

Catalysts in career transitions:

Academic researchers transitioning into sustainable careers in data science

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Abstract

Academic careers are becoming less linear and secure, and are increasingly shaped by environmental constraints. As a result, highly qualified early and mid-career researchers, in particular from STEM (Science, Technology, Engineering, and Mathematics) disciplines, are pursuing careers outside academia. This paper advances theory and empirical research on career transitions and sustainable careers by investigating how junior academics transition into the field of data science by exploring the facilitators of their career transition and the ways in which they experience career sustainability in their new occupational field. This study relies on 28 in-depth interviews with early and mid-career STEM researchers from elite universities who decided to join a data science “bootcamp” to pursue a new career as data scientists. Our study reveals the career barriers that junior researchers experience in academia and how *career catalysts* increase their career adaptability, facilitating a career transition into sustainable careers in data science. Our study shows that career sustainability is experienced through the reaffirmation of interviewees’ identity as researchers outside of academia as well as in the reconciliation between their previous career expectations and actual career outcomes after transitioning into data science.

Keywords:

Career transitions, sustainable careers, academic careers, (big) data science, career adaptability

1. Introduction and problem statement

Academic careers have been perceived as “protean” and “boundaryless” (Arthur & Rousseau, 1996; DeFillippi & Arthur, 1994): the academic is often portrayed as an autonomous professional who chooses where, and under what conditions, to work (Baruch & Hall, 2004). They do not depend on any single organization as they move from one research project to another, often across borders, in search of intellectual challenges, knowledge sharing and career opportunities (Arthur & Rousseau, 1996). “Nothing [else] in the world today, in any institution” enjoys such a high level of autonomy and security as a professorship - the culmination of an academic career (Baruch & Hall, 2004, p. 248). However, as the academic sector is increasingly competitive, academic careers, especially those of early and mid-career researchers from STEM (Science, Technology, Engineering, and Mathematics) disciplines, are becoming less linear and secure, and increasingly shaped by environmental constraints (Baruch, Dany, Pralong, & Davense, 2014; Dany, Louvel, & Valette, 2011; Scaffidi & Berman, 2011). From the early stages of their career, doctoral researchers often experience poor supervisory advising, mentoring, financial support and career perspectives (De Janasz & Sullivan, 2004; Green & Bauer, 1995; Kaslow, Bangasser, Grus, McCutcheon, & Fowler, 2018). Post PhD, academics are faced with short- and fixed-term contracts and a downward trend in tenured and tenure-track positions (Baruch & Hall, 2004; Bryson, 2004; Petersen, Riccaboni, Stanley, & Pammolli, 2012; Petersen et al., 2012; Van der Weijden, Teelken, De Boer, & Drost, 2016). Also, the lack of sustainable academic jobs in their preferred location pushes some researchers towards international mobility (Ackers, 2008). Furthermore, contemporary academic careers are constrained by high expectations (Baruch et al., 2014; Dany et al., 2011), particularly in top research universities, requiring a strong focus on rapid research outputs, rankings, teaching excellence, organizational citizenship, and fundraising (Alberts, Kirschner, Tilghman, & Varmus, 2014).

As a result, highly qualified early and mid-career STEM researchers are increasingly seeking - or are forced to seek - more stable career opportunities outside of academia (Clair et al., 2017; Etmanski, 2019), redirecting their efforts to new occupational fields which are still related to science, but with better career prospects (Maher, Wofford, Roksa, & Feldon, 2017). This is in spite of the fact that doctoral researchers conventionally embark on a PhD project motivated by their love of science and with the intention to remain in academia (Curtin, Malley, & Stewart, 2016; Gibbs & Griffin, 2013; Van der Weijden et al., 2016). Meanwhile, the private sector is offering numerous jobs to highly-skilled graduates from the hard sciences (Neumann & Tan, 2011). In particular, *data science* is a growing industry and an increasingly important occupational field for STEM researchers, with many organizations eager to hire data scientists. Indeed, a Harvard Business Review article deemed the data scientist role “the sexiest job of the 21st century” (Davenport & Patil, 2012). By using scientific methods and algorithms, data scientists are able to find relationships and explanations in formless, vast quantities of data (Akhtar, Frynas, Mellahi, & Ullah, 2019; Redman, 2013), helping organizations to succeed in their data-driven projects.

The phenomenon of STEM academic researchers pursuing careers outside academia, including the field of data science, calls for a deeper understanding of the facilitators of career transitions towards sustainable careers. To date, scholars have only begun to discuss systematically the indicators and dynamics of sustainable careers, and empirical research on the topic is still in its infancy (De Vos & Van der Heijden, 2017; De Vos, Van der Heijden, & Akkermans, 2018; Van der Heijden, B. & De Vos, 2015). Moreover, although scholars have already identified career adaptability as an important facilitator of career transitions (Rudolph, Lavigne, & Zacher, 2017), we still know little about non-individual resources that can facilitate career transitions into sustainable careers. Furthermore, academic careers comprise a highly neglected occupational category that remains particularly understudied within the careers literature (Baruch et al., 2014; Kaulisch & Enders, 2005; Kindsiko & Baruch, 2019; Williams & Mavin, 2015). Research on academic careers

has also mainly focused on career outcomes within the academic career, paying less attention to the “process” of career development (Clair et al., 2017) that is associated with career transitions outside academia. This paper addresses these research gaps and aims to investigate *how academic researchers cross career boundaries in search of a sustainable career in data science as well as to examine the facilitators of academic researchers’ career transition and the ways in which they experience career sustainability in their new occupational field*. Specifically, we address: (1) the factors that motivate academic researchers to cross boundaries beyond academia; (2) the facilitators, i.e., strategies and stakeholders, of their career transition; and (3) the extent and ways in which they experience career sustainability after their transition. Our study involves a constructionist thematic analysis of 28 in-depth, qualitative interviews conducted with early and mid-career researchers from STEM disciplines at elite universities, who made the decision to leave academia and to join a data science ‘bootcamp’ in the UK, with the aim of pursuing a career in data science.

The contribution of this paper is threefold. First, it provides much needed theoretical and empirical insights into the dynamics of sustainable careers (De Vos, Van der Heijden, & Akkermans, 2018; Van der Heijden & De Vos, 2015). Specifically, our study expands our understanding of career sustainability in the context of career transitions, and identifies novel *career catalysts* that expand career adaptability and facilitate individuals to transition into a new occupational field. We define *career catalysts* as facilitators of career transitions into sustainable careers, which are usually independent stakeholders (not linked to employers) and which help individuals to adapt their mindset to new industries and roles, to understand potential future employers and jobs, and ultimately to gain meaningful employment. Second, this study contributes to scholarly knowledge on academic careers, in particular to research that reveals the darker aspects of careers, by studying the career barriers experienced by academics and showing how these barriers have the potential to enable sustainable careers (Baruch & Vardi, 2016; Gunz, Evans, & Jalland, 2000; Inkson, Gunz, Ganesh, & Roper, 2012). This paper also offers a much-needed understanding of the potential for alternative careers for

junior researchers and the crucial role of universities in preparing academics for non-academic career paths. Finally, while data science is a growing industry (Batistič & Van der Laken, 2019; Waller & Fawcett, 2013) and management scholars have only just started to debate its impact on organizational performance (Sena, Bhaumik, Sengupta, & Demirbag, 2019), research within this field, and particularly on individuals starting a career in data science, is scarce at best. Therefore, the third contribution of this paper is to provide a timely and unique glimpse into the role and career perspectives of data scientists.

In the next section, we outline the notion of sustainable careers and discuss the process and facilitators of career transitions. We then introduce the methodology of our empirical study, followed by a presentation and discussion of our findings regarding the career barriers, boundary crossing and career sustainability experienced by academics transitioning into data science. Finally, we discuss the theoretical and practical contributions of our study, reflect on its limitations, and propose future research avenues.

