Chapter 9
Every Woman Is a Vessel: An Exploratory Study on Gender and Academic Entrepreneurship in a Nascent Technology Transfer System

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Abstract Previous research shows that women are under-represented among academic entrepreneurs, indicating a gender gap in this field. Using a case-oriented approach combining interview analysis and fuzzy-set analysis, we explore potential barriers to women's engagement in academic entrepreneurship as perceived by both the researchers and the heads of technology transfer offices (TTOs). The inclusion of the latter group foreshadows the relevance of different actors who can influence the gender gap in academic entrepreneurship settings. We thus contribute to the body of knowledge about female academic entrepreneurship. The potential barriers are modelled as internal and external. We reveal that internal barriers (e.g., work-family balance and ambition) are perceived as more crucial than external barriers by both groups of respondents. However, TTOs and researchers seem to partially disagree about those barriers, which may impact the effectiveness of mechanisms implemented to mitigate the gender gap in academic entrepreneurship. Moreover, although both TTOs and researchers recognise the gender gap, neither party identified TTOs as responsible for reducing the associated disparities. Our fuzzy-set analysis, performed to explore the causal relationships between different gender gap conditions and female academic entrepreneurial activity, reveals two combinations of barriers underlying women's low engagement in academic entrepreneurship.

Keywords Female entrepreneurship · Academic entrepreneurship · Technology transfer · Gender gap · Patents

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J. M. Azagra-Caro et al. (eds.), *University-Industry Knowledge Interactions*,
International Studies in Entrepreneurship 52,
https://doi.org/10.1007/978-3-030-84669-5_9

9.1 Introduction

Women's engagement in academic entrepreneurship is taking place in the era of an entrepreneurial turn (Foss & Gibson, 2015). However, the issue of female academic entrepreneurship and the gender gap was long limited to feminist studies. Areas like innovation, technology, and entrepreneurship were traditionally characterised by gender blindness, emphasising that science and innovation operate on meritocratic principles for which only results and contributions matter (Ranga & Etzkowitz, 2010). Nonetheless, a change is happening. Alsos et al. (2016: 11) claim that 'gender and innovation is an emerging field of research' that has 'quickly gained a strong and influential foothold'. The same sentiment is mirrored in the entrepreneurship literature (Brush et al., 2019; Foss et al., 2019).

As universities are becoming increasingly entrepreneurial, we are presented with somewhat conflicting evidence on the extent of the gender gap in academia (e.g., compare Milli et al., 2016 with Colyvas et al., 2012) even in larger and more explored systems, such as the United States. However, the transition to more entrepreneurial universities is even more ill-informed in less-developed nascent systems, which can face unique setbacks. Thus, strategies to recognise and mitigate gender gap barriers are particularly important in small nascent systems.

To shed light on the barriers underlying the gender gap in academic entrepreneurship, we provide a literature-based model of internal (i.e., work-family balance, risk-taking, ambition, experience) and external (i.e., lack of presence, access to finance, peer effect, gender-differentiated TTO support, networking) barriers, drawing on the gender, entrepreneurship, and innovation literature.

Utilising a case-oriented approach and combining interview data from TTOs and university researchers, we elucidate the barriers to female academic entrepreneurship as recognised by university researchers and heads of TTOs. We thus answer the call for more research on other actors in academic entrepreneurship, especially brokers, and try to move beyond 'consistently recommending "fixing women"' by 'isolating and individualising' perceived problems (Foss et al., 2019: 409–410).

We discover that both TTOs and researchers give more attention to the internal barriers to women's engagement. However, we also uncover some differences between the perceptions of the providers of academic commercialisation support and the perceptions of users of said support (researchers). This mismatch can have important policy consequences as it may contribute to nascent technology transfer systems' slower progress in overcoming the gender gap in academic entrepreneurship compared to their more developed counterparts.

A common limitation of research exploring nascent systems in small countries, such as in the case of our research setting, is the use of small samples that prevent more advanced analysis. Although we interviewed the heads of the majority of Slovenian TTOs, our sample was small. Thus, to overcome this limitation, we used fuzzy-set qualitative comparative analysis (fsQCA), which enables the analysis of small samples but still allows for generalisation (Ragin, 2008). We also answer the call by Henry et al. (2016: 217) to further 'develop the methodological repertoire'

in gender entrepreneurship studies, including that related to case studies. fsQCA allowed us to explore the different conditions (i.e., combinations of barriers) leading to women's lower engagement in academic entrepreneurship.

As an original contribution, we show which combinations of barriers underlie women's lack of engagement in academic entrepreneurship in nascent systems. We contribute to extant gender and (academic) entrepreneurship theory by highlighting the importance of internal and external barriers of the gendered academic entrepreneurship and the nuanced perceptions of these barriers by two important groups of actors, i.e., the TTOs and researchers. We also further our understanding of how these barriers can affect the outcomes of academic entrepreneurship by introducing the fsQCA methodology to explore gender issues in nascent systems.

