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What makes them leave? A path model of postdocs' intentions to leave academia

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Abstract A growing number of postdoctoral academics cite stressful working conditions for considering abandoning their studies and leaving the academic profession entirely before they obtain a tenured position. This paper identifies the mechanisms by which work stress influences postdocs' intentions to leave academia. Based on Schaubroeck et al.'s (1989) stress-turnover-intention model, we propose a professional turnover-intention model that includes both the effort-reward imbalance model as a comprehensive measure of work stress and affective professional commitment. The research model is tested using structural equation modeling (SEM) and data from 421 postdocs. The results show significant support for the hypothesized effects. In particular, a three-path-mediated effect is found from work stress to the intention to leave academia via strain and job satisfaction. Additional analyses reveal significant gender differences: The relationship between overcommitment and strain is stronger for female postdocs than it is for male postdocs, and the direct link between work stress and the intention to leave academia applies only to female postdocs. Further, job satisfaction fully mediates the relationship between affective professional commitment and the intention to leave academia. Thus, we provide a model on an academics' professional turnover intention that goes beyond previous research by incorporating two important mediators, strain and job satisfaction. We also confirm the relevance of affective professional commitment to professional turnover intentions in the realm of academia. Specific policy recommendations for retaining more postdocs in academia are given.

Keywords Intention to leave the profession · Postdocs · Effort-reward imbalance · Work stress · Professional commitment · SEM

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Introduction

Postdoctoral academics are a fast-growing and increasingly important academic group, as they are highly educated professionals who are both productive and innovative (Davis 2009; O'Grady and Beam 2011; Yang and Webber 2015). They are seen as "the source of future productivity" (van der Weijden et al. 2016, p. 26) because they promote the exchange of knowledge within and between scientific and scholarly networks (Horta 2009). The Association of American Universities (2005, p. 5) defines a postdoc as a "recent doctoral graduate, in a temporary position, engaged in full-time research under the supervision of a faculty member, in preparation for an academic career." This definition is in line with those widely used in studies on postdocs (e.g., Åkerlind 2005; Miller and Feldman 2015; Scaffidi and Berman 2011).

The number of postdoctoral academics who consider abandoning their studies and leaving the academic profession entirely before obtaining a tenured position is growing, and their reasons for doing so constitutes a knowledge gap for both academic research and practice (e.g., Fitzenberger and Schulze 2014; Ipsos 2013; Powell 2015). The term "academic profession" refers to people who teach and/or do research at institutions of higher education (Teichler et al. 2013). Purposely not included in this definition are academics who are doing (request-based) research in industrial companies, as these jobs lack the academic freedom that is a central feature of academic work in universities and non-university research institutions. Moreover, the academic profession is characterized by an extended period of apprenticeship. In contrast to other university graduates, who often become full professionals after only a few years working in their fields, most young academics continue to learn and to do research for 10 to 15 years after graduation before they secure a permanent position in academia, which is usually that of a full professorship (Höhle and Teichler 2013).

Postdocs are frequently exposed to particularly taxing working conditions, such as high workload and overtime work, and substandard rewards, including low job security and low salary (e.g., Brechelmacher et al. 2015), which often result in work stress (Kinman and Jones 2008). These conditions are particularly the case in Germany's higher education system, where the tenure-track system has not yet been established. Berndt et al. (2014) revealed that 33% of the postdocs in Germany have at least seriously considered leaving academia, and many policy reports describe postdoctoral working conditions in Germany as unsatisfactory and counterproductive (EFI 2017; Konsortium BuWin 2017), leading to a rise in (even public) debate on the topic (Agarwala 2015).

Clarifying the causes of postdocs' intentions to leave academia will help to address the substantial loss of educational investment and talent for both the individual and the academic institutions they leave (Kim et al. 2013), as well as the less easily quantifiable loss that results from the loss of innovation, productivity (in terms of scientific and scholarly output), and exchange of knowledge (e.g., Horta 2009; van der Weijden et al. 2016). There is high demand from academic institutions for qualified faculty, as well as from non-university research institutes in Germany (e.g., Leibniz Institutes, Fraunhofer Institutes, or Max Planck Institutes). Both non-university research institutions and universities seek academic excellence, which includes attracting the most qualified candidates (EFI 2017). This search is encouraged by incentive schemes that prioritize funds for departments and universities with strong research records, such as the "initiative for excellence" (DFG 2017), which is funded by the federal government.

Research on employee turnover has a long tradition, going back to the 1950s (for reviews, see Griffeth et al. 2000; Steel and Lounsbury 2009). This stream of research distinguishes two types of turnover: *organizational* turnover, which refers to leaving an employer, and *professional* turnover, which refers to leaving one's profession entirely in favor of another

profession. Although professional turnover and organizational turnover are related, they are different work outcomes that merit separate investigation (e.g., Ryan et al. 2012; Xu 2008). Professional turnover is usually a much harder decision because of the foregone investment (Blau 2000), but research on academics' turnover intentions focuses primarily on organizational turnover (Daly and Dee 2006; Kim et al. 2013; Lawrence et al. 2014; Manger and Eikeland 1990) and often does not differentiate between institutional and professional turnover (Johnsrud and Rosser 2002; Matier 1990; Rosser 2004; Rosser and Townsend 2006; Smart 1990; Xu 2008; Zhou and Volkwein 2004).

Few studies analyze postdocs' intention to leave academia entirely. Some find that the conviction that one is up to pursuing an academic career in terms of ability, scientific productivity, academic network, and perceived self-efficacy predicts large parts of a postdoc's intention to leave the academic profession (Chlosta et al. 2010; Evers and Sieverding 2015; Geuna and Shibayama 2015). Some of these factors may be correlated with gender, such that women are more likely to give up an academic career than men are (Evers and Sieverding 2015; Geuna and Shibayama 2015). However, these studies focus on individual factors and neglect issues like the effects of the demanding working conditions that affect large groups of postdocs—issues that can be addressed to an extent and have the potential to offer solutions for organizations that seek to reduce turnover. Most research that analyzes these kinds of factors and their relationship to the intention to leave the academic profession focuses on tenured or tenure-track faculty and shows that stress experiences and job satisfaction are predictors of the intention to leave the academic profession (e.g., Barnes et al. 1998; Kinman and Jones 2008; Ryan et al. 2012). However, the research ignores the role of affective professional commitment in academics' professional turnover intention, even though it is an important factor in other professionals' turnover intentions (e.g., Blau 2009; van der Heijden et al. 2009). Moreover, it is not clear how the influencing factors relate to one another in forming professional turnover intentions or how important each factor is for explaining postdocs' professional turnover intentions, so these remain open questions. Therefore, this paper seeks to determine the mechanisms by which work stress relates to post docs' intention to leave academia.

