 (0.603)

Statistically significant estimates are set in italics

***1 %; **5 %; *10 %—statistical significance

Exporting USOs are highly R&D-intensive, with R&D expenditures that are, on average, five times higher than the corresponding sales (11 times for the laggard export group). Despite the high intensity in R&D, only a few USOs (18 %) possess active patents by 2012. As expected, in the large majority of the cases, the USOs' main driver/leader came from academia, whereas only about a quarter were led by founders from firms/industry. These USOs show a broad breadth or scope in terms of internationalization, with 72 % targeting several external markets and 64 % pursuing a niche market strategy.

Only a small fraction (17 %) of the USOs have resorted to support from TTOs, although more than one third acknowledges that support from TTOs and other S&T support infrastructures (e.g., science parks, incubators) is highly important in accessing resources and managing IPR. More than one third of the USOs considered that weak university-industry relations, labor market rigidities, and the existence of a confusing and nonintegrated policy and regulatory framework constituted important obstacles in their establishment and business activity development. Distance to markets and suppliers are considered important obstacles by 23 % of the USOs. Universities associated with USOs have, on average, 7 patents per researcher and 2.8 publications indexed in the Thomson Reuters Web of Science (formerly ISI Web of Knowledge).

The majority (54 %) of the exporting USOs belongs to the ICT/software/digital media sectors (19 % energy/environment/sustainability and 9 % bio/pharma or medical devices/diagnostics) and are located in Portugal's North region (45 %).

It is clear from the estimations that the way in which the speed of internationalization is operationalized is not irrelevant (see Table 3). When considering the speed of internationalization as a continuous variable (models 1A–6A), comparing to the dummy variable reflecting the “earliness” of internationalization (models 1B–6B), contextual factors, most notably factors related to the support of TTOs and the relevance attributed to S&T infrastructures support, emerge as much more relevant in explaining “earliness” (that is, taking 3 years or less to start exporting) than in explaining the speed of internationalization as it is traditionally computed (time lag between the firm's foundation and its first exports).

Speed of internationalization

Detailing the results of the estimation for the speed of internationalization (models 1A–6A), we found that entrepreneur-specific factors matter in explaining the USOs' rapid internationalization. However, among the entrepreneur-specific factors considered, only the founders' technology-related skills emerge positively and significantly related to faster internationalization. H2b-USOs whose founder(s) has (have) business/management degrees internationalize faster—obtains only mild support in model 6A ($\hat{\beta} = 0.610, p < 0.100$). We, thus, corroborate H2a but fail to support H1, H2b–c, and H3.

Regarding business-related factors, and at a first glance, quite surprisingly, USOs that are more R&D intensive are slow to internationalize ($\hat{\beta} = -0.257, p < 0.050$; model 1A), which contradicts H4a. For this sample, we also failed to obtain support for the hypothesis that USOs with a higher innovation rate (registered patents) tend to

internationalize faster (H4b). Although there is evidence that USOs with a global market strategy (that is, internationalizing in several foreign markets) tend to internationalize faster, which means that H6a is corroborated, niche market positioning failed to be associated with high internationalization speed (H6b is not supported).

According to our results, USOs whose main driver/leader emerged from industry do not significantly differ from those whose driver came from academia, which contradicts H5. Although size does not seem to impact on the speed of internationalization (refuting H7), younger USOs tend to internationalize faster, giving support to H8. When significant (only in model 4A), past performance emerges as negatively related to the speed of internationalization, meaning that USOs that experienced low past performance tend to internationalize faster (thus, H9 is not confirmed).