9.2 Female Academic Entrepreneurship: Towards a Conceptual Framework

There are inherent restrictions in innovation and entrepreneurship research when focusing on gender issues. First, similar to other economic studies, gender has primarily been included only as a dummy variable, and still today, there is a 'proliferation of large-scale empirical studies', with limited interpretative value (Henry, C. et al., 2016). Second, the restrictions are connected to prevailing meritocratic ideals in terms of individuals' participation in scientific activities, with little room for individual-level innovation and entrepreneurship research, let alone a focus on gender disparities. This is underlined by the prevalence of studies on the team, institutional, and organisational levels (Modic & Yoshioka-Kobayashi, 2020; Ranga & Etzkowitz, 2010).

However, gender issues are gaining prominence outside the field of gender studies, confirming what Alsos et al. (2016) and Foss et al. (2019) have pointed out: there is budding interest in gender issues in innovation and entrepreneurship studies. In terms of technology transfer and, in particular, female academic entrepreneurship, research points out that female academics show a significantly lower propensity to start ventures than men do (Ebersberger & Pirhofer, 2011; Pitchbook, 2018). Also in terms of other channels of technology transfer, women seem to be less present than men are; e.g., women are less likely to be included as inventors in patent activity in comparison to men (Frietsch et al., 2009; Milli et al., 2016). There is evidence that most women inventors with patents come from academia (Martínez et al., 2016), yet this is poorly researched in nascent systems.

Exploring nascent systems is also interesting in terms of the structural vs culturalist viewpoint. The structural approach, which asserts that similarities are to be expected across countries with similar structures (e.g., levels of industrialisation, occupational systems), is opposed by culturalist theory, which argues that dissimilarities are to be expected as a result of intrinsic country-specific characteristics; that is, culture modifies the effect of a country's social structure on individuals (Gauthier,

2000; Paisey & Paisey, 2010). Previous research indicates that more developed technology transfer systems might follow similar patterns (e.g., Grimpe & Fier, 2010), but it is unclear which effect prevails in nascent systems. Identifying gender gaps and the barriers to female entrepreneurship in a system, such as the Slovenian one, whose institutional set up shares many similarities to other nascent systems, e.g., the Hungarian one (Novotny, 2017), can shed more light on this.

We focus on the barriers to female academic entrepreneurship and have classified the barriers in two types according to the source: external and internal. This also allows us to contrast the 'deficit' and 'difference' models, according to Corley (2005). External barriers are related to the environment and range from systemic to peer-level factors. Barriers classified as internal are related to the individuals themselves. Therein, according to the literature, a range of demographic and economic factors and barriers act as either drivers or inhibitors of entrepreneurial behaviour (Loscocco & Bird, 2012). In addition to the barriers presented in the entrepreneurship literature, we also take into account barriers from the psychology and sociology literature, which have often been seen as being relevant as female academic entrepreneurship engagement deterrents (Brush et al., 2019). Corley (2005) contrasted the 'deficit model', which sees female scientists as less productive than male scientists because they have fewer opportunities than men do, with the 'difference model', which views female scientists as less productive than male scientists because the two genders are 'different'. The external barriers reflect the 'deficit' model, and the internal barriers reflect the 'difference' model.

While focusing on barriers, we take into account two important actors in the academic entrepreneurship ecosystem: researchers who engage in academic entrepreneurship and TTOs. The latter relate to the meso-level in the 5 M framework, proposed by Brush et al. (2019) to study female entrepreneurship since they claim the gatekeepers of resources (such as TTOs) matter. In systems without professor privilege, science commercialisation begins when researchers disclose a technology to a university's TTO. After disclosure, the majority of the decision-making process is left up to the TTO. Goel et al. (2015) conceptualised TTOs as one of the main bottlenecks to successful science commercialisation. TTOs can also have diverse recognition of barriers to successful commercialisation and female engagement therein than researchers do. Having a strong position, but diverse perceptions, can have important consequences for the academic entrepreneurship ecosystem and for decreasing the gender gap therein (Fig. 9.1).

We hence also draw attention to the fact that entrepreneurs often rely on subjective perceptions rather than on objective expectations of success when pursuing entrepreneurial opportunities (Arenius & Minniti, 2005; Minniti, 2009). We argue the same is true for staff at TTOs, based on indices from previous research (Shane et al., 2015). In regards to female entrepreneurship, evidence suggests that subjective perceptions also contribute to explaining differences between the participation of men and women (Minniti, 2009). Different groups can thus have diverse perceptions. Acknowledging the role of subjective perceptions has influenced our research design. Hence, we not only focused on specific 'perceptual variables' (Arenius & Minniti, 2005) but, as a broader approach, we also studied the barriers to women's