We develop a comprehensive causal model on professional turnover intention that relates constructs like work stress, professional commitment, psychological strain, and job satisfaction, with the intention to leave the profession. In so doing, we contribute to research in several ways. First, we extend the literature on professional turnover intentions in general by proposing a structural modeling approach to uncover the interrelationships among influence factors. Second, we contribute to the literature on turnover in academia by showing that the relationship between postdocs' work stress and professional turnover intentions is not only direct but also indirect via strain and job satisfaction. Third, we add to the stress literature in general and in particular to evidence on the explanatory power of a prominent work stress measure, the effort-reward imbalance (ERI) model, in the context of individuals' turnover intentions. In addition, based on our findings on postdocs' professional turnover intentions, we make suggestions for academic institutions and higher education policy that seek to improve the situation of postdocs in Germany.

Postdocs in Germany

Postdocs in Germany face particularly stressful and insecure working conditions. After completing their doctorates, postdocs usually work under regular employment contracts at universities and non-university research institutes. Their working conditions usually feature fixed-term working contracts

of up to 6 years, although in some disciplines, such as the humanities, contractual periods are often less than 1 year (Konsortium BuWin 2017). In addition, because of the prevailing ban on internal promotion, postdocs have to change organizations at least once to find a secure and permanent position (usually as full professor; Bäker 2015). What's more, postdocs who work as research assistants are assigned to a chair or institute that is run by a full professor (Harley et al. 2004), so they are directly under the control of these full professors. The relationship between the postdoc and the professor may be problematic because it can lead to high workload in the form of administrative and teaching-related duties assigned by the superior and render the young academic and his or her career highly dependent on a single professor who is responsible for work tasks, evaluations, and contract renewal and whose recommendation is often critical when the postdoc applies for a permanent position elsewhere (Harley et al. 2004; Hüther and Krücken 2016).

With recent reforms, a postdoc can also take a position as a junior professor or a research group leader, where he or she is more independent. However, these positions seldom feature a tenure option (Hüther and Krücken 2016). What's more, immediately after receiving a Ph.D., postdocs typically work as research assistants at a chair so that most newly appointed junior professors are 35 or 36 years old, which is 3 or 4 years after they complete the Ph.D. (Hüther and Krücken 2016; Konsortium BuWin 2017). Because of the ban on internal promotion, this group of postdocs also has to change organizations in order to secure a permanent position as full professor. The competition for full professorships is fierce because there are few other tenured positions in the German higher education system. Academics average 41 years of age when they are appointed to a tenured professorship in Germany for the first time (Federal Statistical Office 2016b).

Overall, then, postdocs' working situations are characterized by career insecurity, high dependency on single professors, high workload in the form of teaching and administrative duties, and the need to change organizations in order to get promotions to tenured positions in academia during a period of life when people are typically enmeshed in family life with children. Not surprisingly, such a working environment is particularly challenging for women, who drop from around 45% of Ph.D. graduates to only around 23% of professors (Federal Statistical Office 2016a, 2016b), a rate that is much lower than that in other EU countries (Teichler et al. 2013).

Several policy initiatives have been established in Germany to improve the career prospects of postdocs in the German higher education system. For instance, the federal government funded a thousand tenure-track professorships (providing 1 billion Euro for the period 2017–2032; BMBF 2017b) and some of the federal state governments provided funds to institutions of higher education that increase their shares of women professors and ensure gender equality. Another initiative is the "female professorship program" (BMBF 2017a), which finances several full professorships for higher education institutions with convincing strategies for ensuring gender equality. These funds help to ensure that institutions will compete to get the best female academics.

Conceptual background

In contrast to the literature on professional turnover, the literature on organizational turnover provides several models that describe the turnover process (e.g., Mobley 1977; Price and Mueller 1981) and that have been adapted to explain academics' organizational turnover intention. A common feature of these models is to show the role of variables related to the work environment (e.g., salary, autonomy, professional development) on academics' turnover intention via job satisfaction (e.g., Rosser and Townsend 2006; Zhou and Volkwein 2004) or organizational commitment (e.g., Daly and Dee 2006). Unlike this extant research, our approach builds on

Kinman and Jones (2008), who use the ERI model, a subjective stress measure, to map academics' stressful working conditions. Using the concept allows the high level of effort most postdocs must expend in terms of workload and overtime work and their low rewards in terms of income, career opportunities, job security, and esteem to be described. Thus, the ERI model (Siegrist 1996) maps the stressful working conditions of postdoctoral academics. Further, Kinman and Jones (2008) show that work stress (as measured by the ERI model) increases academics' psychological distress, job dissatisfaction, and intentions to leave academia. We combine the four variables of work stress, psychological distress, job satisfaction, and intention to leave academia in a single structural approach, as proposed in Schaubroeck et al.'s (1989) stress-turnover intention model. In their theory-driven path model, work stressors influence organizational turnover intention via strain, job satisfaction, and organizational commitment. More precisely, as illustrated in Fig. 1, the framework hypothesizes that work stressors fuel strain because stressors cause frustration and diminish the workers' perceptions of their effectiveness at work (Schaubroeck et al. 1989). As strain impairs well-being in all parts of life, it is negatively linked to job satisfaction. For its part, job satisfaction enhances the worker's attitude toward the organization, thereby increasing organizational commitment. Organizational commitment and its associated feelings of belonging and loyalty, then, negatively relate to turnover intentions (Katz and Kahn 1978). In addition, work stressors should directly reduce job satisfaction and organizational commitment because work stressors provoke negative emotions and attitudes (Schaubroeck et al. 1989).