2. Theoretical framework

2.1 From boundaryless to sustainable careers

The boundaryless career concept (Arthur & Rousseau, 1996; DeFillippi & Arthur, 1994) and the protean career concept (Hall, 2002) are valuable in reflecting the complexity of modern careers (Gunz, Peiperl, & Tzabbar, 2007; Inkson et al., 2012; Tams & Arthur, 2010). However, the extent to which the traditional, lifelong career has ceased to exist has been overemphasized (Chudzikowski, 2012; Rodrigues & Guest, 2010) and the description of academic careers as boundaryless has been oversimplified (Dany et al., 2011). Instead, whether a career is experienced as bounded or boundaryless, depends on the individual (Dowd & Kaplan, 2005). Notwithstanding the valuable insights that both the boundaryless and the protean career concept have brought us in the light of career mobility debates, we argue that they do not fully cover the complexity of the initiators and

facilitators underlying career transitions, and how career transition outcomes are perceived and experienced by individuals. In particular, contemporary career theory lacks a systematic attention to the stakeholders operating within given contexts. Building upon De Vos et al. (2018), we thus posit that the extent of “activeness” of the central career actor is dependent on and interacts with the context, and, therefore, we propose that a systemic or multiple-stakeholder perspective is needed (cf. Colakoglu, Lepak, & Hong, 2006). De Vos et al. (2018) advocated that it is this “systemic perspective that sets the sustainable career concept apart from other contemporary ‘types’ of careers” (p. 2), including the protean and boundaryless career concepts. A systemic perspective recognizes the importance of career contexts (Ituma & Simpson, 2009; Pringle & Mallon, 2003), the interdependency of career agency and context (Tams & Arthur, 2010), and the subjective meanings of career gatekeepers who influence what is expected and accepted within a certain context (Gunz et al., 2007).

Incorporating a systemic or multiple-stakeholder perspective, the concept of sustainable careers (De Vos et al., 2018; Van der Heijden & De Vos, 2015) can be defined as “a sequence of career experiences reflected through a variety of patterns of continuity over time, thereby crossing several social spaces, characterized by individual agency, herewith providing meaning to the individual” (Van der Heijden & De Vos, 2015, p. 7). Individuals attach different value and meaning to different career events (e.g., career challenges, development or transitions) and career outcomes (e.g., salary, promotion, hierarchical position or leisure) over time (Van der Heijden & De Vos, 2015). As a result of a cyclical, self-regulatory process (Lord & Maher, 1990), sequences of career experiences create unique spaces for individual agency. Thus, the individual being the central actor and “owner” of the career has a major impact on the sustainability of their career. As the study of sustainable careers implies that the individual is the focal unit, it also entails the application of a non-normative framework wherein all parties involved do justice to the idiosyncrasy of career preferences (Van der Heijden, 2005). Individual perceptions of career (non)sustainability and related

career choices and outcomes are shaped by contextual factors, including organizational, institutional and societal factors as well as labor market, job characteristics, family and private life (De Vos et al., 2018). Although the sustainable career framework acknowledges the shared responsibility of individuals and employers in aligning their interests (for example, individuals by nurturing their careers and employers by providing career opportunities) (Van der Heijden & De Vos, 2015), we need to understand better the potential role of other strategic stakeholders in shaping sustainable careers. The handful of empirical studies on sustainable careers conducted so far has mainly focused on the achievement of career sustainability *within* the current employing organization and under direct supervisors and organizational initiatives (Bozionelos, Lin, & Le, 2019; Chudzikowski, Gustafsson, & Tams, 2019; Straub, Vinkenburger, & Van Kleef, 2019). However, given the constant changes in the labor market in the current global economic and technological environment, maintaining and enhancing one's career sustainability in the context of career transitions *across* industries and organizations is more important than ever (Lawrence, Hall, & Arthur, 2015).

2.2 Career transition as a means to protect one's career sustainability

Career transitions are “influential events in people's working lives” (Chudzikowski, 2012, p. 298) that imply movement across boundaries and discontinuities and interruptions in people's careers (Gunz et al., 2007). Career transitions can be examined across three dimensions: vertical (i.e., promotions and demotions), horizontal (i.e., changes in function, division or department) and organizational (i.e., transitions within or across organizations and industries) (Chudzikowski, 2012; Nicholson & West, 1988; Schein, 1971; Sullivan & Arthur, 2006). In this study, we focus on career transitions along the organizational dimension. We posit that this type of transitions have the potential to protect one's career sustainability, not only when they are initiated voluntarily (Chudzikowski, 2012) - career moves that are more closely associated with the idea of boundaryless careers - but also as a result of experienced career barriers, traumas and shocks that prompt or push

individuals to look for a healthier, happier and more productive career path (Van der Heijden, 2005), indicators that have been associated with sustainable careers (De Vos et al., 2018). Earlier research has shown that unfulfilled wishes to have a permanent or “better” job affect career attitudes and job behaviors, including job satisfaction, professional commitment and organizational citizenship behaviors, while triggering individuals’ desire and effort to find alternative employment (Feldman & Turnley, 2004). Thus, often, individuals solve job or career tensions by “moving on”, i.e., leaving their working organization (Chudzikowski et al., 2019). For example, a career transition from within organizations into self-employment has been found to have positive outcomes in terms of increasing one’s work-life balance (Mallon & Cohen, 2001). Thus, faced with the need to make a career decision as a result of the unique, complex mosaic of objective experiences and subjective evaluations that result from the interplay between agency and context over time (De Vos et al., 2018; Forrier, Sels, & Stynen, 2009), a career transition across the organizational dimension might be the best solution.

2.3 Facilitators of career transitions

Previous research on learning and vocational behavior has tended to focus on the individual resources - what individuals can do to develop themselves - that can facilitate career transitions in the context of barriers and shocks. For example, the dynamic learning approach (Boud, Keogh, & Walker, 1985) emphasizes the importance of critical experiences in the stimulation of reflection and learning: reflection on past experiences initiates action, including a new way of doing something, the clarification of an issue, the development of a skill or the resolution of a problem (ibid.). Scholars proposing a dynamic learning approach to career choice development also argue that successfully moving through an influential event, such as a transition into a new occupational field, requires individuals to undergo specific career choice development activities (Van Esbroeck, Tibos, & Zaman, 2005). These activities often include sensitization (becoming aware of the choices available),

exploration of the self (understanding one's skills, capabilities, and values), exploration of the environment (collecting information about relevant career options), exploration of the relationship between self and the environment (exploring factors that can influence choices), specification (limiting of options) and making a decision (choosing one option) (ibid.). Dynamic learning thus enables individuals to sharpen the understanding of their own needs and motives, their personal and organizational context, and to make it possible to refine perceptions continuously regarding their person-career fit over time (Parasuraman, Greenhaus, & Linnehan, 2000).

Within career construction theory, career adaptability is a crucial construct that denotes the individual's resources or self-regulatory capacities that allow individuals to cope with complex tasks, transitions and traumas (Savickas & Porfeli, 2012). These resources include concern (preparing for future career tasks), control (taking responsibility for career development), curiosity (exploring future selves and career opportunities) and confidence (believing that they can successfully solve a specific career-related problem) (Savickas, 1997; Savickas & Porfeli, 2012). Social capital is also a relevant individual resource (Kwon & Adler, 2014), utilized by actively seeking advice from peers and other professionals in the field of interest of the individual undergoing a career transition. In particular, those individuals who are willing to adapt their behaviors are more likely to develop these competencies and effectively manage career-related changes (Tolentino et al., 2014), including finding better job opportunities, re-employment and transitioning to work (Koen, Klehe, Van Vianen, Zikic, & Nauta, 2010; Koen, Klehe, & Van Vianen, 2012). Career adaptability has also been found to positively impact subjective well-being (Rudolph et al., 2017), happiness (Johnston, Luciano, Maggiori, Ruch, & Rossier, 2013) and overall quality of life (Soresi, Nota, & Ferrari, 2012). Overall, the literature suggests that individuals who engage in self-reflective practices, self-manage their career development activities confidently, and take control of re-directing their own careers (Lent & Brown, 2013; Lent, Ezeofor, Morrison, Penn, & Ireland, 2016) can better overcome labor market

challenges and reposition themselves in more advantageous career circumstances, compared with those who are less engaged in such behaviors.