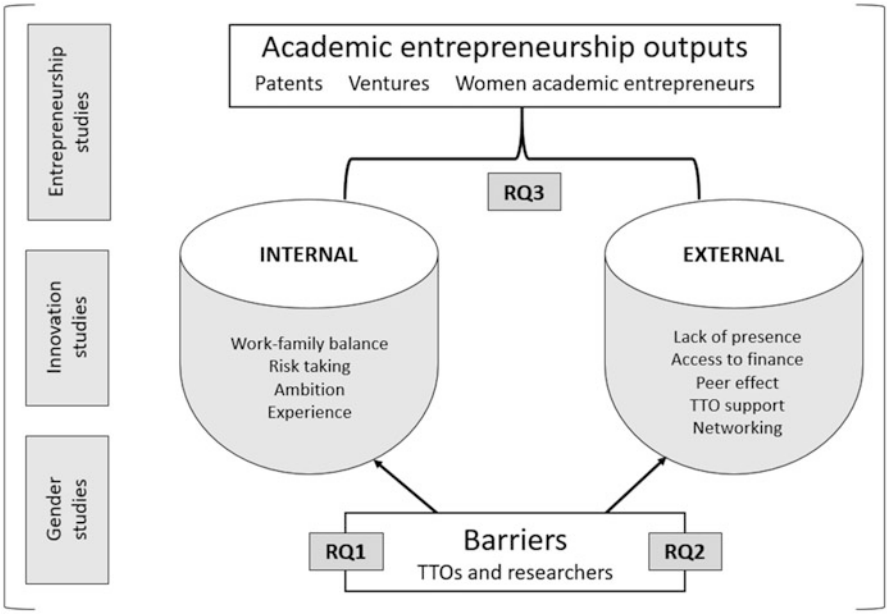

Fig. 9.1 Conceptual framework

engagement in academic entrepreneurship as perceived by individual researchers as well as heads of TTOs.

We thus explore the internal and external barriers to female engagement in academic entrepreneurship recognised by TTO staff (RQ1) compared with those recognised by researchers (RQ2). We then proceed by scrutinising which combinations of barriers are (relevant) causes for women's low engagement in academic entrepreneurship (RQ3).

9.3 Operationalisation of Selected Barriers

We adopt a dichotomous view of the barriers to women's engagement in academic entrepreneurship, dividing them into *internal and external barriers*, which allows us to capture both the deficit model and the difference model proposed by Corley (2005).

In terms of internal barriers, we first take into account potential gender differences in work-family balance. The effect of women's family roles on their scientific careers has been extensively studied. For example, Shauman and Xie (1996) hypothesised that having children results in reduced career mobility for women scientists. In contrast, Sullivan and Meek (2012) argued that entrepreneurship provides flexibility, enabling women to manage their work-family balance better.

Second, we take into account gender differences in risk-taking (e.g., see Loscocco & Bird, 2012 and literature therein), for which risk aversion due to fear of failure seems to be more pronounced among women than men (Arenius & Minniti, 2005). Third, we focus on women's presumed lack of ambition in terms of research commercialisation (Abreu & Grinevich, 2017; Ebersberger & Pirhofer, 2011). For instance, Abreu and Grinevich (2017) discovered that women feel more ambivalent about research commercialisation than men do, which correlates to lower rates of spin-out activity among women. Fourth, research often emphasises that researchers' age and experience as well as TTO's age, reflecting their experience (e.g., Colyvas et al., 2012; Friedman & Silberman, 2003) matter in science commercialisation.

Focusing on external barriers, first, we account for a lack womens' interest in academic entrepreneurship (Colyvas et al., 2012; Rosa & Dawson, 2006), either due to self-selection (Abreu & Grinevich, 2017), male-dominated fields being more often seen as a context for inventive activities (Wajcman, 2010) or to womens' lower perceptions of the impact of their research on industrial beneficiaries (Azagra-Caro & Llopis, 2018). Second, one of the most important elements for an academic entrepreneurial endeavour to succeed is access to finance. Although there is evidence that women experience less overt discrimination in gaining access to funding than previously thought (e.g., Brush et al., 2014), research also shows that men tend to have better access to capital for start-ups (Robb & Coleman, 2009; Brooks et al., 2014). Third, we focus on perceptions of the value of women's innovation skills and peer effects. In some contexts, women's innovations are perceived as lesser than their male counterparts' innovations (Alsos et al., 2016). Furthermore, peers may be perpetuating these ideas, with Goel et al. (2015) theorising that perhaps women remain occupied with the administrative work and thus have fewer opportunities to conduct research that generates entrepreneurial interest. Fourth, we consider the role of TTO's support service, for which a TTO's actions should be seen as a part of a collaborative community with the potential to affect many facets of academic entrepreneurship outcomes, including those connected to gender participation. Shane et al. (2015) discovered that randomly assigning a female faculty member to an invention disclosure discouraged a TTO from forming a spin-off company. TTO staff may be more willing to support male inventors than female inventors. Fifth, we acknowledge that academic entrepreneurship is greater among academics with wide-ranging networks, but women could have less access to networks that provide social resources (Stephan & El-Ganainy, 2007; Bird, 2011).

In terms of outputs, to test our model, we include three outputs that most accurately capture the main characteristics of female academic entrepreneurship. Specifically, we take into account two factual indicators – patents and academic ventures – and one indicator that is in itself a perceptual variable – female academic entrepreneurs (Arenius & Minniti, 2005); the latter is an operational necessity due to the lack of statistical data on women entrepreneurs in academia.

9.4 Research Set-Up, Methodology and Data

The nascent Slovenian system presents an interesting research set-up: spin-out companies are not listed among main the outputs of TTOs operations; however, TTOs publicly acknowledge them (Suhadolnik, 2018). A rather specific legal regulation related to the definition of university start-ups that needs to be taken into account in nascent systems in which legal regulations prevents public research organisations (PROs), including universities, to have ownership shares in academic start-ups. This has prompted a more open definition of academic start-ups in order to capture all relevant start-ups. We define an academic start-up as a business endeavour initiated by an academic researcher or a researcher from a PRO on the basis of publicly funded intellectual property. This allowed us to also tap into *hidden technology transfer*, i.e., technology transfer outside the formal system (Fini et al., 2010), which is needed if we want to gain a clearer picture of the true extent of academic entrepreneurship in similar institutional set-ups and the potential gender gap therein.