Schaubroeck et al.'s (1989) model offers a theory-based framework that links work stressors, strain, and attitudinal factors to turnover intention in a multivariate context. It has received considerable attention in empirical work on work stress and turnover intention (Netemeyer et al. 1995; Podsakoff et al. 2007), but we extend the model to address the issue of *professional* turnover intentions in the academic sector. In specific, we (1) adjust the measurement of work stress; (2) take into consideration the direct relationship between strain and turnover intention; (3) consider individuals' professional commitment as a factor in professional turnover intention; and modify the causal relationships of professional commitment with respect to (4) job satisfaction and (5) work stress.

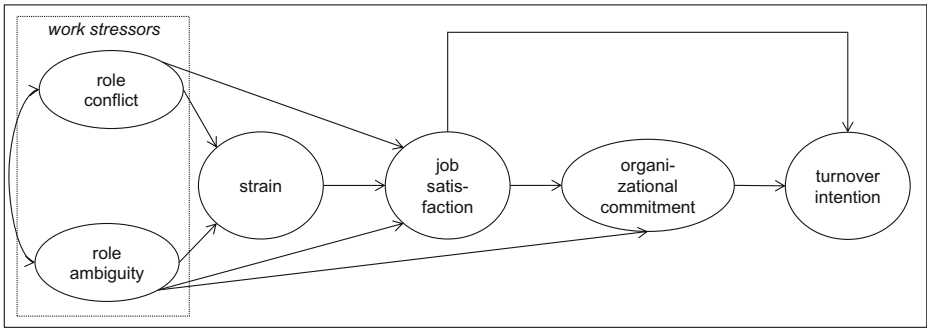

Fig. 1 Model of the relationship among role conflict, role ambiguity, and turnover intention. (See Schaubroeck et al. 1989 and Podsakoff et al. 2007)

The relationships among ERI, overcommitment, strain, job satisfaction, and the intention to leave the academic profession

To begin with, we replace role conflict and role ambiguity in Schaubroeck et al.'s (1989) model with the ERI model (Siegrist 1996), which is widely accepted and employed in research on workplace stress and has been validated numerous times, including in research on academics (e.g., Kinman and Jones 2008). Unlike the measures of role conflict and role ambiguity in Schaubroeck et al. (1989) and the hindrance stressors versus challenge stressors in Podsakoff et al. (2007), the ERI model focuses on a broad range of perceived work-related stressors and resources. Based on the norm of social reciprocity, the ERI model postulates that the negative consequences of work-related stress, such as the intention to leave and impairment of affective commitment and individual well-being (Allisey et al. 2012; van Vegchel et al. 2005), result from a violation of social reciprocity, that is, from a high level of work effort that is not equalized by rewards (money, esteem, and career opportunities). The ERI model explicitly focuses on individuals' perceptions of effort and reward, and their relationship to each other. Negative consequences of an unfavorable imbalance between effort and rewards are to be expected, regardless of the objective severity of work stress, because the individual's perception of efforts, rewards, and their adequacy determine the consequences (Siegrist 2016).

The ERI model takes not only extrinsic efforts like overtime work, work pressure, and inconsistent demands into consideration but also overcommitment, an intrinsic component of effort. Overcommitment may shape the individual's perception of his or her effort and rewards, thereby enhancing the deleterious effects of ERI on several outcome variables, and may even trigger negative outcomes like irritation (Krisor and Rowold 2013). Overcommitment describes an individual motivation and coping pattern that is characterized by an excessive commitment to work and a high level of need for approval, so it can be considered a psychological risk factor that is especially relevant to academics (Siegrist et al. 2004)—especially postdocs, who tend to accept heavy demands at work and to exert excessive effort (Brechelmacher et al. 2015). In sum, the model's view of stressful working conditions is not limited to single stressors (Barnes et al. 1998; Ryan et al. 2012) but is broadened in a way that depicts the high level of work-related effort (e.g., high workload regarding teaching duties, research, and administrative work) and low rewards (e.g., part-time positions, poor promotion prospects) of postdocs particularly well. Since organizations can influence the factors captured by the ERI model, bringing the ERI model into play offers the opportunity to derive concrete recommendations for actions that reduce workplace stress.

The ERI model is comprised of three basic assumptions: (1) Individuals with an ERI are at increased risk of strain, (2) overcommitted individuals have an increased risk of strain, and (3) at the highest risk of strain are individuals who experience an ERI and are also overcommitted. Therefore, overcommitment is expected to positively moderate the effect of ERI on strain (Siegrist et al. 2004) because the imbalance between high effort and low rewards leads to strong negative emotions that in turn launch several processes in the individual and increase the probability of suffering from psychological strain (Siegrist 2000). However, people do not usually remain passively in such an unfavorable working situation but try to reduce their effort and/or increase their rewards in order to mitigate the situation (e.g., Calnan et al. 2000; De Jonge et al. 2000), so developing an intention to leave may be seen as a coping strategy in response to an ERI (Derycke et al. 2010). Being overcommitted further adds to the effort component, thereby increasing negative emotions and leading to a dysfunctional perception of effort and rewards (Siegrist et al. 2004) and aggravating the negative reactions.

Moreover, according to the ERI model, overcommitment is directly, positively related to strain, and it moderates the relationship between ERI and strain such that the association is stronger for overcommitted postdocs than it is for those who are not overcommitted. As stressful working conditions compromise job satisfaction (Calnan et al. 2000), we expect a negative association between ERI and job satisfaction. Further, intending to leave one's profession can be seen as a way of coping with adverse, stressful working conditions (Derycke et al. 2010), so we also hypothesize that ERI is directly and positively related to the intention to leave the profession.

H1 ERI is positively associated with psychological strain.
H2 Overcommitment is positively associated with psychological strain.
H3 Overcommitment positively moderates the relationship between ERI and psychological strain.
H4 ERI is negatively associated with job satisfaction.
H5 ERI is positively associated with the intention to leave the profession.