Non-individual resources in career transitions have been studied to a much lesser extent, although the potential of a career transition to direct individuals towards more sustainable career paths is influenced by wider organizational, institutional, societal and family factors. Past research has shown that some organizational resources (offered by the employing organization) can facilitate career transitions, including career planning, targeted career training, advice from line managers, mentoring and coaching by career specialists (e.g., Clair et al., 2017). However, our data points to new, independent *career catalysts* in the context of career transitions that had not been recognized before and that urge us to expand our knowledge about the facilitators of career transitions beyond the individual and organizational domains.

2.4 Research aim and questions

The primary aim of this study is to examine the process of career transition into sustainable careers by looking specifically at the case of academic researchers transitioning into the data science field.

To achieve this aim, we formulate the following research questions:

- 1) What motivates academic researchers to seek a career in data science?
- 2) What are the facilitators of academic researchers' career transition into data science?
- 3) To what extent and in what ways do (ex-)academic researchers experience career sustainability in the field of data science?

3. Method

3.1 Research design and setting

This study is part of a broader research project on data science careers and data scientists' professional identity. Our empirical research draws on qualitative, semi-structured, in-depth

interviews with 28 current and former participants of a data science bootcamp in the UK in 2017. The program is run by a data science company, (hereafter referred to as “DataCo”), which specializes in applying artificial intelligence to real-world issues. The eight-week bootcamp is designed to provide a stepping-stone for high-caliber doctoral students and postdoctoral researchers to transition from academia into data science. It involves dedicated workshops and lectures as well as the completion of a data science project, which bootcamp participants develop together with large companies, start-ups and governmental offices.

The first author initially learned about DataCo and its data science bootcamp through her professional network and approached its managers to present the research idea. It had to be made fully clear that our purpose was to study the process of career transition from academia into data science, rather than to carry out an impact evaluation of DataCo’s data science bootcamp. DataCo allowed us to carry out the research project without any specific requests or conditions. We adhered to research ethics guidelines and secured a favorable opinion from the first author’s university’s Research Ethics Committee.

3.2 Researchers’ standpoint

The research team consisted of two faculty members from the areas of Management, Organizations and Occupational Psychology and a research associate contracted on a temporary basis working in the field of experimental Psychology. Based on our own previously conducted research on careers, the two senior members of the research team were interested in understanding whether and how a career transition into a sustainable career can be achieved. We were particularly intrigued by the fact that this sample consisted of academics. Yet, we were also interested in data analytics and data science as occupational fields that are developing at a rapid pace and increasingly influencing societies and businesses. As such, this research was both theoretically driven and empirically motivated. Although the two senior members of the research team did not contemplate leaving their

academic roles when this research was conducted (and still do not), they recognized some of the challenges faced by the interviewees, especially in relation to nowadays' expectations in academia to secure research funding, to publish in top international journals, and to take on heavy teaching workloads. The research associate had recently transitioned from the private sector to higher education and had not experienced academic life as such yet, but decided to pursue a PhD degree, keeping an open mind for both academic and non-academic career options. After interviewing some of the bootcamp participants, she felt excited about the field of data science.

Participants' motivation to be interviewed was not monetary as they did not receive any incentive or compensation for taking part. We believe that bootcamp participants contacted us and agreed to be interviewed because they identified with our purpose: They wanted to reflect on, revise and talk about their own experiences. Some participants also seemed interested in understanding the experiences of other bootcamp participants in order to make sense of their own career opportunities and choices. Having been academics themselves, they were also curious about and supportive of this research project. Clearly, some of them had a good understanding of our approach after the original briefing, others asked for more details of our methodology or dissemination plans.

3.3 Participant recruitment

The research team prepared an information sheet for DataCo to be disseminated among potential participants. The information sheet included the study's objectives and procedure as well as the researchers' profile and an invitation to participate in an interview. Due to the different levels of difficulty in reaching out to potential participants, we employed different recruitment methods for current and former bootcamp participants. Beginning with the recruitment of current participants, DataCo confirmed that they had sent our information sheet to their current bootcamp cohort (of approximately 20) by email, asking people to sign up on a spreadsheet with interview slots, if interested in taking part. In this first round, 14 potential interviewees signed up. There was no

attrition between bootcamp current participants signing up for an interview and the final number of interviewees in this group. Once we concluded interviewing current bootcamp participants, we moved onto recruiting former participants. We asked DataCo to send the information sheet to previous years' cohorts. After a first email, two people contacted us. In order, to increase this number, we asked DataCo to disseminate our invitation further, which they did by sending a second email and by including it in their monthly bootcamp newsletter. Using a snowballing technique, we also asked interviewees if they could let fellow former participants know about our research project and tell them to contact us if interested in participating. Three more candidates were recruited through these methods to a total of five. As a further step to increase the number of former bootcamp participants, DataCo suggested us to reach out to people via LinkedIn (DataCo did not agree to share bootcamp participants' contact details, but a list of former bootcamp participants was publicly available [it is not available anymore]). We sent an invitation to 37 former bootcamp participants via LinkedIn. Sixteen people (43%) replied to us, of which seven rejected our invitation and nine were interviewed. The research team did not disclose to DataCo managers the names of the people who got in contact with us nor the final list of the people interviewed.

3.4 Final sample

We halted data collection when we reached a similar number of current and former bootcamp participants and were satisfied that our sample represented the overall gender split of bootcamp participants. The final sample included 28 interviewees (21 men and 7 women). Half of the interviewees were current bootcamp participants (2017), while the other half had completed the bootcamp in the previous two years. The ages of the interviewees ranged from 25 to 42, with the majority ($n = 19$) between the ages of 28 and 38. Seven of the participants were married and four had dependent children. All but one interviewee had completed a PhD, with ten having gone straight from completing their PhD to the DataCo bootcamp. Of the remaining interviewees, ten came from

postdoc positions and senior research fellowships (ranging from 1 to 10 years of experience), four from work outside academia, one from travelling, and one from a teaching post within academia. Interviewees typically had PhDs in Physics, Biology, Electronic and Electrical Engineering, and Neuroscience. The majority received their PhDs from globally top-ranked universities such as the University of Oxford, University of Cambridge, University College London, Imperial College London, Harvard University and Massachusetts Institute of Technology. The sample was diverse in terms of nationality with 18 interviewees coming from the UK and Western Europe and the remainder from Eastern Europe and Asia.

3.5 Data collection

This qualitative research employed in-depth, semi-structured interviews in order to identify a range of perspectives on and experiences with career transitions from academia into data science and to allow individuals to demonstrate what is important to them (Bryman, 1988; Harding, 2013). We created two interview questionnaires, one for current bootcamp participants (Appendix A) and another one for former bootcamp participants (Appendix B). Both sets of interview questionnaires explored people's motivations and experiences around leaving academia and moving into data science. Key questions for this study included why people opted for a career in data science, other career options they had considered, how they experienced and prepared themselves for the career transition and what factors were crucial in their career transition. Former bootcamp participants were also asked about the expectations they had of a job in data science, and the extent to which these expectations had been fulfilled.

The first and third authors conducted the first two interviews together to pilot the interview questionnaires and to ensure consistency in the interviewing process. The remaining 26 interviews were conducted by the first (N = 14) and third authors (N = 12) separately, neither of whom knew any of the research participants personally. We first interviewed current bootcamp participants,

followed by the group of former bootcamp participants. Interviews lasted between 30 and 120 minutes with an average of 53 minutes. In addition, 5 to 10 minutes were dedicated to debriefing and confirming participant consent. Interviews were conducted at the location most convenient for the interviewee, that was the DataCo headquarters (N = 11), in a nearby café (N = 3) or via Skype (N = 14). All but two interviews were tape-recorded and transcribed verbatim. The transcripts were typically 13 pages long, ranging from 6 to 19 single-spaced pages. In the case of the two interviews that were not recorded, notes were taken directly on the interview questionnaire template.