Slovenian research has remained silent on potential gender gaps in academic entrepreneurship, although gender issues play a prominent role in Slovenian society, and there have been several research endeavours connected to women entrepreneurs in Slovenia (e.g., Modic et al., 2015). Nevertheless, only a few have also encompassed academic entrepreneurship (e.g., Adam et al., 2014) and did not focus on women in particular. However, Slovenia is among the most advanced countries in the European Union according to some gender statistics (Eurostat, 2019). The first TTO in Slovenia was established in 1996. Ruzzier et al. (2011) claimed that until 2009, PROs managed to form a formal spin-off or spin-out company, indicating that the PROs' start-up tradition is young. However, some universities have formed successful start-ups, several of which remain in close contact with their PROs. The Slovenian government has provided financial support to TTOs continuously since 2009; including for the National Consortium of PROs for Technology Transfer (TTO Consortium). The TTO Consortium currently consists of eight members, producing the majority of all technology transfer outputs in Slovenia.

Due to the mostly anecdotal evidence relating to the nascent technology transfer system under scrutiny, we first had to conduct a short preliminary patent analysis, before pursuing a multiple-case approach. The analysis explores the presence of women in patenting and women's patent potentials. With a multiple case study, multiple cases are explored to understand differences and similarities between the cases (or types of cases), which can then be used to analyse the data both within and across situations and to reveal contrasting or similar results in individual cases (or types of cases) (Yin, 2014; Gustafsson, 2017).

We conducted semi-structured interviews with the heads of Slovenian TTOs to answer RQ1. We invited all eight TTOs that are members of the TTO Consortium to participate. All but one responded positively. Through the interviews, we analysed barriers that prevent female researchers from coping with the challenges of

entrepreneurship. The interview guide consisted of open questions and a four-point Likert scale to allow the respondents to rank the predicted influence of individual barriers.

Furthermore, we conducted eight interviews with female and male researchers to answer RQ2. We included male researchers to provide diversity and account for factors that have equal or divergent intensity for both genders. The researchers came from different fields (e.g., informatics, electro-engineering, chemistry) to account for differences related to their field of work. Researchers engaged in entrepreneurship were connected to six different TTO-facilitated technologies. We also included female entrepreneurs from the only two Slovenian academic ventures with predominantly female founders.

We used the fuzzy set qualitative comparative analysis (fsQCA), which enables the analysis of small-N samples, to shed light on RQ3. With carefully selected cases, including those of general importance in relation to the research problem, the method allows for reasonable generalisation. FsQCA is a recent and rapidly developing method in comparative social research (Ragin, 2008; Modic & Rončević, 2018). The underlying assumption of fsQCA is that patterns of attributes exhibit different features and lead to different outcomes depending on how they are arranged. In addition, fsQCA assumes that contextuality, i.e., how attributes within cases are arranged (present/absent conditions) and interacted, determines outcomes rather than the net effect of all attributes. To achieve this, the fsQCA was developed using the functions and rules of Boolean algebra. We constructed an original dataset from the interviews to determine which combinations of barriers hinder women's engagement in academic entrepreneurship.

We took into account several factors based on theory and previous research to operationalise both types of barriers and provide answers to our research questions. Our operationalisation of the barriers is in Table 9.1. Anchor values were assigned to each of the variables using a joint calibration approach[1] and are available in Appendix 1. After the calibration, we merged the individual internal and external barriers into two super groups and tested them against the joint output to test the robustness of our data and proposed model. The calculations were done using Boolean algebra and its addition rule. The purpose is to test the robustness of our data and the proposed model.

Each of the variables in our model obtained a score, which we then translated to a fuzzy-set value between 0 (indicating the complete absence of the variable) and 1 (indicating the complete presence of the variable). This was done as follows: 1 corresponded to 0 in the fuzzy set; 2 corresponded to 0.334; 3 corresponded to 0.667; 4 corresponded to 1 (see also Table 9.1). For example, the specific interviewee age groups were assigned fuzzy-set values as follows: 20–30 years corresponded to 0 in the fuzzy set; 31–40 years corresponded to 0.334;

[1] In this approach, anchor values are determined by joint discussion and agreement among all authors to ensure the values correspond with theory and data and to avoid individual bias. Similar approaches have proven successful in prior research (e.g., Modic & Rončević, 2018).