Excluding the sector-related variables, contextual factors do not generally emerge as a critical determinant of the USOs' speed of internationalization. TTO support contributes to accelerating USOs' international endeavors, which is in line with H10, but estimated coefficients are only significant in models 4A–6A ($\hat{\beta} = 0.333$, $p < 0.050$; model 4A). The importance attributed to S&T support mechanisms and the obstacles faced in firm establishment and development failed to emerge as relevant for the speed of internationalization (thus, H11 and H12 are globally not supported). Challenging H11d, the results (models 1A–3A) show that USOs that attribute high importance to S&T support mechanisms for IPR internationalize slower. Additionally, and being statistically significant only for models 1A–3A, USOs that consider physical infrastructures and distance to markets and suppliers an important obstacle to their business development tend to internationalize faster (thus, H12e receives some support). Host university characteristics and region failed to determine the speed of internationalization of USO, thus H13 and H14 are not corroborated.

Finally, the sector emerges as an important factor influencing the USOs' speed of internationalization (which supports H15). Indeed, USOs operating in the energy/environment/sustainability, bio/pharma (models 1A–5A) or medical devices/diagnostics (models 1A–3A), and microelectronics/robotics sectors (models 4A–6A) tend, on average, to internationalize faster than those from ICT/software/digital media, whereas the opposite occurs in the case of USOs operating in the agri-food sector (models 4A–6A).

Earliness of internationalization

'Earliness' in internationalization (models 1B–6B), that is, going international within the first three years in business, is mainly explained by the existence of TTO support and the importance USOs attribute to S&T infrastructures and support mechanisms, namely those related to networking and business advice. Indeed, USOs that have resorted to TTOS support tend to present an odds ratio of earlier internationalization 19 times $\left(e^{\hat{\beta}=2.958}, p < 0.100; \text{model 2B} \right)$ higher than those that do not seek for such support mechanisms, which corroborates H10. Additionally, USOs that consider network and business advice a highly relevant support mechanism tend to internationalize earlier than the other USOs (presenting an odds ratio of earlier internationalization

32 times higher— $\left(e^{\hat{\beta}=3.463}, p < 0.100; \text{model 2B} \right)$, providing support to H11b.

Contradicting H11c and H11a, USOs that consider S&T infrastructures an important support mechanism to access funding and resources (only in models 5B–6B) tend to be laggards in internationalizing. The evidence gathered is not sufficient to distinguish early internationalizing USOs from laggards in the importance attributed to IPR support or to the several obstacles listed, failing to back H11d and H12. The same applies to the hypotheses associated to the entrepreneur-specific factors (H1–H3), to the majority of the business-specific factors (H4b–H6b) or to the region (H10). Although contradicting H4a, the results suggest that higher R&D intensity is negatively and significantly correlated with earlier internationalization. In other words, earliness in internationalization is associated with lower R&D-sales ratios. Younger and smaller USOs are, in general, earlier exporters, thus corroborating H8 and H9. USOs whose host university presents a higher number of patents per researcher tend to be laggards in terms of internationalization, which contradicts the hypothesis formulated (H13a). Publication and research center performance did not emerge as relevant to distinguish early from laggard USOs, thus failing to support H13b and H13c.

Finally, the sector stands as an important determinant of earliness in USO internationalization (i.e., H15 is backed), with firms from microelectronics/robotics showing a much higher odds of earlier internationalization than those from ICT/software/digital media.

Discussion and conclusions

Policymakers and technology transfer institutions place great expectations on USOs, which are potentially very important for countries whose basic research at universities is strong (Sternberg 2014). These firms comprise theoretically the most efficient means to transfer new technological knowledge into business, i.e., into new products and services (Conceição et al., 2012), with recent evidence suggesting that, in the long term, USOs have greater capabilities to develop wealth-creating business models than other new technology-based firms (Ortín-Ángel and Vendrell-Herrero 2014).

Even though internationalization remains the preferred growth strategy for many USOs (Björnåli and Aspelund 2012), and rapid and extensive internationalization may be attractive for these firms (Pettersen and Tobiassen 2012), research on the determinants of their speed of internationalization is scarce. Understanding the speed of internationalization is particularly important considering that Portugal's economic model, like in many other developed countries such as Spain or Germany, is export-led (Altomonte et al. 2013; Teixeira and Barros 2014) and policymakers and managers aim to expand their economies and succeed through internationalization. Moreover, the country has a dual economy that presents special traits compared with other industrialized countries, namely that productive specialization is more centered on traditional sectors than high-tech sectors, which generally characterizes USOs worldwide. Therefore, an understanding of the factors behind the USOs' speed of internationalization could help policymakers to better frame and shape their interventions, in order to stimulate investments towards technology-based entrepreneurship and foster international competitiveness.