3.6 Data analysis

We adopted a constructionist thematic analysis approach to identify, analyze and report key themes, categories and their relationships (Braun & Clarke, 2006). In social constructionism, the social world is constructed through social processes and relational practices (Young & Collin, 2004). As such, a constructionist approach allowed us to examine the realities, meanings and experiences of participants in relation to their careers as affected by social structures, processes and relations (Burr, 1995), including, for example, institutional expectations, professional networks, and labor market conditions.

To analyze our data, we first familiarized ourselves with all interview transcripts by reading them in detail and by documenting notes and initial ideas. Interview transcripts were then entered into NVivo ready for coding. In the first round of coding, the third author grouped the content of our data set following the major topics covered by our interview questionnaires and generated initial categories. This allowed us to start identifying factors motivating career transitions. For example, for the interview question “What were the reasons not to pursue an academic career?”, 13 codes were generated, including “academia is competitive”, “research needs to be delegated”, “lack of impact” and “lack of academic jobs”. Subsequently, the first author carried out a second round of analysis grouping codes of similar meaning within the themes that were relevant to our research questions

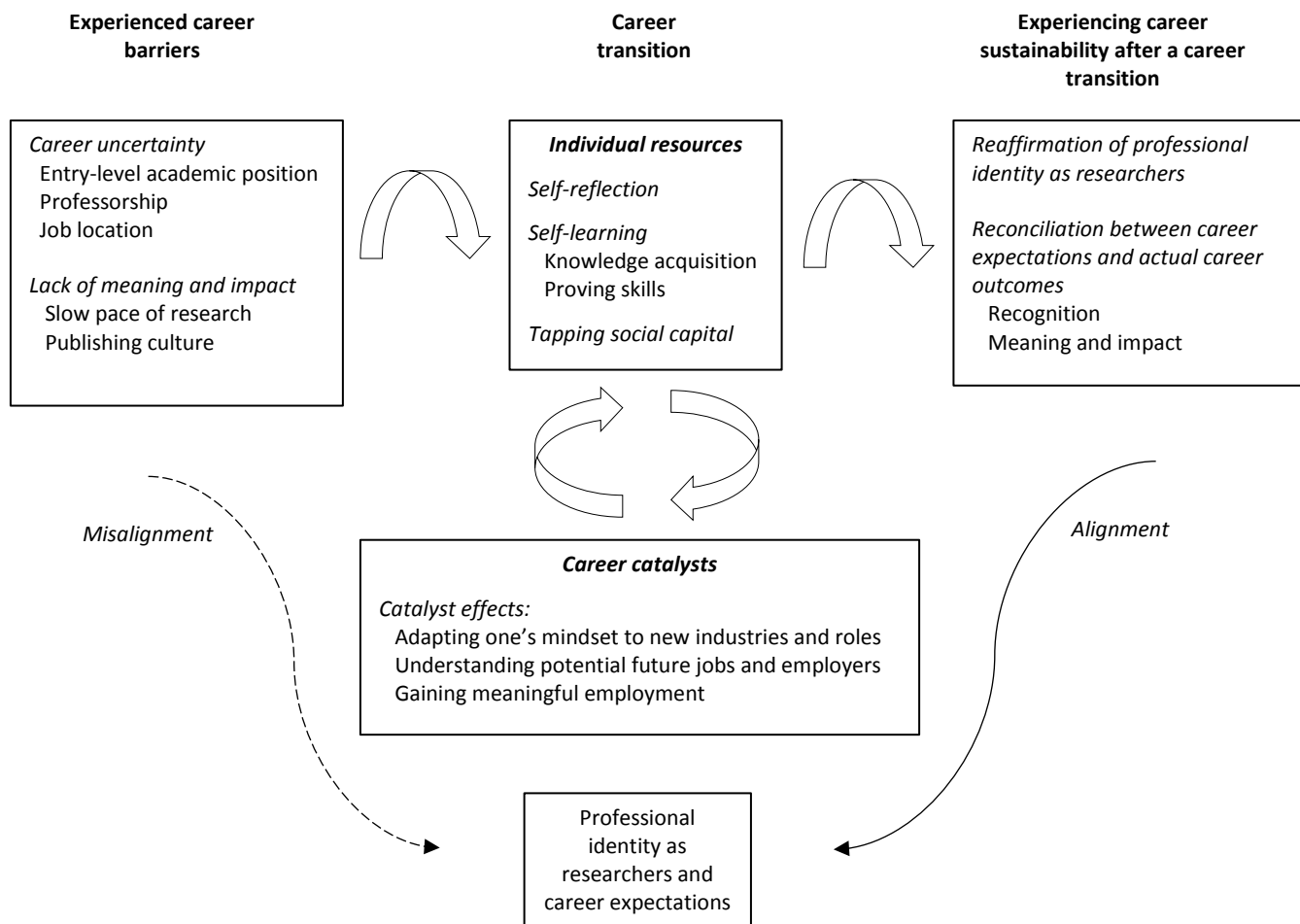
and identifying patterns in the data. In this phase, it was found, for example, that the motivation to transition into data science stemmed primarily from career barriers and unfulfilled expectations in academia. In a third round of coding, the first author focused on theorizing the process of career transition, including interpreting the meaning and significance of facilitators and strategies in career transitions and their implications for the lived experiences of interviewees. New issues and relationships were then found in the data, for example, the crucial role of the data science bootcamp as a *career catalyst* and the ways in which interviewees experienced career sustainability after transitioning into data science. In a fourth phase of analysis and in an iterative process, we went back to our theoretical framework drawn from the literature on academic careers, career transitions and sustainable careers, herewith constantly redefining both our categorizations and theoretical framework (Charmaz, 2006). In order to ensure trustworthiness and reliability in the interpretation of data, the transcripts and coding structure were revised until reaching coding saturation, i.e., only new instances of the existing codes, and not new codes, were found (Charmaz, 2006). In addition, the first and third author discussed and agreed on the interpretation and categorization of the data.

Our analysis was then organized around three overarching themes that directly responded to our research questions: 1) the barriers experienced in academia, 2) the facilitators of career transitions, i.e., the activities undertaken by individuals and the stakeholders involved to protect the individuals' career sustainability, and 3) their experiences in the new field. A final list of themes, sub-themes and categories of coding with qualitative descriptors was created and refined (see Tables 1-3), which allowed us to gain a strong theoretical understanding of career transitions in relation to the scholarly area of career sustainability. In the last phase of the analysis towards the preparation of our findings, we identified interview extracts that were illustrative of our final categories of coding. All three authors read and revised the interview extracts multiple times to ensure that they were coherent, consistent and representative across the variety of participants. Pseudonyms were used in the presentation of interview extracts in order to protect the participants' identities.

4. Findings

The findings are grouped into three major themes, which are summarized in Figure 1. Figure 1 depicts how experiences regarding career sustainability tend to start off from career barriers faced by the participants, and unfulfilled career expectations in the participants' original occupation, which prompted the process of transitioning into a sustainable career. Pertaining to this process of career transition, Figure 1 shows individual resources, (i.e. the key actions taken by participants to re-position themselves) as well as the presence of *career catalysts* (i.e. independent stakeholders that facilitated their career transition) and their catalyst effect. Because of the difficulty, non-linearity and individuality of experiences in career transitions into career sustainability, we use thick bent arrows to represent their relationships. Finally, the narrower bent arrows show how the new data scientists experienced career sustainability, i.e., through the reaffirmation of their identity as researchers and fulfillment of career expectations (solid arrow), experiences which were absent or misaligned while in academia (depicted by the dotted line). Next, we present our findings in more detail. Tables 1-3 provide additional illustrative quotes and a description of our final list of themes and categories.