Table 9.1 Operationalisations of internal and external barriers with anchors

		Descriptions of barriers	
	Fuzzy sets	[Anchors researchers]	[Anchors TTOs]
INTERNAL	INT1: Work-family balance	Description: Women choose to pursue academic entrepreneurship more rarely than men do due to their family obligations.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	INT2: Risk-taking tendencies	Description: Women choose to pursue academic entrepreneurship more rarely than men do because employment in a public research organisation is more stable.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	INT3: Ambition	Description: Men are more ambitious than women are.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	INT4: Experience[a]	Description: Age of researcher	Description: Age of TTO
		[20–30 years = 0; 31–40 years = 0.334; 41–50 years = 0.5; 51–60 years = 0.667; 61–70 years = 1]	[0–1 years = 0; 2–-5 years = 0.334; 6–-8 years = 0.5; 9–-12 years = 0.667; 13+ years = 1]
EXTERNAL	EXT1: Lack of presence	Description: Women are creative in areas that are interesting for entrepreneurship.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	EXT2: Access to finance	Description: Women have more problems acquiring start-up capital for an academic venture.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	EXT3: Peer effect	Description: Women are allocated more administrative work (routine, non-creative) compared to their male colleagues.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	EXT4: Gender differentiated TTO support	Description: TTOs support differentiates between genders.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
	EXT5: Networking	Description: Women in academia have weaker social networks than men do.	
		[1 = 0; 2 = 0.334; 3 = 0.667; 4 = 1]	
OUTPUTS	OUT1: Patents[a]	Description: Researchers' number of patents weighted by age.	Description: Number of patents in the last year per FTE.
		[Less than 0.5 = 0; 0.5 to less than 1 = 0.334; 1 to less than 1.25 = 0.334; 1.25 to less than 1.5 = 0.667; 1.5+ = 1]	[Less than 0.5 = 0; 0.5 to less than 1 = 0.334; 1 and less than 1.33 = 0.5; 1.33 and less than 3 = 0.667; 3 and more = 1]
	OUT2: Ventures[a]	Description: Extent of collaboration in an academic venture.	Description: Number of academic ventures normalised by TTOs' age.
		[No venture and no intention of establishing one = 0; there was never any significant	[Less than 0.1 = 0; 0.1 and less than 0.33 = 0.334; 0.33 and less than 0.34 = 0.5; 0.34

(continued)

Table 9.1 (continued)

		Descriptions of barriers	
	Fuzzy sets	[Anchors researchers]	[Anchors TTOs]
		realisation of collaboration = 0.334; the venture is active = 0.5; academic venture has more than 20 employees = 1]	and less than 0.5 = 0.667; 0.5 and more =1]
	OUT3: Female academic entrepreneurs	Description: Women are academic entrepreneurs less often than men.	Description: Women are encountered as academic entrepreneurs less often than men.
		[Less than 5% = 0; 5–10% = 0.334; 10–50% = 0.667; more than 50% = 1]	

[a]Factual variables

41–50 years corresponded to 0.5; 51–60 years to 0.667; and 61–70 years to 1. None of the interviewees was below 20 years of age or above 70 years of age.

In terms of outputs, data for OUT1 were gained by calculating the number of patents weighted by the researchers' age and the number of patents in the previous year by full-time employment equivalent for TTOs. Data for OUT2 were gained by calculating researchers' extent of collaboration in an academic venture and the number of academic ventures normalised by the TTOs' age. Lastly, OUT3 was created on the basis of both researchers' and TTO representatives' perceptions regarding the extent of women's engagement in academic ventures encapsulated in their Likert scale evaluation.

To be able to test the robustness of the proposed model, we created two expressions on the internal and external barriers. We applied the Boolean function of 'OR' to both calculations, as follows: for internal barriers, allINT, including work-family balance, risk-taking, ambition, and lack of experience, and for allEXT, including women's lack of presence in specific fields, access to finance, networks, gender-differentiated support by TTO, and peer effect. The formulas allINT = fuzzyor (INT1,INT2,INT3,~INT4[2]) and allEXT = fuzzyor(EXT1,EXT2,EXT3,EXT4, EXT5), respectively, were used. Following the same logic, the allOUTPUT variable, we used a multiplication approach (i.e., Boolean Algebra 'AND' function) combining the normalised numbers of patents, ventures, and women in academic entrepreneurship: allOUTPUT = fuzzyand(OUT1,OUT2,OUT3).

Since we were interested in the absence of women's engagement in academic entrepreneurship, we applied Boolean negation to the allOUTPUT variable as follows: ~allOUTPUT = fuzzyneg(allOUTPUT). To test the robustness of the

[2]The INT4 barrier was operationalised as the researcher's age and the TTO's age (years of existence). The barrier, in this case, is a lack of experience resulting from the younger age; therefore, we re-calculated the barrier and included it in the analysis as 'absence of experience'. We used ~INT4 = fuzzyneg(INT4).

model, we elaborated the expression ~allOUTPUT = f(allINT, allEXT). We applied the Boolean Truth Table with a consistency cut-off at 0.80[3] and Quine-McCluskey algorithm to the expression.

9.5 Results

9.5.1 Preliminary Analysis: Patents and Start-Ups by Women in the Selected Nascent System

To provide context for our research setting, we first tested the claims of Martínez et al. (2016) that most women inventors with patents come from academia. In May 2019, we analysed all 261 patents granted in 2018, as reported in the Slovenian patent database (SIPO.DS). Based on a fractional count, the majority of patents (60.3%) belong to companies, 29.1% to individual inventors (among them only 12.2% are women), and 10.5% to universities or research institutes.