The relationship of strain with job satisfaction and the intention to leave the profession

Another way in which we extend Schaubroeck et al.'s (1989) model, with a view to the attitudinal outcomes of strain, is by adding a direct link between strain and turnover intention. That employees who experience job-induced strain lose job satisfaction and often experience a depressive mood, which lowers feelings of satisfaction in all life domains, has been widely discussed since the mid-1990s. Such employees also tend to think about leaving their jobs or organizations (e.g., Harris et al. 2005). Empirical evidence on the relationship between strain and the intention to leave has accumulated for, for example, truck drivers and salespeople (Boyd et al. 2009; De Croon et al. 2004). In line with these results, we assume that postdocs who experience psychological strain are more likely to question their occupations than are those who have no such perceptions (Boyd et al. 2009). Eventually, employees under psychological strain may see withdrawing from the job or the profession as the only way to escape from the work situation (Harris et al. 2005). Thus, psychological strain decreases job satisfaction and increases postdocs' intention to leave the profession.

H6 Strain is positively associated with the intention to leave the profession.
H7 Strain is negatively associated with job satisfaction.

The relationships among professional commitment, job satisfaction, and the intention to leave the profession

We substitute organizational commitment with affective professional commitment to focus on the employee's emotional connection with the profession (Lee et al. 2000). Research shows that employees' intention to leave their professions and affective professional commitment are closely related (Blau 2000; Yousaf et al. 2015), while organizational commitment (i.e., personal connection with the organization) and the other dimensions of professional commitment (normative and continuance commitment) play smaller roles in explaining the intention to leave the profession (Blau 2009; Snape and Redman 2003). Moreover, academics tend to be strongly committed to their profession (Teichler et al. 2013), having chosen an academic career to realize

their ideals, such as the search for knowledge and truth. Where they do their research is often less important than the work itself, as the structure of an academic career usually requires academics to be mobile. As a result, they change their organizations at least once in their academic careers (Kreckel 2008), which hinders their ability to establish strong bonds with their organizations.

We also reconsider the relationships among commitment, job satisfaction, and turnover intention. Empirical evidence shows that both job satisfaction and affective professional commitment directly and negatively influence turnover intention (van der Heijden et al. 2009; Weng and McElroy 2012), while meta-analytical findings show that affective professional commitment and job satisfaction are positively correlated (Lee et al. 2000) because both constructs rely on an affective evaluation of work life. In addition, empirical studies on the causal relationships indicate that the influence of commitment on turnover intention also works indirectly via job satisfaction (e.g., Tett and Meyer 1993). This assumption is based on social identity theory, which postulates that strong identification with an organization or profession strengthens personal identity and self-worth (van Dick and Wagner 2002), so, such identification can have positive consequences for individual job satisfaction (van Dick et al. 2004). In sum, we argue that affective professional commitment contributes to academics' personal identity and reduces the intention to leave academia both directly and indirectly via job satisfaction.

H8 Job satisfaction is negatively associated with the intention to leave the profession.
H9 Affective professional commitment is negatively associated with the intention to leave the profession.
H10 Affective professional commitment is positively associated with job satisfaction.

The relationship between ERI and professional commitment

Finally, we propose a negative relationship between ERI and affective professional commitment. If academics experience an ERI, they may perceive a conflict between their own values and goals and their academic work, which can lead to frustration and disillusionment and eventually erode their commitment to the academic profession. Our approach is in line with meta-analytical findings (Lee et al. 2000) that show the negative impact of stress on affective professional commitment.

H11 ERI is negatively associated with affective professional commitment.

The hypothesized relationships are shown in Fig. 2.

Method

Data and sample

We conducted an empirical study among academics in Germany from whom we collected data in spring 2015 using an online questionnaire. We contacted academics who were working at universities and non-university research institutes in Germany via e-mail to randomly selected deaneries and administrative offices of professorships and research institutes. Some control questions regarding occupational career and institutional references were included, the purpose of which was to secure the participation of academics while excluding other persons. Our

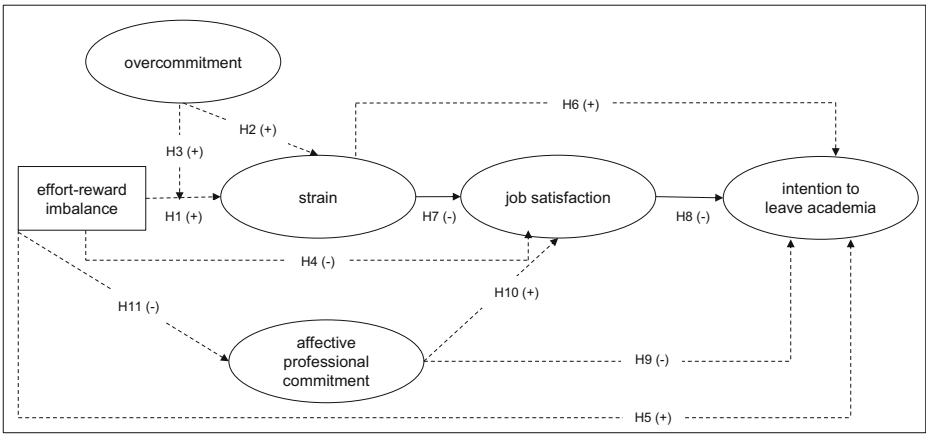

Fig. 2 Analytical framework ["+" = positive association and "-" = negative association; dotted lines mark extensions to Schaubroeck et al.'s (1989) model]

procedure was aimed at reaching as many academics as possible in order to acquire a comprehensive data set.

Overall, 2065 people participated in the survey and completed the questionnaire in full. We limited our sample to 421 academics who held a Ph.D. and who either had a fixed-termed employment contract with a university or non-university research institution as a postdoc with no tenure-track option or had received a temporary fellowship. Table 1 provides an overview of the most important respondents' characteristics.

Of the 421 respondents, 71.7% worked at universities and 28.3% worked at non-university research institutes. Engineering scientists made up 9.5% of the respondents, while 47.7% were humanities scholars and social scientists, 21.9% were natural scientists, and 20.9% were life scientists.