Figure 1: Towards career sustainability after a career transition



4.1 Career barriers

When asked about their motivations to enter a new occupational field, most interviewees referred to the aspects of academic careers they disliked and their ultimate decision to leave academia. As Austin put it, “I don’t see it so much as entering into data science as an exit from academia, which I guess is not quite the same thing”. The barriers identified by interviewees related to two major issues: career uncertainty and lack of meaning and impact in their academic roles (see also Table 1).

4.1.1. Career uncertainty. At some point in their academic life, interviewees realized that although “a lot of people want to stay in academia, not everyone has the opportunity” (Paul). Participants perceived that their current jobs and future careers were characterized by uncertainty in relation to three main aspects: not knowing what their next academic job would be (e.g., postdoctoral positions, non-tenure track positions, lecturing jobs with or without research obligations, or research fellowships), whether they would reach a tenure track or full professorship in the longer term, and where their next or final job would be located. Brody’s experience illustrates the perception of career uncertainty after more than 5 years of postdoctoral work:

I [have] already chang[ed] continent twice, I don’t want to move again... The type of effort that I would have to put to get that [postdoctoral] position, [it’s] not worth the level of... satisfaction that I was experiencing... This was one of the reasons why I made this transition [into data science].

(Brody)

Career uncertainty was a source of stress for some of the participants. For example, Kyle, a mid-career researcher, who said “there weren’t many permanent positions in reputable universities in the UK”, felt that he needed to reach some level of “mental stability of having a job”, not having to “worry about applying for grants and so on”.

4.1.2 Lack of meaning and impact in their academic roles. Some interviewees referred to the lack of meaning and impact that their academic work had begun to represent. They were disillusioned about the slow pace of the research process and the difficulty in achieving concrete results on their own.

Walter’s experience illustrates this:

There are a lot of things that frustrated me in academia that made me feel that it wasn’t the path that I wanted to pursue... I found generally the pace to be a little bit too slow and there were a lot of...

[unmet] promises and deadlines, and there wasn’t much of a drive to actually make something happen. (Walter)

Interviewees from different stages in their academic careers also struggled to find meaning and purpose in meeting academic requirements and expectations, such as publishing at an accelerated pace in the face of scientific rigor and perfectionism. For Austin, it became clear during his PhD studies that publishing was going to be a central part of an academic career. However, this was unfulfilling:

You publish a paper, who knows? Maybe someone reads it, maybe no-one reads it and that's like 2 years of your life.... I felt like the impact in academia was minimal. I didn't feel like producing research papers was a very meaningful output for me. (Austin)

Interviewees questioned the value and impact of their research activities and became aware of a misalignment between their own professional and personal values and interests and those of their organizations and of academic research more broadly.

Interviewees' perceived career uncertainty and lack of meaning and impact in their work contradicted their vocational identity as academic researchers and the expectations they had upon an academic career, mostly in relation to scientific development and societal impact. Eventually, interviewees made the difficult decision to leave academia and pursue a new career path.

Table 1: Themes and illustrative quotes of career barriers: Factors influencing academics' decisions to leave their original occupation

Themes and codes	Illustrative quotes
Career uncertainty	
<i>Entry-level academic position</i>	The motivations [to enter data science] weren't positive; the motivations were all negative... It's very hard to get a postdoc [position] and it's even harder to get a postdoc in the place you want... even if you get a postdoc, getting to a permanent position is not trivial and this is a euphemism for it's virtually impossible. (Alissa)
Uncertainty in relation to securing an entry-level academic job and in relation to the job's nature	I was a bit disillusioned with academia and I realized that getting to really a top university would not be an option, and being in a non-top one like where I worked [in a teaching-oriented university] I also felt, well, I won't have the opportunities of doing a lot of research either. (Lola)
<i>Professorship</i>	And that is I think part of what attracted me to moving [into data science] because you're mostly moving [away] from a profession [academia] where I don't know, something like 5% of all PhD students become professors or maybe that's just in Physics. But anyway there's like
Uncertainty in relation to whether a	

<p>tenure track or full professorship will be achieved in the long term.</p>	<p>so little demand for physicists now that you know that you will not actually get a permanent position at a university. (Dominic)</p> <p>Maybe at the postdoc level there were sufficient positions, but the reality is that only a handful of percentage of PhDs actually end up with a permanent position. And then especially at [a world-leading university in the US], I'd seen a ton of really good professors who after spending 6 or 7 years on the tenure track, they were just kicked out and they had to go somewhere else. So the idea of not being entirely sure what is going to happen in say 10 years but having very little control over that. That I think was the major issue [motivating him to enter data science]. (Anthony)</p>
<p><i>Location</i> Uncertainty in relation to the location of their next or final job</p>	<p>Academia means that you have to move probably very far and that essentially you would go on some sort of high-risk project from which it then would again be very difficult to move on until you actually come to a position where you have some assurance that you're not going to be fired in the next two years or lose your job or your contract expires. (Patrick)</p> <p>I left academia because I didn't want to have a life which seemed very likely of moving around a lot as a postdoc, with the uncertainty of having an academic career at the end of it. (Eva)</p>

Lack of meaning and impact

<p><i>Slow pace of research</i> Perceptions about academic work lacking dynamism</p>	<p>Ultimately I'd like to be able to create an impact on something but I want it to be quite fast and I don't believe that [happens] in academia. I think my experience has always been rather slow. (Adam)</p> <p>Academia [is] not exactly as dynamic and as agile I would say as some of the industry jobs, so therefore I'm probably looking for a bit more dynamism. (Vincent)</p>
<p><i>Publishing culture vs. real impact</i> Perceptions about the emphasis on publishing without achieving a real impact</p>	<p>So you don't necessarily see the impact if you're writing a paper because some people might read it; some people might do something with it; often people might not do anything with it, so I think the impact, I think that's an important factor [motivating him to enter data science]. (Paul)</p> <p>And maybe I was very romantic about the ideals [in academia], you know. I didn't know... that you end up spending at least a third, and I'm being very generous here, at least a third of your time in academia writing grant or fellowship proposals, breaking down your papers so you can get more of them out to get more grants. This is not what I really signed up for in academia. (Kyle)</p>

4.2 Career transition

We found that a career transition into a new occupational field involved not only leveraging individual resources, i.e. engaging in self-reflection and self-learning and tapping social capital, but also in actively identifying and utilizing key *career catalysts*, in this case, participating in a data science bootcamp (see also Table 2).

4.2.1 Self-reflection. For interviewees, thinking about opportunities outside academia was not only a rational planning process of future career steps, but also a more fundamental process involving self-

reflection, “soul-searching” and risk-taking. By engaging in a long process of self-exploration, interviewees were able to reconnect with their interests and purpose. They reflected on the aspects they were not enjoying in academia, and the impact their academic role was having on their personal relationships with families and partners. Interviewees then identified the type of challenges and activities that would bring them greater joy and satisfaction:

I did enjoy research itself, although there were tons of frustrations... I kind of realized that if I do progress beyond the postdoc level for example, I'm going to be stuck mainly in writing grants or writing up teaching curriculums and so on and I'll be delegating the actual research parts to postdoc [researchers] and PhD students... I realize now even though I was ready to sacrifice [social life outside of academia], that I wouldn't be very happy as a postdoc and later on even less happy as a potential professor. (Anthony)

Engaging in self-reflection allowed interviewees to identify where their passion lay, making them reject other career options (e.g., finance) that were aligned with their skills but not their passion:

I just knew I didn't have a passion for it [finance] and knew that [in] more traditional data science you end up working on projects... [that are] more grounded in the real world. (George)

The self-reflection process interviewees engaged with was highly emotional. All but two interviewees expected to fulfil an academic career, and the process of recognizing that their ideal academic position was now unlikely to be reached, was hurtful for some of them:

It was very painful because you go from being so certain you're going to be a scientist to not [you will not be], so that was very painful, but it was not like I just threw a dart at a dart board and it landed at data science, it was like a lot of research went into this. So I feel quite sure about it. (Eva)

Once interviewees had identified data science as a career path that is better aligned with their interests, purpose and passion, they worked towards realizing a career transition.