These 261 patents have 620 inventors; among them, 14.4% have women inventors listed. However, if only academic inventors (i.e., patents belonging to universities and institutes) are considered, the share of women is much larger (34.1%), which is consistent with the findings of Martínez et al. (2016). Since women inventors in academia represent more than 50% of all women inventors, we can assume that the typical female inventor is employed at a higher education institution or PRO (see Table 9.2).

Next, we looked at the gender balance based on patents with more and less (commercial) potential. We took into account whether the patent application process started in Slovenia with a less demanding patenting process or it started or continued in a (more demanding) international patenting process. This approach enabled us to differentiate patents with more and less potential as the latter (patents going through an international process) undergo more rigorous examination and have broader geographical coverage and higher applicant costs. Table 9.3 shows that the share

Table 9.2 Inventors and academic inventors

	All inventors		Academic inventors	
	Number	Percentage	Number	Percentage
Women	89	**14.4**	45	**34.1**
Men	531	85.6	87	65.9
Sum	620	100	132	100

[3]Consistency measures the degree to which the term and the term solution are subsets of the outcome (Ragin, 2008). We followed the idea of reporting positive experience the cut-off is set at 0.70 (Schneider & Wageman, 2007). We set the cut-off even more strictly, at 0.8, to ensure higher levels of degree to which cases in the dataset are members of the proposed solution. Similarly, the coverage threshold, representing the degree of the outcome being explained by the proposed solution, is also set to 0.8.

Table 9.3 Inventors broken down by patent potential

	Domestic patents (223)		Patents with international examination (38)		Academic patents with international examination (4)	
	Number	Percentage	Number	Percentage	Number	Percentage
Women	60	**11.8**	29	**25.7**	7	**41.2**
Men	447	88.2	84	74.3	10	58.8
Sum	507	100	113	100	17	100

of women inventors is much higher for patents with more potential, especially when the (co-)owner is a PRO.

We also conducted an initial review of the PROs' start-ups, deriving the information from the TTOs' websites and articles related to academic start-ups in Slovenia. The review revealed 24 currently acknowledged spin-outs in Slovenia connected to the consortium of TTOs (May 2019). The majority of the spin-outs' founders are men; in only two cases did the initiative for establishing an academic company come exclusively from women.

9.5.2 Interview Analysis

The majority of TTOs, who vary significantly in terms of experience, reported that in the last year, women researchers applied for fewer patents than men did, even though the number of male and female researchers in these TTOs was mostly similar. Four out of the seven TTOs reported having spin-outs and establishing measures to promote academic entrepreneurship. The majority of the TTO representatives noted that women rarely participate in academic entrepreneurship. However, no TTO reported measures to encourage women's participation in entrepreneurship, although one respondent explicitly outlined the need for more support for women who are having issues with work-family balance. Overall, respondents think TTOs' support should be equally accessible to both genders. There was little convergence in terms of external barriers to women engagement in academic entrepreneurship. While some stated that women have more difficulties dealing with risks in entrepreneurship and may consider working in a PRO to be a safer option, others claimed that both genders face these risks equally and that employment in a PRO is not 'safe' anymore. The majority also believed that women face equal difficulties in obtaining start-up funding as men do and that their professional networks are comparable. In contrast, the majority of TTO representatives recognised that women researchers engage in administrative and other 'less valuable' work more frequently than their male colleagues do.

Our interviews with researchers pointed out that for the internal barriers, family and lack of ambition are seen as most problematic. However, the researchers did not see that TTOs encourage male researchers more, that women are less creative in areas of interest for academic entrepreneurship, or that women are burdened with

more administrative work. They also did not believe that women's inventions are less respected in society. Indeed, one of the researchers commented, *'It looks like women are rare, but when they do something, there is a higher probability they will do it well and thoughtfully'*. Some emphasised that *'women are less trusted in the business environment*' while others claimed that society recognises the benefits of female business owners. Another researcher believed that traditional patterns still prevail both in society in general and in academia. Men are traditionally seen as leaders and women as supporters, which is also evident in other more mature systems, such as the United Kingdom, where the respondent was working at the time of the study. This individual, along with a female researcher who was working in the United States, also pointed out the very different financial opportunities available for start-ups in mature technology systems in comparison to nascent systems. Appointing a female start-up leader in traditional environments can even have a negative effect on entire start-up teams. Another researcher believed the main reason for the absence of women in academic entrepreneurship is women's higher social responsibility: they are afraid of bankruptcy and the negative effects it has on employees.

Both types of respondents (TTOs and researchers) observed that women rarely participate in academic entrepreneurship. In terms of internal barriers, both types of respondents recognised the decision to have a family as an obstacle to female academic entrepreneurship, while they disagreed about which of the two genders might be more ambitious. In terms of external factors, the TTO representatives recognised that women engage in 'less valuable' work more frequently than their male colleagues do, seeing this as a serious barrier to their engagement in academic entrepreneurship. Interestingly, the majority of the researchers did not share this view, with some even arguing that women can develop trustworthy networks by serving as administrative project leaders. In addition, the TTO representatives did not believe that their organisations play a particular role in supporting female academic entrepreneurship, a view shared by the researchers, who also did not perceive that TTOs encourage one gender more than the other.

We thus provide answers to RQ1 and RQ2, while detecting some differences among the TTO representatives' and the researchers' perceptions of important barriers.