A systematic comparison between the characteristics of the sample and the whole population of postdocs cannot be carried out as statistical data about the latter is not available. However, to ensure that our sample was adequately representative, we compared it with the samples in two studies on postdocs' career prospects that were carried out in Germany (Evers and Sieverding 2015; Fitzenberger and Schulze 2014). The comparison revealed that the distribution of age, number of children, and years since Ph.D. completion in these studies is similar that of to our sample. However, although the number of female Ph.D. graduates and

Table 1 Description of the sample

Characteristics	n	%	M	SD
Gender				
Female	225	53		
Male	196	47		
Age (years)	421		36.49	6.01
Volume of employment (%)	421		90.07	18.38
Length of employment (years)	421		3.37	2.78
Duration of contracts (years)	421		2.13	1.27

n = 421, *M* mean, *SD* standard deviation

habilitations of female postdocs have increased sharply in recent years (Federal Statistical Office 2016a, 2016b), female academics may be overrepresented in our study.

Variables

All variables used in the questionnaire were measured by established scales. *ERI* (nine items) and *overcommitment* (three items) were assessed via the German short form of the ERI questionnaire (Rödel et al. 2004). The ERI variable was calculated for every participant using the formula e/(rc), where e is the sum score of the effort scale (three items), r is the sum score of the reward scale (six items), and c is a correction factor for the number of items in the effort and reward scales (Siegrist et al. 2004). Responses were made on a four-point scale (1 = strongly disagree to 4 = strongly agree).

Following earlier studies (e.g., Niedhammer et al. 2006), *strain* was measured using eight items adopted from the German version (Hautzinger and Bailer 1993) of the Center for Epidemiological Study Depression Survey (CES-D) questionnaire (Radloff 1977). Respondents were asked to use a four-point scale (0 = rarely or none of the time to 3 = most of the time) to describe how often they felt a certain way in the past.

We also adapted Meyer et al.'s (1993) scales of *affective occupational commitment* (three items) and *intention to leave the profession* (three items) to the academic context. The questions on the respondents' intentions to leave the profession explicitly sought to determine whether the participants intended to leave not only academia (e.g., for a better job in practice) before completing one's qualifications or career goals, but the profession.

Job satisfaction was measured with four items derived from Fischer and Lück's (1972) scale. Reponses for the last three variables were made on five-point Likert scales (1 = strongly disagree to 5 = strongly agree).

Cronbach's alpha was computed to estimate our scales' reliability, and the values, ranging from 0.71 to 0.87, suggest moderate to high internal consistency (Nunnally 1978). As we measured both the independent and the dependent variables with the same questionnaire, our results may have been affected by common method variance (CMV). CMV usually stems from respondents' socially desired response behavior or evaluation apprehension, issues that may be mitigated by procedural remedies. For one, CMV is more likely in simple models than it is in more complex ones. Since our model is comprised of relatively complex moderated and mediated relationships, CMV is unlikely to occur (Chang et al. 2010). Podsakoff et al. (2012) suggest using instructions for the questionnaire that assure respondents that their opinions are valued, anonymity is granted, and there are no right or wrong answers. They also recommend explaining to respondents how the data will be used. All of these remedies were implemented to maximize the accuracy of respondents' answers. In addition, we performed a common factor test in order to determine whether a single factor explains the majority of the variance observed (Podsakoff et al. 2003; Podsakoff et al. 2012). The common variance was 0.28, which is clearly the minority of the variance, so we expect that CMV is not a concern in our model.

Limitations

Our study faces four primary limitations. First, because of the cross-sectional design of our study, the effects we measured cannot be interpreted in a strict causal sense. Second, the

explanatory power of the significance tests is limited since our online sample is not an ideal random sample; whether the overrepresentation of female academics is caused by a sharp increase in the share of female academics who complete a Ph.D. or a self-selection bias we can only speculate. Third, people who are either extremely satisfied or dissatisfied with their jobs may be overrepresented in our sample, biasing the results, as such people may be more eager to complete a survey like this one in order to vent their feelings than are people who are moderately satisfied. Therefore, we compared two groups of respondents with regard to their level of job satisfaction: those who answered shortly after receiving the invitation for the survey and those who waited until they were reminded, assuming that, if the sample was biased, the group of early respondents would differ significantly from late respondents in terms of job satisfaction, while late respondents would be more similar to the non-respondents than to the early respondents. A chi-square test on homogeneity revealed that there was no systematic difference between early and late respondents concerning their job satisfaction [X^2 (df = 11, n = 421) = 7.052, p = 0.795], indicating that there is no overrepresentation by extremely satisfied or dissatisfied postdocs to be suspected in our sample. Fourth, we focused on postdocs in Germany, so our results may not be generalizable. Although postdocs in different countries face similar challenges on their way to academic tenure, working and employment conditions differ by country in many respects (e.g., the number of permanent positions and teaching load; e.g., Esdar et al. 2015; Huisman et al. 2002). Thus, the observed effects may be different for academics from other countries.

Results

Table 2 lists the means, standard deviations, and correlations among the variables. As none of the correlations exceed the threshold of 0.70, and the highest variance inflation factor is 1.57, a serious risk of multicollinearity can be ruled out (Anderson et al. 2014).