4.2.2 Self-learning. Interviewees demonstrated a strong dedication to self-learning, including the acquisition of new knowledge and proving their own skills. This process was carefully planned, involving the identification of both existing knowledge and skills (e.g., most commonly mathematics, statistics and programming skills) and those that still needed to be acquired (e.g., machine learning) in order to carry out data science tasks.

Interviewees talked about the different online tutorials and courses they had completed, books and articles they had read and conferences they had attended to develop the required skills. Interviewees spent evenings and weekends on self-training. They seemed to have enjoyed this process and to have drawn a high level of satisfaction from it, describing it as “kind of fun” and “actually enjoyable”.

As part of self-learning, interviewees often developed their own small data science projects, or entered competitions as a way to practice and test their skills. Doing so allowed them to prove to themselves that they were on the right path to becoming a data scientist. Patrick explained an online resource he used voluntarily to hone and test his skills:

It’s essentially a massive playground for data scientists... if you win one of these competitions, then in the data science community everyone thinks ‘wow, he’s done a good job’... (Patrick)

Interviewees thus demonstrated dynamic learning and career adaptability by exercising a high level of career agency to develop the skills necessary to transition into data science.

4.2.3 Social capital. Interviewees indicated that some traditional sources of guidance in the light of career transitions were insufficient or non-existent. For example, interviewees noted that university career offices, PhD supervisors and their departments did not provide them with the information and support they needed to pursue careers outside academia. This lack of information and support from organizational stakeholders was compensated by interviewees’ utilization of social capital, including reaching out to colleagues and friends, who informed them about the characteristics of data science

and made them realize that they already possessed the basic skills required to become a data scientist. Some of the interviewees also reached out to professional networks, through career websites such as LinkedIn, and found relevant advice and guidance from senior professionals in data science. Overall, social capital provided participants with important introductory information about a potential new occupational field. Interviewees also sought to gain insights into potential career paths by attending talks and conferences, where they met data science bootcamp representatives from the UK and the US. They then realized that “there is also this interesting career path in data science”, which they were “not aware of”. The utilization of individual resources was maximized by the presence of a key *career catalyst* - the DataCo bootcamp - as well as the favorable labor market conditions in the era of big data.

4.2.4 Career catalysts. In contrast to common career development methods such as career training workshops or development centers that are planned and run by employers, we identified the DataCo bootcamp as an independent stakeholder which served as a *career catalyst*. We found that career catalysts focus more on supporting participants’ transition across fields, i.e. from academia into industry, rather than on providing training on specific technical skills. Our data points to three key benefits offered by career catalysts: i) adapting individuals’ mindset to new industries and roles, ii) understanding potential future employers and jobs, and iii) gaining meaningful employment. According to the interviewees, the bootcamp helped them “change their mindset from academia into industry”. This included changing “their confrontational way of talking to people to a more participatory approach” as well as learning to work with a diverse group of people, as opposed to the isolation they were used in academia:

... sometimes from the... company perspective, they think that you are basically a laboratory rat; you cannot talk to anybody, you cannot actually put yourself into a company’s perspective... that is a big jump from academia [to industry]... the [DataCo bootcamp] helps to actually bridge that. (Isaac)

At the core of the program was the execution of a data science project at an organization in the private or public sector, having the opportunity to “work with real data” and “solved real problems”. The DataCo program put thus participants in direct contact with organizations implementing or seeking to implement data-driven projects. Organizations presented their projects, and participants had the opportunity to choose what project to work on. This allowed interviewees to get to know their potential future employers, and understand their needs, expectations and practices. It also allowed them to “make a wise decision” by evaluating whether potential employers were a good fit for their personal characteristics, interests, skill set, and future career plans.

[The DataCo bootcamp] gave me [an] idea about how a large organization treats data scientists, [how] a small start-up... would deal with data scientists... and not only [in terms of how they do] data science, but also about [the] organization [itself]. (Jorge)

Although interviewees might have gained valuable insights from professionals and friends in the field, the catalyst effect of the data science bootcamp was crucial in ultimately allowing interviewees to cross boundaries confidently and, more importantly, to gain more sustainable employment. What would have been seen before as an idea of “an interesting career path” had become a tangible and promising opportunity. The majority expressed that they would not have achieved such a quick and smooth career transition without the career catalyst:

I joined [the DataCo bootcamp] in September/October last year, and after a couple of weeks I started an internship in this company as part of the [DataCo bootcamp], and at the end of the 6 weeks they were happy [with his work] and I was happy [with the company], so basically they made me an offer... It was like the bootcamp that was on Friday... and then the next Monday I was there with the new [work] contract. (Brody)

The presence of the career catalyst was thus a proximal determinant of individuals’ transition from academia into data science and, as shown below, of their experience of career sustainability in a new field.

Table 2: Themes and illustrative quotes of career transitions: Individual resources and career catalysts in career transitions

Themes and codes	Illustrative quotes
Self-reflection	
Thinking about one's interests, goals and passion	<p>So I was searching for something quite specific. Something where I could still do research, where some of my previous experience and skills could be useful, and at the same time... I realized academia will not be an option so it would have to be in industry. And data science just seemed to be ticking those boxes. (Lola)</p> <p>I would like to do something that somehow exploits my skill set at the moment so coming from [technology field], that's time series based, so we could look at applying time series in other areas like finance or energy modelling; those would be two things I am looking at or perhaps oil and gas industry... My emphasis is that I come from a background where I enjoy dealing with computation and thinking about those problems but also getting some results. (Paul)</p>
Self-learning	
<p><i>Knowledge acquisition</i></p> <p>Range of resources participants independently used to develop their data science skills</p>	<p>I actually went to the library and borrowed a few books but I found that I quite like Googling stuff so we have a lot of resources on the internet and also statistics programming coding examples for certain machine learning aspects. (Patrick)</p> <p>I did do quite a lot of preparatory work. I read a lot of books, did some online courses and started to build my own data science models, and put them on GitHub. (Zane)</p>
<p><i>Proving skills</i></p> <p>Ways in which participants sought to prove their readiness to be a data scientist</p>	<p>For example, Kaggle is a place where you do online machine learning competitions. It's a competition so you have to get the smallest error... but the top 10 people, the difference between them [in their results] is like a tiny order of magnitude... I wouldn't say that I'm trying to compete to get the best score, I do it for the learning experience. (Eva)</p> <p>I started some projects on my own... I was looking for something to do on Python, which I had just installed. And so I built the same algorithms... I built something on my computer from my own music database... if you play one song and the microphone of the computer adjusts it, it can recognize which song it is. That took me a couple of weeks... I was very fed up with my PhD so I took unpaid leave for a month and that's when I had time to focus on this and properly learn some Python. (Finn)</p>
Social capital	
<p><i>Finding out about data science through social capital</i></p> <p>Experiences that show how participants became aware of the data science career path through networks and relationships</p>	<p>I have a friend working in data science and I was telling him all the things I did in my PhD. He just said to me 'Hey, you're a data scientist'. So basically I was using all the tools that data scientists use but I had no idea that that was the new name for the job. (Juan)</p> <p>I had a friend who worked at [DataCo]; I said 'I'm kind of interested in moving in this direction. What do you think I should do?' And he said 'You should definitely come and do the [DataCo bootcamp]' and I said 'I kind of like that idea but I'd also like to go and live at home with my parents who I really like, I could spend 2 or 3 months learning to do all this stuff on my own' and he said 'You'd be missing a lot of stuff. You wouldn't be getting any business experience. You're missing the network; you're missing the education. You should really come here'. (Austin)</p>
Career catalysts	
<p><i>Utilizing and benefitting from career catalysts</i></p>	<p>(Adapting individuals' mindset to new industries and roles) [The DataCo bootcamp] trained us a lot... Something that I never paid much attention to... [and] I'm trying to get better at is that at least in the environment where I came from [academia], sometimes people are really</p>

Experiences that show how participants benefitted from the presence of career catalysts and their effect on individuals' careers

confrontational, so basically everybody during a meeting was showing to everybody else that he is the smartest guy in the room... I mean sometimes you convince people not just... [by] using only logical and analytical argument but sometimes it's easier to convince if you also make people feel part of the decision. (Brody).