Five key results emerge from our study. First, and differently from other new technological ventures and SMEs, the internationalization speed of USOs is critically dependent on TTO support. Indeed, USOs that seek support from TTOs started their international activities faster and earlier. TTOs have been included in university organizational structures, or have been operating in their name, in order to facilitate the transfer of knowledge and know-how from academia to business (Algieri et al. 2013). The TTOs' resources and ability to identify licensees lead to faster commercialization times (Markman et al. 2005) and are thus more likely to accelerate USO internationalization.

Second, and in line with the 'learning advantages of newness' perspective (Autio et al. 2000; Sapienza et al. 2006), we found that younger USOs tend to be in a better position to internationalize earlier than older USOs, as they are less likely to be constrained by the past and can therefore learn more effectively from their foreign activities (Zhou and Wu 2014). Thus, younger Portuguese USOs reveal higher levels of entrepreneurial spirit and entrepreneurial capabilities (Oviatt and McDougall 2005).

Third, as earlier studies have established (e.g., Covin et al. 1990; Zahra and Garvis 2000), firms in different industries face different competitive challenges, causing them to use different approaches to internationalization, achieving consequently different levels and speeds of internationalization. Our results show that USOs that operate in microelectronics/robotics internationalize faster and earlier than USOs operating in ICT/software/digital media. Firms in microelectronics/robotics require access to substantial financial and technological resources to manage their substantial R&D requirements, short product life cycles, frequent technological replacements, and fierce international competition. Early internationalization enables USOs in microelectronics/robotics to enter new markets earlier than their competitors and thus enjoy first mover advantage. Due to the short life cycle of products in this sector, first mover advantage can be more significant (Balconi and Laboranti 2006), justifying the earlier internationalization of USOs operating in this sector.

Fourth, high R&D-intensive USOs reveal low internationalization speed, being, in general, laggards in terms of internationalization. This result seems to contradict one of the pillars of the literature on born globals/international new ventures (e.g., Oviatt and McDougall 2005), which emphasizes knowledge intensity as a major source for firms' international competitive advantage. One of the key traits of USOs is the length of technology development and time to market/commercialization. These firms tend to spend many years on publically financed/subsidized R&D activities before launching products on the market (Pettersen and Tobiassen 2012). This longer technology development-commercialization cycle explains the low sales levels and thus high R&D intensity ratios and slow pace of internationalization.

Five, the way the speed of internationalization is operationalized (as a continuous variable—time between foundation and international activities—or as a dummy one—taking the value of 1 if the firm starts exporting within the first 3 years of its establishment) matters in assessing the determinants of the speed of internationalization. Indeed, networking and small size explain earliness (i.e., internationalizing in the first 3 years) but not the unconstrained speed of internationalization. In contrast,

USOs with a global market strategy, founders with technical skills, and operating in the energy/environment/sustainability, bio/pharma, or medical devices/diagnostics sectors tend to present faster internationalization rates but not internationalization earliness.

In terms of scientific/research implications, our study advances the current understanding of the earliness/speed of internationalization of university spin offs, extending the arguments from a broad-based international entrepreneurship perspective to emphasize the role of technology transfer offices and other S&T support infrastructures with respect to early internationalization.

With regard to practical implications for management and policy, our research suggests that entrepreneurs or founders should consider the considerable potential of TTOs in boosting their firms' early internationalization. University managers and local public authorities should also stimulate contacts between USOs and the available (regional) S&T infrastructure, most notably TTOs, by promoting events and activities that bring these two groups together. Technology transfer officers could further facilitate seminars where USO managers/founders share their international experiences and learn from each other, encouraging the creation of (social) networks of international managers, and provide them with incentives to do so as a way to foster the exchange of their professional experiences in foreign markets.