Measurement models

We assessed the fit of a five-factor measurement model to our data by drawing on the Goodness-of-Fit Index (GFI), the Tucker Lewis Index (TLI), the Incremental Fit Index (IFI), the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA). The Chi-square/df ratio (1.591) for the measurement model is below the threshold of 3.0 (Kline 1998), and the GFI (0.94), TLI (0.96), IFI (0.97), and CFI (0.97) all exceed the threshold of 0.90 (Homburg and Baumgartner 1995). The RMSEA (.04) stays below the cutoff point of 0.06 (Hu and Bentler 1999), and the standardized factor loadings in the confirmatory factor analysis (CFA) are all above 0.57,

Table 2 Descriptive statistics and correlations among variables

	M	SD	1	2	3	4	5
1 Intention to leave academia	2.70	1.03					
2 Job satisfaction	3.80	0.83	−0.48				
3 Strain	0.75	0.55	0.16	−0.36			
4 Affective professional commitment	4.16	0.75	−0.31	0.50	−0.07		
5 Overcommitment	3.00	0.64	0.09	−0.14	0.41	0.09	
6 ERI	1.50	0.56	0.29	−0.29	0.31	0.03	0.34

n = 421, r > |0.14| are significant at p < 0.001, *M* mean, *SD* standard deviation

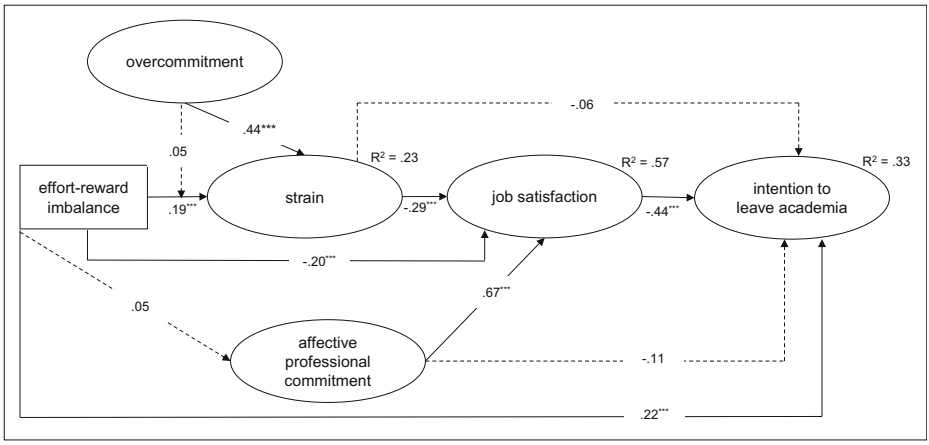

Fig. 3 Results Structural Model; $n = 421$; ***$p < 0.001$; Dotted lines mark non-significant relationships

exceeding the recommended minimum of 0.40 (Ford et al. 1986). In sum, our measurement model indicates a good model fit. Comparison with a one-factor model (Chi-square/df ratio: 8.374; GFI: 0.60; TLI: 0.49; IFI: 0.54; CFI: 0.54; RMSEA: 0.13) and a three-factor model (Chi-square/df ratio: 2.710; GFI: 0.89; TLI: 0.88; IFI: 0.90; CFI: 0.89; RMSEA: 0.06) reveals that the five-factor model fits our data best.

Structural model

To test our hypotheses we applied structural equation modeling (SEM), which is recommended for testing complex, mediated relationships (Hox and Bechger 1998). The fit indices of our hypothesized model suggest good model fit (Chi-square/df ratio = 1.898, GFI = 0.92, TLI = 0.93, IFI = 0.94, CFI = 0.94, RMSEA = 0.05). The results explain a substantial level of variance for strain ($R^2 = 0.23$), job satisfaction ($R^2 = 0.57$), and intention to leave academia ($R^2 = 0.33$). Figure 3 displays the standardized coefficients.

The results support most of our hypotheses. We found seven direct effects among the investigated constructs, with the strongest association between affective professional commitment and job satisfaction (H10; $\beta = 0.67$, $p < 0.001$), demonstrating the importance of affective professional commitment for young researchers' satisfaction with their jobs. Our results also show that job satisfaction can be compromised by ERI (H4; $\beta = -0.20$, $p < 0.001$) and strain (H7; $\beta = -0.29$, $p < 0.001$) and that strain increases with ERI (H1; $\beta = 0.19$, $p < 0.001$) and overcommitment (H2; $\beta = 0.44$, $p < 0.001$).

Concerning our primary objective—that is, explaining postdocs' intention to leave academia—we found that both job satisfaction (H8; $\beta = -0.44$, $p < 0.001$) and ERI (H5; $\beta = 0.22$, $p < 0.001$) directly affect the intention to leave. Postdocs are more likely to leave academia as their job satisfaction decreases and their ERI increases.

We also found a mediated effect of ERI on the intention to leave academia, supporting large parts of our hypothesized path model. To this end, we used the joint significant test to test a three-path mediated effect between ERI and the intention to leave (MacKinnon et al. 2002; Taylor et al. 2007). The test states that "evidence for mediation [is given] if each of the three paths in the mediated effect is significantly nonzero" (Taylor et al. 2007, p. 244). In our case, the two-tailed significance levels provided by bootstrapping (2000 bootstrap samples, 99%

confidence level) were high for all three paths: *ERI* → *strain* ($p < 0.001$), *strain* → *job satisfaction* ($p < 0.001$), and *job satisfaction* → *intention to leave* ($p < 0.001$). As we also found a direct association between *ERI* and *intention to leave*, this relationship is partially mediated by *strain* and *job satisfaction*. The relationship between *strain* and the *intention to leave* is fully mediated by *job satisfaction*, as there is no significant, direct relationship between *strain* and *intention to leave academia* (H6; $\beta = -0.06$, $p = 0.292$).

Using the same approach, we confirmed that the relationship between *affective professional commitment* and *intention to leave* is fully mediated by *job satisfaction* because the two-tailed significance levels (2000 bootstrap samples, 99% confidence level) are high for both paths: *affective professional commitment* → *job satisfaction* ($p < 0.001$) and *job satisfaction* → *intention to leave* ($p < 0.001$), while the path between *affective professional commitment* and the *intention to leave* is not significant (H9; $\beta = -0.11$, $p = 0.261$).

We found no hypothesized moderating effect of *overcommitment* on the relationship between *ERI* and *strain* (H3; $\beta = 0.05$, $p = 0.356$), and *ERI* and *affective professional commitment* were found to be unrelated (H11; $\beta = 0.05$, $p = 0.347$).

Additional analyses

As gender differences regarding the intention to leave academia and the intention to pursue an academic career have been reported before (e.g., Evers and Sieverding 2015; Geuna and Shibayama 2015), we performed a multigroup moderation (Byrne 2004) to test differences between male and female postdocs. The differences for the two groups are reported in Table 3.