9.5.3 Fuzzy-Set Analysis

We proceeded with the fuzzy-set analysis to answer RQ3. In our research context, the notion of relevance is defined as seeking correlations between the proposed barriers and lower levels of women's engagement in academic entrepreneurship.

The results indicate that both sets of barriers, i.e., internal and external, are important and contribute towards the proposed outcome. The solution's consistency is 0.823944, and its coverage value is 0.87405. We can thus reliably conclude that the absence of female academic entrepreneurship is conditioned upon a combination

of the presence of internal barriers (lack of work-family balance, lack of risk-taking, lack of ambition, and lack of experience) and the absence of external barriers (lack of presence, difficulties accessing funding, negative peer effect, lack of gender-differentiated support for women by TTO, weaker networks). In other words, the presence of internal barriers, together with the absence of external barriers, represents *a sufficient condition*[4] for the absence of female academic entrepreneurship. This finding is in line with the results from our qualitative analysis.

After finding a set of barriers that resulted in sufficiency for the absence of women's engagement in academic entrepreneurship, we initiated the test of necessity. To perform this test, we first computed a new variable for both internal and external barriers using the following formula: solution = allINT*~allEXT. The new variable was tested in terms of the *necessity* for the analysed absence of women's engagement in academic entrepreneurship. Applying the same threshold as above, the values for consistency and coverage result to be 0.876405 and 0.823944. To conclude, the presence of internal barriers, along with the absence of external barriers, is a *necessary condition*[5] for the absence of women's engagement in academic entrepreneurship. In our case, the presence of internal barriers along with the absence of external factors leads to an absence of women in academic entrepreneurship.

After analysing the whole model, we analysed the impact of individual barriers. Based on the results for the whole model, we were able to outline two potential internal barriers and one external barrier that might be more relevant than the others: work-family balance (INT1), ambition (INT3) and gender-differentiated support by TTO (EXT4).

Two combinations of barriers were elaborated and tested, forming a sufficient condition for the absence of women's engagement in academic entrepreneurship. In Table 9.4, we show our application and the above-mentioned results of the Quine-McCluskey algorithm using the formula ~allOUTPUT = f(INT1, INT3, EXT4). The result proved the joint consistency at 0.812805 and coverage at 0.811891.

Based on a Boolean Truth Table analysis as standard analysis in fsQCA, we can reliably conclude that two paths lead towards women deciding not to engage in academic entrepreneurship. The first path combines work-life balance, together with the absence of gender-differentiated support by TTO. The second path includes a lack of ambition among women and the absence of gender-differentiated support by TTO.

[4] A sufficient presence of a condition (or combination of conditions) is enough for the output to occur. Since the inclusion interpretation is sometimes more theoretically relevant than the correlation interpretation, the sufficiency check is part of standard fuzzy-set analysis. The calculation method is parallel to the Kolmogorov-Smirnoff test (Smithson, 2005).

[5] The test of necessity gives information about conditions that need to be present for the output to occur. Analysis of necessity is an analysis of correlation. The calculation method is parallel to Chi square tests in discrete membership of sets (Smithson, 2005).

Table 9.4 Complex solution using the Quine-McCluskey algorithm

Model: ~allOUTPUT = f(INT1, INT3, EXT4)			
Algorithm Quine-McCluskey			
Frequency cut-off: 14			
Consistency cut-off: 0.908414			
	Raw coverage	Unique coverage	Consistency
INT1*~EXT4	0.686423	0.218352	0.879544
INT3*~EXT4	0.593539	0.125468	0.808959
Solution coverage	0.811891		
Solution coverage	0.812805		

The fuzzy-set analysis offered a response to RQ3. We were able to detect two combinations of barriers that can lead to the absence of women's engagement in academic entrepreneurship.

9.6 Discussion and Implications

Why is encouraging women's engagement in academic entrepreneurship so important? As our research has confirmed, women are rare in entrepreneurship and patent development, but we find indications that, regarding patents, women can achieve even better results than their male counterparts can. There are also indications that women can make very valuable contributions to academic entrepreneurship (Suhadolnik, 2018). Promoting the participation of female scientists in academic entrepreneurship can also lead to outcomes that pursue different goals and address different markets.

Women's lower participation in academic entrepreneurship thus remains an interesting topic. However, the small sizes of samples, especially in nascent systems, is limiting research to case studies and thus preventing researchers from drawing general conclusions. In these circumstances, it can be challenging to cover sufficient number of cases to satisfy doubts about representation, generalisation, and validity (Goedegebuure & van Vught, 1996) without a proper methodological approach. Using methods like fuzzy-set analysis can mitigate these issues, but further methodological discussions on appropriate small-sample analysis approaches are needed. The call for qualitative research needs to be, in our opinion, supplemented with a call for the diligent application of quantitative methods on qualitative data. We answer this call by applying an innovative approach wherein the case-oriented approach is upgraded with fuzzy-set analysis, revealing new dimensions to collected data and providing medium-level generalisation (Modic & Rončević, 2018).