Despite the novelty of the present study, it has several limitations that need to be noted. First, our sample only included USOs in a single country (Portugal). Therefore, the results obtained from the specific research context can by no means be generalized to USOs in other countries. It is therefore important for future research to explore how different national contexts may affect the speed of early internationalization. Second, our analysis conveys a possible survival selection bias which many studies in this area share (Zhou and Wu 2014). The relation between survival and speed of internationalization might therefore stand as a challenging avenue for future research. Third, we implicitly assume that either all firms want to internationalize, consider internationalization a positive process, or are able to internationalize from foundation. Some firms may, however, deliberately choose not to internationalize early which may result in a low speed of internationalization. Moreover, as Cesinger et al. (2012) and Chetty et al. (2014) noted, being an early internationalizing firm might not directly result in enhanced performances. Fourth, we considered a one-dimensional view on the speed of internationalization referring to speed solely as time (the time it takes to internationalize), and thus could not fully capture the complexity of speed and how changes in key internationalization constructs create speed (Chetty et al. 2014) or how USOs' post-entry growth and/or survival rates related with the speed of internationalization (Autio et al. 2000).

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Appendix

Table 4 Means and correlations

	Mean	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Speed of internationalization	2.361	1	0.495	-0.033	0.146	0.147	0.130	0.080	0.037	-0.122	0.090	0.133	0.011	-0.038
2 Earlier exporters (d)	0.500	1	-0.029	-0.067	-0.052	-0.001	-0.048	-0.113	0.018	0.018	0.095	0.052	0.097	-0.175
3 Founder(s) industry experience (d)	0.667	1	0.042	0.137	0.172	0.172	0.272	-0.049	0.084	0.122	0.122	-0.072	0.075	0.181
4 Technology (d)	0.756	1	1	-0.020	0.291	0.188	0.146	0.146	0.063	0.066	0.066	0.094	0.080	0.213
5 Business/management (d)	0.295	1	1	0.332	0.124	-0.081	0.037	0.215	0.082	0.108	0.168	0.103	0.103	0.103
6 Technology and business/management (d)	0.221	1	1	0.170	-0.087	-0.063	0.171	0.054	0.130	0.103	0.103	0.103	0.103	0.103
7 Number of founders FTE	1.869	1	1	0.029	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038	-0.038
8 R&D intensity	5.143	1	1	0.430	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126
9 Patents (d)	0.179	1	1	0.045	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
10 Main driver—industry (d)	0.244	1	1	-0.143	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
11 Global (d)	0.718	1	1	-0.044	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107	0.107
12 Niche (d)	0.641	1	1	-0.257	1	1	1	1	1	1	1	1	1	1
13 Size	10.4	1	1	1	1	1	1	1	1	1	1	1	1	1
14 Age	5.9	1	1	1	1	1	1	1	1	1	1	1	1	1
15 Past performance (€)	28,841	1	1	1	1	1	1	1	1	1	1	1	1	1
16 TTO (d)	0.167	1	1	1	1	1	1	1	1	1	1	1	1	1
17 Resource access (d)	0.372	1	1	1	1	1	1	1	1	1	1	1	1	1
18 Network (d)	0.269	1	1	1	1	1	1	1	1	1	1	1	1	1
19 Financial (d)	0.128	1	1	1	1	1	1	1	1	1	1	1	1	1
20 IPR (d)	0.333	1	1	1	1	1	1	1	1	1	1	1	1	1
21 Weak UI relations (d)	0.321	1	1	1	1	1	1	1	1	1	1	1	1	1
22 Institutional O. (d)	0.359	1	1	1	1	1	1	1	1	1	1	1	1	1
23 Financial O. (d)	0.256	1	1	1	1	1	1	1	1	1	1	1	1	1
24 Managerial O. (d)	0.141	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 4 (continued)