Z-scores show that the estimates for the paths *overcommitment* → *strain* and *ERI* → *intention to leave* differ significantly for men and women. The estimates reveal that the relationship between *overcommitment* and *strain* is considerably stronger for women (b = 0.52) than it is for men (b = 0.24); that is, being overcommitted contributes much more to women's experiencing strain than it does for men. Further, the direct positive relationship between *ERI* and the *intention to leave the profession* is clearly stronger for women (b = 0.42) than it is for men (b = 0.12). Even more, compared to our basic structural model, the path *ERI* → *intention to leave* is significant only for women ($p = 0.000$), not for men ($p = 0.262$). Therefore, work stress resulting from adverse working conditions is directly related to female postdocs' considering leaving academia but not to men's considering leaving academia.

One could assume that there are differences between academics based on their fields of study (Xu 2008). For example, postdocs who belong to the hard sciences may have better career chances outside academia, such as in companies' research divisions, than social scientists do. Therefore, we performed another multigroup moderation test (Byrne 2004) to test differences between postdocs in the hard sciences (natural and life sciences, engineering sciences) and postdocs in the soft sciences (humanities and social sciences). However, there were no significant differences between the two groups, as the z-scores in Table 4 show. This result supports the robustness of our results and substantiates their applicability to all scientific fields.

Discussion

With the exception of four relationships (H3, H6, H9, and H11), our proposed relationships received considerable support. The results demonstrate a complex relationship of both direct

Table 3 Multigroup moderation test on gender

	Male		Female		
Path	b	p	b	p	z-score
OC → strain	0.24	0.000	0.52	0.000	2.653***
ERI → APC	0.07	0.451	0.07	0.508	−0.045
ERI → strain	0.24	0.000	0.12	0.071	−1.325
OC (moderation) → strain	0.05	0.318	0.01	0.767	−0.656
ERI → job satisfaction	−0.25	0.010	−0.32	0.000	−0.500
APC → job satisfaction	0.83	0.000	0.72	0.000	−0.653
Strain → job satisfaction	−0.49	0.000	−0.36	0.000	0.865
ERI → ITLP	0.12	0.262	0.42	0.000	2.023**
APC → ITLP	−0.34	0.064	0.02	0.848	1.637
Job satisfaction → ITLP	−0.39	0.012	−0.44	0.001	−0.269
Strain → ITLP	−0.10	0.500	−0.07	0.486	0.155

b = estimate; p = significance level: ***$p < 0.01$; **$p < 0.05$, *OC* overcommitment, *ERI* effort-reward imbalance, *APC* affective professional commitment, *ITLP* intention to leave the profession

and indirect associations between ERI and postdocs' intention to leave the profession. Our model explains 33% of the variance in postdocs' intention to leave academia, which exceeds the amount of variance explained in most studies that do not differentiate between academics organizational and professional turnover intentions (e.g., 13–14% in Smart 1990; 27% in Zhou and Volkwein 2004; 32% in Rosser 2004). In contrast to these studies, we use ERI, a work stress approach to measuring postdocs' demanding working conditions, include professional commitment as an explanatory variable in postdocs' turnover intentions, and use postdocs' intentions to leave academia as the outcome variable.

We show that ERI relates both directly and indirectly (via a path over strain and job satisfaction) to postdocs' intention to leave academia. The postdocs' perceived imbalance

Table 4 Multigroup moderation test on scientific fields

	Hard sciences		Soft sciences		
Path	b	p	b	p	z-score
OC → strain	0.40	0.000	0.30	0.000	−1.074
ERI → APC	0.09	0.391	0.05	0.642	−0.280
ERI → strain	0.26	0.000	0.14	0.023	−1.263
OC (moderation) → strain	0.02	0.383	−0.08	0.248	−1.394
ERI → job satisfaction	−0.32	0.000	−0.21	0.013	0.898
APC → job satisfaction	0.78	0.000	0.73	0.000	−0.339
Strain → job satisfaction	−0.37	0.000	−0.45	0.000	−0.503
ERI → ITLP	0.27	0.022	0.32	0.000	0.387
APC → ITLP	−0.16	0.353	−0.16	0.188	−0.006
Job satisfaction → ITLP	−0.33	0.049	−0.41	0.000	−0.399
Strain → ITLP	0.01	0.914	−0.18	0.129	−0.161

b = estimate; p = significance level: ***$p < 0.01$; **$p < 0.05$, *OC* overcommitment, *ERI* effort-reward imbalance, *APC* affective professional commitment, *ITLP* intention to leave the profession

between high efforts and low rewards seems to evoke negative emotions and strain reactions, which lead the postdoc to devalue his or her current job situation. As a result, job satisfaction decreases, increasing the intention to leave academia. Thus, we confirm previous research findings on the direct relationships between work stress and academics' intention to leave academia and between job satisfaction and academics' intention to leave academia (Barnes et al. 1998; Kinman and Jones 2008; Ryan et al. 2012) and extend the literature by demonstrating an indirect relationship between work stress and individuals' intention to leave the profession. This result is remarkable considering the relatively high levels of respondents' job satisfaction (Table 2). Rogge and Tesch (2016) argue that academics are highly motivated and that most are highly satisfied with their scientific work while being unhappy with their career prospects. Our result that overcommitment amplifies strain confirms Kinman and Jones' (2008) finding of a positive relationship between overcommitment and psychological distress among academics. In contrast to studies of other professions (e.g., Boyd et al. 2009; De Croon et al. 2004), our study does not support a direct link between psychological strain and turnover intentions; instead, the effect of psychological strain on the intention to leave academia is fully mediated by job satisfaction.