(Understanding potential future employers and jobs) There's lots of talks, lots of socializing, lots of events, so you really have to take that time to get to know the spectrum because someone coming from academia is also in a very isolated environment... There were numerous talks by so many people who want to employ data scientists in their company and that just is so revealing because you can quickly gauge the standard of what tools people expect and what they're looking for when they are employing a data scientist. (Adam)

(Gaining meaningful employment) The project was of course the central part of the [DataCo bootcamp] and something very useful, it allowed me to gain real experience in doing data science... the organization at which I was doing the [data science] project... basically at the end of the day it gave me a job because they liked how I worked throughout the project and they offered me to join the team. (Lola)

(Overall catalyst effect) Yes, I think it [gave] me the opportunity of actually transitioning [from academia into industry]. I think without the [DataCo bootcamp] I couldn't have done it. So actually I think it was... an excellent bridge from academia to a good job market... I'm sure I couldn't have worked for a company. For me that's really a big change, the [DataCo bootcamp] was really, really, really big change. (Isaac)

4.3 *Experiencing career sustainability after a career transition*

For our interviewees, career sustainability after transitioning from academia into data science with the support of career catalysts, was experienced through the reaffirmation of their identity as researchers as well as the reconciliation of the unfulfilled expectations they previously had about an academic career (see Table 3).

4.3.1 Reaffirmation of professional identity. As mentioned earlier, interviewees drew on their past experiences in academia to shape their person-career fit with the data scientist role. An interviewee described it as “the best of two worlds”. The current labor market and the increasing focus on data and data-driven decision-making provided interviewees with the opportunity to continue doing those aspects of academic work that they enjoyed the most, but in the corporate world. Interviewees experienced career sustainability by finding “a job which is in some ways quite similar to academia”, and involved using and building upon their existing research skills. George, who had been working as a data scientist for 2 years, confirmed that his expectation to continue applying scientific methods in his new career field was met:

I didn't want to leave science as such and scientific methods... I wanted to actually do something positive and solving [problems] mathematically and on a daily basis [do] computer programming, so that's still fairly big [in data science] I guess and yes, I definitely managed to continue to do exactly that. (George)

Interviewees talked about conducting activities that resembled academic research, including not only solving complex problems through scientific methods, but also communicating their work by attending and presenting papers at relevant conferences and even seeking to publish articles. Furthermore, as interviewees were used to working together with other high-caliber academics in intellectually challenging environments, they expressed their satisfaction with being able to continue embarking on interesting and intellectually challenging projects, finding “interesting solutions to very difficult problems”, as Alissa put it.

4.3.2 Reconciliation between career expectations and actual career outcomes. Although interviewees found jobs in data science that were in many ways similar to their previous academic job, their new role as data scientists was experienced more positively. Interviewees' current career situation in data science projected a sense of reconciliation between what could have been in academia but is happening now. Enhanced recognition, both in subjective and material terms, was a clear indicator of career sustainability in our sample. Some interviewees might have felt insecure about their career transition into data science for not having “made it” in academia and others found themselves taking on less senior roles in data science due to their lack of experience in the field. However, they soon found that their expertise and skills were highly valued and perceived this recognition materially in the form of rapid promotion and high compensation. As Brody, who had been working in data science for only six months, explained:

I was concerned before doing this transition, because I was in a senior position in academia... I had to go back to do an internship [as part of the DataCo bootcamp]... Then I was hired as senior data

scientist, so not really junior level but a bit higher, so this is something that I negotiated... And actually they are changing my position again... I will be head of group starting next month... It's working very well, and I'm moving quickly, advancing career position. (Brody)

Furthermore, while some interviewees had perceived a lack of meaning and impact in their academic work, they felt a strong sense of adding value to society after transitioning into data science:

So I think there is opportunity to have real impact on people's lives... Data is extremely interesting; it affects people in a fundamental way, and although [let's] say in academia, in the field I was in, it has some effect, it's not as direct, so this seems more real... Yes, I like that idea that you can try and make an impact... (Walter)

Overall, for our interviewees, the perspectives of a sustainable career in data science - built on existing capabilities and grounded in personal interests and purpose - were positive. The great majority of the ex-academics who had already worked as data scientists for at least six months said that they did not regret having left academia, were pleased with the transition process, and would recommend this career path to their colleagues in academia.

Table 3: Themes and illustrative quotes of experienced career sustainability after a career transition: Career outcomes

Themes and codes	Illustrative quotes
Reaffirmed professional identity	
Characteristics of the academic researcher role that continue being nurtured in their role as data scientists	<p>We've actually just had 2 papers accepted for conferences this year which is quite good... It's very much like applied data science or applied machine learning that maybe in an academic setting you wouldn't necessarily come across [with], but it's a problem that we've found when we were trying to push our models out into the business... (Dominic)</p> <p>What characterizes me as a data scientist I think is that yes I used my programming skills and my statistical knowledge to really make a difference inside the company. So concepts like uncertainty on a measurement were completely unknown, so people [at his company] were looking at this chart going up and down... now they understand that sometimes we just need to take more data before we can really draw a conclusion, so that made a difference for taking a lot of decisions... I... grow [a] more scientific approach [at his company]. (Brody)</p>
Reconciled professional identity	
Positive aspects expected to happen in academia but that did	<p>(<i>Recognition</i>) And I also feel [the environment is] less competitive, which seems odd, the idea that the commercial sector should be less competitively separated, but the nice thing about being in data science in a company which has not had a data scientist, it's like you're the best</p>

not happen and are now being experienced in their role as data scientists

data scientist because there's no-one there breathing down your neck, whereas in academia, you're always going to be with people who make you feel I should do better. (Austin)

(Increased impact) I feel like just being a part of this huge revolution that's going on in artificial intelligence, is kind of a lift for me, like it kind of gives me, it makes me feel like I'm working on something that actually is quite important. (Dominic)

(Overall satisfaction) I feel like I've been very lucky, and the opportunities I've been given I've taken, I don't know if that's just part luck, part of my ability to do whatever the job was, but I feel I sort of landed on my feet when I came into data science. There wasn't really any sort of period where I don't know, it was quite easy, it seemed a bit too easy. I'd been working quite hard to get to that point. That's how I feel about it. (Duncan)

5. Discussion and conclusion

The aim of this study was both to explore how early and mid-career STEM researchers transcend career boundaries in search of a sustainable career, and to understand the facilitators of their career transition. Through in-depth qualitative interviews with 28 ex-academics who had prepared themselves to become data scientists, we found that career barriers have the potential to prompt individuals to engage in a process involving self-reflection and self-learning as well as tapping social capital and utilizing *career catalysts* to protect the sustainability of their careers. Central to their career transition and experience of career sustainability was the presence of key *career catalysts*, which in our study was a data science 'bootcamp'. This career catalyst served as a bridge between academia and industry, and facilitated a quick and smooth career transition into data science leading to stable and fulfilling jobs (see Figure 1 for an illustrative representation of our theoretical model). Without the presence of the career catalyst, undergoing a career transition with the objective to protect one's career sustainability would have been harder and lengthier. In our study, career sustainability was reflected in the reaffirmation of interviewees' professional identity as researchers - outside academia - as well as in the reconciliation between their previous career expectations and their actual career outcomes after transitioning. These career outcomes included subjective and material recognition and increased meaning and impact in their professional life. By accepting and pursuing a new occupational role in data science, interviewees reaffirmed their professional identity

as researchers, without having to suffer from the previously experienced contextual barriers in academia.