Our research highlights a nascent system perspective, which may also be a limitation of the study. Arguments provided by the structural approach point out similarities, while the culturalist approach points out dissimilarities among systems. These different approaches lead us to believe that, without further research, we still

stand on the precipice of knowing whether we will find similar results in terms of academic entrepreneurship and the gender gap across systems that share a similar framework. We suggest further comparative studies to explore the similarities and differences between nascent, catching-up, and mature technology systems and the role of women therein. Due to different regulative settings, researchers need to adapt their research designs to ensure they capture all relevant academic ventures and thus any hidden technology transfer (Fini et al., 2010).

Unsurprisingly, according to our research, both TTOs and researchers perceive a gender gap in academic entrepreneurship inside the nascent Slovenian system. The gender structure in Slovenia, where women are more interested in the social sciences, life sciences, and humanities and men are more interested in technical sciences (University of Ljubljana, 2018), only partially explains this gender gap since women rarely set up academic enterprises even in PROs, which have approximately equal numbers of researchers of both genders. Other significant barriers must exist.

Our study reveals three interesting issues. First, we found distinctions between the perceptions of barriers by TTOs and researchers. Second, neither group recognised TTOs' potential to remedy women's low participation in academic entrepreneurship.

In line with the inability to recognise gender issues as an important issue to be addressed, our fuzzy-set analysis reveals two sets of barriers leading to women's lack of engagement in academic entrepreneurship: (1) lack of work-family balance and lack of gender-differentiated TTO support and (2) lack of ambition and lack of gender-differentiated TTO support.

Both sets of respondents paid more attention to the internal barriers that may influence women's lower participation in academic entrepreneurship, than to the external barriers. This tendency seems to be consistent with the contemporary individualistic view that each person (not society), is solely responsible for their success – a difference model viewpoint, yet as seen from the fuzzy-set, these are combined with external barriers, pointing out to the deficit model. The TTO representatives and researchers generally agreed that among internal barriers, the main problem is the work-family balance for women, while the researchers also pointed out that men are more ambitious than women are. We can see the reasons for these perceptions in traditional cultural patterns that are still very alive in formal (de jure) gender-equal societies. Regarding external barriers, on average, respondents believed both genders have equal networks and access to finance.

Internal factors can be hard to overcome without strong public action. Thus, women's low engagement in academic entrepreneurship can be improved by special efforts or programmes within PROs focused on helping female researchers innovate and engage in entrepreneurship. For this task, TTOs or university management have to create policies to deal with gender issues and clearly define the managerial and operational implications of the gender-differentiated approach. Thus, experimental policy initiatives might be the first step to overcoming the barriers to women's engagement in academic entrepreneurship. However, special care must be given to balancing the influx of potential users with the capabilities of support organisations

(e.g., TTOs). Nevertheless, in countries where TTO offices or other actors have strong cooperative platforms at their disposal, this issue might be mitigated.

Also, when designing support mechanisms, one needs to acknowledge that TTOs do not always perceive the same barriers as researchers do. Consequently, they might set up support mechanisms that address non-key marginal issues and disregard other barriers researchers experience. A co-development of gender initiatives with (male and female) researchers can mitigate this. It would be beneficial that this co-development also encompasses the initiative's design phase.

Lastly, most research on women in science and technology transfer is dedicated to barriers, but there is a gap in our understanding of the (natural or constructed) advantages that can position women researchers in certain niche areas. However, understanding the advantages next to the barriers can have the potential to aid in understanding how to construct either teams or policy support mechanisms better. Women are praised for their strong empathy and ability to provide practical everyday solutions, yet we know little about how these qualities can be harnessed to achieve better overall technology transfer results. A holistic understanding of advantages and barriers is also an opportunity for work in technology transfer and academic entrepreneurship to provide inputs to other fields dealing with women's contributions.

Appendix 1: Fuzzy-Set Matrix

Fuzzy set	OUT1	OUT2	OUT3	INT1	INT2	INT3	INT4	EXT1	EXT2	EXT3	EXT4	EXT5
RESP1	0.667	0.334	1	0	0	1	0.667	0	0	0	0	0.334
RESP2	0.334	0.5	0.334	0.667	0	0	0.5	0.334	0.667	0.667	0.334	0
RESP3	0.334	0	0.667	0.5	0	0.334	0.334	1	0.5	1	0	0
RESP4	0.5	0	0.5	0.667	0.334	0	0.5	0	0	0	0	0
RESP5	1	0.334	0.667	0.667	0	0.667	1	0.667	0.5	0	0	0
RESP6	0.667	0.667	0.5	0.667	0	1	0.667	0	0	0.334	0	0.667
RESP7	0.334	0.334	0.334	0.667	0.334	0.334	0.5	0	0.5	0.5	0.5	0.667
RESP8	0.667	1	0.667	0.667	0.334	0.5	0.667	0.667	0	0.334	0	0
RESP9	0.667	0	0.667	0	1	0.667	0.5	0.334	0.334	0	0	0.667
RESP10	0.5	0	0	1	0.667	0.667	0.334	0.667	0.667	1	0	1
RESP11	0.334	1	0.5	0.667	0.667	1	0.334	0	0.334	0	0	0
RESP12	0.334	0	0.667	0.667	0.667	0.5	1	0.334	0	0.667	0	0
RESP13	0	0.334	1	0.667	0.667	0.5	0.667	0.334	0	0.334	0	0
RESP14	1	0.5	1	1	0.667	0.667	0.667	0	0.667	0.334	0	0.334

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