	Mean	1	2	3	4	5	6	7	8	9	10	11	12	13
25	Infrastructures/distance to markets	0.231												
26	Univ. patents per researchers	7.042												
27	Univ. ISI publications/researcher	2.843												
28	Research units with very good or excellent	0.576												
14		17	18	19	20	21	22	23	24	25	26	27	28	
1	-0.558	-0.211	0.091	0.150	-0.240	0.091	-0.103	-0.035	-0.059	0.014	0.021	0.132	-0.052	-0.111
2	-0.522	-0.080	0.123	0.056	-0.103	-0.052	0.063	-0.124	0.080	-0.045	0.063	0.067	-0.210	-0.192
3	-0.109	0.050	0.107	-0.200	0.028	-0.053	-0.014	-0.034	-0.198	-0.173	-0.188	-0.185	0.158	0.073
4	0.009	-0.187	-0.093	0.004	-0.186	0.121	0.013	-0.096	-0.080	-0.055	0.045	-0.113	0.234	0.238
5	-0.087	-0.063	-0.147	0.045	0.045	0.181	0.013	-0.090	0.084	0.166	-0.192	-0.128	-0.046	0.230
6	-0.100	-0.038	-0.081	-0.023	-0.021	0.169	-0.013	-0.115	0.080	0.055	-0.231	-0.049	-0.004	0.074
7	-0.064	-0.145	-0.006	-0.132	-0.130	-0.132	-0.029	0.130	-0.225	0.058	0.025	-0.172	0.157	0.142
8	0.018	-0.170	0.129	0.164	0.092	0.015	-0.119	-0.072	-0.054	-0.046	-0.097	-0.037	0.252	0.042
9	0.086	-0.115	0.078	-0.004	0.021	0.142	0.089	-0.175	-0.031	-0.188	-0.089	-0.153	0.196	0.135
10	0.006	0.089	0.076	0.052	-0.115	-0.037	0.035	0.001	0.053	0.034	0.033	-0.066	-0.001	-0.033
11	0.022	-0.006	-0.172	-0.119	-0.172	-0.092	-0.145	0.090	0.108	0.113	0.107	0.054	0.279	0.262
12	-0.119	-0.109	0.133	0.107	0.135	0.140	0.276	-0.174	-0.150	-0.003	0.083	0.060	-0.109	0.098
13	0.335	0.083	-0.131	-0.119	-0.097	-0.121	-0.046	0.091	-0.049	0.043	0.028	-0.308	0.133	0.284
14	1	0.695	-0.234	-0.147	0.007	-0.124	-0.173	0.108	0.044	0.030	0.145	0.046	0.173	0.295
15	1	1	-0.135	-0.221	0.071	-0.164	-0.166	-0.068	-0.216	-0.166	-0.095	0.112	-0.093	0.021
16	1	1	0.065	0.059	0.065	0.018	0.061	0.032	0.094	-0.039	-0.001	0.006	-0.138	-0.086
17	1	1	0.325	0.170	0.488	0.488	0.488	-0.052	-0.135	0.033	0.053	-0.159	-0.221	0.080
18	1	1	0.402	0.402	0.358	0.358	0.358	-0.091	-0.040	0.160	0.198	0.073	-0.098	0.074

Table 4 (continued)

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
19						1			0.028	0.213	-0.061	0.072	0.041	-0.126	0.123
20		0.325					1	-0.069	-0.026	-0.079	0.036	-0.085	-0.294	-0.020	0.053
21								1	0.235	0.154	0.173	-0.115	0.103	0.083	0.119
22									1	0.399	-0.002	0.080	0.065	-0.041	-0.078
23										1	0.181	0.055	0.008	-0.149	0.019
24											1	-0.138	0.083	0.056	0.172
25												1	0.050	-0.044	-0.073
26													1	-0.570	0.524
27														1	0.649
28															1

d stands for dummy variables

Entries set in italics are very high correlation coefficients

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