The contribution of our paper is threefold. First, it further unpacks the dynamics of sustainable careers (De Vos, Van der Heijden, & Akkermans, 2018; Van der Heijden & De Vos, 2015) in the context of career transitions, by expanding our understanding of the interplay between individual agency and contextual factors, including organizational, institutional and labor market factors (Forrier et al., 2009; Inkson et al., 2012). In line with previous research on individual resources, including career development strategies and dynamic learning (Boud et al., 1985; e.g. Cope, 2005; Van Esbroeck et al., 2005) career adaptability (Rudolph et al., 2017; Savickas, 1997; Savickas & Porfeli, 2012) and social capital (Kwon & Adler, 2014), this paper demonstrates that adopting a reflective attitude to one's passion and skills and the concern, control, curiosity and confidence to self-prepare for a new career field, can help individuals to enhance the sustainability of their careers. Our study expands this knowledge by identifying strategic stakeholders that facilitate career transitions beyond the individual and current employer domains, both of which had been more widely studied. In particular, we identify the influence of *career catalysts*, which serve as facilitators of career transitions into sustainable careers by helping individuals to adapt their mindset to new industries and roles, understand potential future employers and jobs, and ultimately gain meaningful employment. *Career catalysts*, we found, are usually stakeholders that act independently from individuals' current employing organization. Our paper also offers new perspectives into the experience of career sustainability. Career sustainability implies moving from an apparently disadvantaged position to a more privileged position where indicators of a sustainable career are more evident. Happiness, health and productivity have been identified as indicators of career sustainability (Van der Heijden, 2005) (see also De Vos et al., 2018). Our findings support this proposition, and narrow it down to show in more detail how this positive state reflects itself in practice: ex-academics are able to continue embracing their professional identity as researchers, e.g.,

by continuing to apply scientific methods, while enjoying higher levels of recognition and a sense of meaning and impact in their new professional life.

Second, our paper expands our understanding of career barriers and how these motivate individuals to seek new career paths. This contribution responds to previous calls to identify both the positive and negative aspects of careers in order to achieve a more realistic understanding of careers and of individuals' experiences at work, and to avoid false dichotomies of career success or failure (Baruch & Vardi, 2016; Gunz et al., 2000; Inkson et al., 2012; Kindsiko & Baruch, 2019). Our paper shows that an individual's decision to leave their current occupational field due to career barriers is a difficult one, and that the process of transitioning into a new career field takes honest self-reflection as well as hard work to self-prepare for a new role. The skills gained from overcoming these challenging experiences (i.e., self-reflection, self-learning and identifying and utilizing catalysts) allow individuals not only to experience career sustainability, but also to be better prepared to overcome the career barriers they are likely to face in the future. Ultimately, career barriers are part of individuals' working lives.

Third, in terms of practical implications, this study provides much needed knowledge on micro-practices of the higher education academy and the struggles associated with academic career experiences (Kallio, Kallio, Tienari & Hyvönen, 2016; Ozbilgin & Bell, 2008). Our findings document not only the barriers experienced by early and mid-career researchers, but also highlight the importance of academic institutions in preparing STEM PhD students for careers outside academia, where they might find more secure job opportunities and a more fulfilling career experience. The structure and content of the career catalyst studied in this paper as well as its catalyst effects are relevant for universities that are interested in improving the career prospects of their doctoral and postdoctoral researchers. It is also highly relevant for policy-makers who are interested in supporting people's career transitions across industries to meet labor market needs. Given that academic jobs in STEM disciplines are increasingly less sustainable for the individual (Bryson,

2004; Petersen et al., 2012; Van der Weijden et al., 2016), our findings suggest that it is imperative to reproduce the career catalysts' effects and establish university-catalyst-employer partnerships in order to benefit a greater number of young researchers who are highly qualified but will not be allowed to pursue a sustainable career in academia. Progression in the contemporary academic career is not always a matter of individual choice and effort, but is also dependent on a variety of chance events (Kindsiko & Baruch, 2019). Regardless of the prestige of their institutions, the career barriers that are currently experienced by academic researchers are likely to continue, herewith causing a shift in their aspirations away from academia (Etmanski, 2019). Yet, junior academics also often spend little time in preparing for a career outside academia and developing transferable skills (Van der Weijden et al., 2016). This paper highlights to those academics, who are experiencing career barriers and questioning their academic careers, what might be beneficial in identifying *career catalysts* that can introduce them to new career paths and equip them with the knowledge and career adaptability needed to successfully transition into new roles. Furthermore, universities, PhD supervisors and line managers within faculties could also candidly direct junior academics to career catalysts to help them achieve a sustainable career, even if it is outside of academia.

Although not all those junior academics who consider a career transition into data science might have access to a career catalyst such as a bootcamp, this paper offers relevant insights into the skills that academics might need to develop and the actions they might need to take in order to protect and further enhance their career sustainability. Our findings might also be generalizable to other occupations and industries and useful for individuals who are considering a career transition, but who might not have access to *career catalysts*. For example, based on our findings, individuals seeking to transition into a new occupational field are encouraged to engage in self-reflection (gaining clear insights into their career expectations and current skills) and self-learning (numerous books, blogs and websites are available to help individuals develop, practice and test core skills). The key benefits of career catalysts identified in this paper can be somehow mirrored through other

resources as well. For example, a mindset change from one field to another (e.g. academia into industry) and understanding potential future employers and jobs and the labor market can also be achieved by studying relevant materials and utilizing one's social capital (reaching out to professional networks, field experts, (ex-)colleagues and friends, or by attending relevant events and conferences to gain a sharper perspective on a particular field or job). Ultimately gaining meaningful employment, another key benefit of career catalysts, can also be achieved by carrying out independent projects in temporary assignments offered by potential employers who might in case of high performance offer individuals a job. Another potential venue for individuals who want to explicitly take care of their career sustainability consists of skillfully identifying, selling and utilizing the skills developed in previous roles (e.g. research skills in the case of academic researchers) in potential new jobs. Without the presence of career catalysts, this process might be lengthier and more difficult, yet still attainable. Similarly, transitioning into a sustainable career might not be as straightforward, but individuals can consciously and continuously question themselves the extent to which their new jobs are aligned with their career expectations and identities, and (re)strategize if appropriate.

Finally, our study also provides empirical insights into the data scientist role, referring to a highly sought-after role by organizations and a role that seems a good fit for STEM academics. At the personal level, the ex-academics in our sample experienced career sustainability in data science because of its similarity with scientific work – work they remained passionate about – but contextual factors also contributed to their experience of career sustainability. Interviewees' quotes indicate that the current job market in data science is promising. This conclusion is supported by reports on jobs' sites: Glassdoor deemed data scientist the best job in the US in 2019 (ranked number 7 in the UK) (Glassdoor, 2019), and Indeed Hiring Lab reported an increase of 256% in data scientists postings in the US since December 2013 (Flowers, 2019). While academia loses talent, organizations are eager

to hire them, and in these dynamics, the agentic individual in search of a sustainable career has much to benefit from.

5.1 Limitations of the study and future research avenues

Our sample included researchers from elite universities who might have been, by default, at an advantaged position to experience career sustainability in comparison with others from less prestigious universities. Our research also points to some influential factors that might be associated with gender and age, such as the limitations of international mobility. Future research might adopt an equality and diversity perspective to analyze more profoundly the experience of career transition and career (un)sustainability on the basis of university of graduation, geographical location, class, race, gender, age and other categories of difference. Furthermore, since people's experiences throughout their career cannot be characterized as a fixed process, longitudinal studies of the experiences of new data scientists (or other professionals who have transitioned to new occupational fields) would provide us with important insights into how experienced career (un)sustainability might change or modify itself over time, for example, due to age-related changes (e.g., motivation, preferences, attitudes and identity) or as a result of new career barriers. Further research might also go into possible hindrances or challenges individuals might face when transitioning from academia into data science without being enabled to benefit from *career catalysts*. Building upon a systemic or multiple-stakeholder perspective on sustainable careers, we argue that the support from independent stakeholders is beneficial. However, more empirical work is needed in order to conclude this concretely.

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