In addition, we showed that affective professional commitment decreases postdocs' intention to leave via job satisfaction, although we could not confirm a direct relationship between affective professional commitment and the intention to leave. Therefore, job satisfaction also fully mediates the relation between affective professional commitment and the intention to leave academia. The results indicate that the positive feelings associated with being part of the academic profession (e.g., pride, happiness) lead academics to evaluate their working situations more positively (van Dick et al. 2004), lowering the intention to leave academia. The relationships among professional commitment, job satisfaction, and turnover intention have not been investigated to date, as research focuses on organizational commitment and its relationship with turnover (Farkas and Tetrick 1989; Tett and Meyer 1993; Vandenberg and Lance 1992). Therefore, we confirm the importance of affective professional commitment in explaining professional turnover intentions in the context of academia, a relationship that research shows for other professions (e.g., medical technologists: Blau et al. 2003; nurses: van der Heijden et al. 2009). Moreover, these findings point to the significance of job satisfaction in the emergence of postdocs' intentions to leave academia. Psychological strain or a strong tie with the profession does not affect the intention to leave until job satisfaction changes. Previous studies show the effect of job satisfaction on professional turnover intentions for tenured and tenure-track academics (Ryan et al. 2012), but our findings provide evidence for its mediating role.

Despite the major support for our research model, we found no direct relationship between ERI and affective professional commitment. In light of our sample's extraordinarily pronounced affective commitment to the profession, postdocs' commitment to the profession may be so strong that their commitment is not affected by ERI and that, therefore, work stress and commitment to the profession are independent of each other. Postdocs with high affective professional commitment may accept an imbalance between effort and reward in order to have an academic career. As Schmidt and Diestel (2012) suggest, affective commitment may give employees "a sense of emotional stability, security, and belonging that makes them more resistant to any kind of work stressor" (p. 483).

In confirming two out of three of the ERI model's hypotheses, our results show a moderate effect of ERI on strain and a comparatively strong effect of overcommitment on strain, but our

study does not support the ERI model's interaction hypothesis. Therefore, overcommitment does not modify the relationship between ERI and strain in our sample. Research has investigated the interaction hypothesis to a much lesser extent than the other two hypotheses of the ERI model, and its results are inconsistent (van Vegchel et al. 2005). Our finding is in line with Kinman and Jones (2008), who examine academics in United Kingdom, so overcommitted academics may not relate their exaggerated efforts to their working conditions or they may view them as part of the job.

The additional analysis shows significant gender differences concerning two paths: First, the relationship between overcommitment and strain is stronger for female postdocs than it is for their male counterparts. Second, a direct link between work stress and the intention to leave academia is present only for female postdocs. In the realm of academia, findings of gender effects on individuals' turnover intentions are mixed (Xu 2008), so we add to the literature by showing that overcommitment has a significantly stronger effect on psychological strain for female postdocs. This result may be related to the characteristics of male postdocs, such as a higher self-efficacy (Evers and Sieverding 2015), which buffer the effect of overcommitment on psychological strain. Moreover, we reveal a strong direct effect of ERI on female postdocs' intention to leave academia, perhaps because postdocs are in a life phase in which family obligations are high. While it is socially accepted for women to leave academia and other professions because they want to start a family, this reason is much less socially accepted for men. Women appear to be more likely than men are to opt for a non-academic career if they perceive an ERI and high personal responsibilities at the same time. Thus, we highlight the importance of academic institutions' balancing effort and reward, especially for female postdocs.

Future research

Our model serves as a solid starting point for studies of the causal relationships among work stressors, mediator variables, and the intention to leave academia.

First, based on our finding that ERI relates directly to academics' turnover intentions and indirectly via strain and job satisfaction, improving the balance between effort and reward can help to reduce turnover intentions, lessen strain, and improve job satisfaction. Therefore, research on programs that reduce ERI is needed. Moreover, as we found considerable gender differences concerning the effects of ERI on postdocs' intention to leave, tests for gender effects should be incorporated into future research (e.g., considering the work-life conflict of postdocs).

Second, the gender difference concerning the relationship between overcommitment and strain calls for further research to uncover the causes of this difference by, for example, testing the moderating effects of individual characteristics like self-efficacy.

Third, as our study does not show a relationship between ERI and affective professional commitment, research should investigate whether professional commitment is independent of work stress for professionals who have high levels of affective professional commitment. The finding of Allisey et al. (2012) on the positive relationship between the reward component of the ERI model and affective organizational commitment suggests the need for investigating separately the effects of the two components of the ERI model—reward and effort—on professional commitment. Identifying the determinants of affective professional commitment is needed because they can help to explain job satisfaction and turnover intentions.

Implications for practice

In academic institutions' striving for excellence, they seek to attract and retain qualified postdocs. Our results suggest several recommendations for such institutions. As our model suggests, ERI is the first link in the chain that explains an academics' intention to leave. Therefore, in order to retain more postdoctoral researchers, academic institutions and higher education policy should work to balance work-related efforts and rewards using either or both of two key approaches: (1) strengthening postdocs' rewards (e.g., by encouraging their superiors to provide more appreciation and recognition and offering tenure-track positions, long-term work contracts, and permanent positions beneath a full professorship for academic services) and (2) reducing the effort required by, e.g., contractually reducing the teaching load required of doctoral and post-doctoral students and/or implementing more scholarship programs and/or more positions at the post-doctoral level (e.g., leader of young researcher groups, assistant professorships) that would allow post-doctoral academics to focus on their own research.

Another approach may be rooted in the subjectivity of the perception of effort, reward, and their adequacy. In the absence of considerable work experience outside academia, the subjective sense of effort and reward may be biased. Perhaps preparation for the postdoc job should include clearly communicating the effort and rewards postdocs should expect so they do not come as a surprise, thereby lifting feelings of dissatisfaction and unfairness.

The relatively high level of overcommitment that we detected among postdoctoral researchers also offers an opportunity to reduce the intention to leave academia. Our results show that overcommitment contributes significantly to postdocs' strain and that strain is indirectly related to turnover intentions. Since Aust, Peter, and Siegrist (1997) show that stress-reduction training reduces the level of overcommitment to work, offering such training to young researchers may help reduce postdocs' intention to leave.

Based on our finding that affective professional commitment affects both the intention to leave and job satisfaction, interventions that foster this kind of attitude could be undertaken. For example, regular meetings between postdocs and their supervisors/mentors could be used to develop personalized research strategies, which would help the postdocs create a positive attitude toward the profession.

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