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# Wages in high-tech start-ups – Do academic spin-offs pay a wage premium?

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ABSTRACT

Due to their origin in universities, academic spin-offs operate at the forefront of technological development. Therefore, academic spin-offs exhibit a skill-biased labour demand, i.e. academic spin-offs have a high demand for employees with cutting-edge knowledge and technical skills. In order to accommodate this demand, academic spin-offs may have to pay a relative wage premium compared to other high-tech start-ups. However, neither a comprehensive theoretical assessment nor the empirical literature on wages in start-ups unambiguously predicts the existence and the direction of wage differentials between academic spin-offs and non-spin-offs. This paper addresses this research gap and examines empirically whether or not academic spin-offs pay their employees a wage premium. Using a unique linked employer-employee data set of German high-tech start-ups, we estimate Mincer-type wage regressions applying the Hausman-Taylor panel estimator. Our results show that academic spin-offs do not pay a wage premium in general. However, a notable exception to this general result is that academic spin-offs that commercialise new scientific results or methods pay a wage premium to employees with links to the university sector – either as university graduates or as student workers.



## 1. Introduction

Academic spin-offs (referred to below as "spin-offs" for convenience) are an important means for transferring specific skills, research results and technologies developed at universities and research institutions[1] to the for-profit private sector. Due to their origin in universities, spin-offs are regarded as operating at the forefront of technological development (Clarysse et al., 2011; Wright et al., 2007a), which leads to a skill-biased labour demand, i.e. spin-offs have a high demand for employees with cutting-edge knowledge and technical skills. In order to attract and hire adequately skilled workers from the labour market, spin-offs may be required to provide higher wages even compared to other high-tech start-ups that emanate from outside the university sector ("non-spin-offs"). However, neither a comprehensive theoretical assessment nor the empirical literature on wages in start-ups unambiguously predicts the existence and the direction of wage differentials between spin-offs and non-spin-offs. This paper addresses this research gap and provides the first empirical evidence on whether spin-offs pay their employees a wage premium.[2]

Wage determination in spin-offs and the analysis of wage differentials across high-tech start-ups also has important policy implications. Some scholars argue that spin-offs need to compen-

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[1] In this paper, we use the term "university" to refer to all kinds of publically funded, not-for-profit research organisations. For Germany, this includes extra-university research institutes like those of the Max Planck Society or the Fraunhofer Society.

[2] As pointed out by an anonymous reviewer, the group labelled non-spin-offs may nevertheless contain so-called corporate spin-offs. Parhankangas and Arenius (2003, p. 464) define a corporate spin-off as a "new business formation based on the business ideas developed within the parent firm being taken into a self-standing firm." Unfortunately, we are unable to identify corporate spin-offs in our data set. Thus, throughout this paper we exclusively focus on academic spin-offs that originate from universities and refer as non-spin-offs to all high-tech start-ups that are not academic spin-offs.

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sate the societal costs that arise from the spin-off process, basically resulting from the academic "brain drain" from the incubator university (Czarnitzki et al., 2014; Toole and Czarnitzki, 2010). Against an abundance of studies focussing on job creation or survival of spin-offs, wages have largely been neglected in this discussion so far, although a wage premium paid by spin-offs could be a potential source to compensate for the societal costs of the creation of spin-offs.

Our empirical study uses a comprehensive linked employer-employee (LEE) panel data set that was generated by matching the ZEW High-Tech Start-Up Survey 2007 with administrative data on employees and establishments provided by the Institute for Employment Research (IAB). Our data set comprises 807 German high-tech start-ups including 120 spin-offs, founded in the period from 2003 to 2005, with their full workforce for at least the first three years of the existence of the firms. Most importantly, the data set further enables us to differentiate between different types of spin-offs with respect to the knowledge that has been transferred into the spin-off. Following Egeln et al. (2003a,b), we distinguish between two types of spin-offs: competence and transfer spin-offs. The latter involve the transfer of scientific results or methods to the spin-offs, while the former are based on the transfer of specific skills from the university to the new venture.

Our descriptive analysis reveals that on average full-time employees in both types of spin-offs receive higher wages than their counterparts in non-spin-offs. However, using a multivariate regression framework in the tradition of Mincer (1974) and a Hausman-Taylor panel estimator we are able to explain these unadjusted wage differentials entirely by differences in worker and firm characteristics of spin-offs and non-spin-offs. Being employed by either a competence or a transfer spin-off does not imply higher wage levels than working in a non-spin-off. A notable exception is university graduates working for transfer spin-offs, who receive a significant wage premium of about 14% compared to their counterparts working for non-spin-offs. For university graduates in transfer spin-offs, a potential negative relationship (e.g., due to non-monetary benefits of working in a transfer spin-off) is dominated by an opposing positive link between transfer spin-offs and wages (e.g., due to sorting of more productive employees).

Our study contributes to the literature in three ways: First, our findings support the notion of sorting of relatively productive high-skilled workers who demand higher wages into R&D intensive environments as provided by transfer spin-offs. Second, we provide evidence that policy makers should consider that the societal costs of spin-offs are, at least to some extent, offset by a wage premium paid by transfer spin-offs to their university graduates. Third, according to our knowledge this paper is the first study where the unit of analysis is the individual employee working for a spin-off. Although the quality of human resources is frequently emphasised as an important source of firm performance and development (see the comprehensive survey of Rothaermel et al. (2007) and the literature quoted therein), existing studies focus on the team of entrepreneurs, their human capital, their transition from academia to their spin-off and their return to academic entrepreneurship (e.g., Åstebro et al., 2013). In contrast, our study provides first evidence of recruitment and remuneration policies of spin-offs at the level of the individual employee.

The remainder of the paper is structured as follows: Section 2 documents the definition of spin-offs we use for our analysis and embeds this definition into the existing literature on spin-offs. In Section 3, we outline the related literature on employment in spin-offs and provide theoretical arguments why wages may differ between transfer spin-offs, competence spin-offs and non-spin-offs. Section 4 documents the linked employer-employee data set and provides descriptive statistics. The econometric model is outlined in Section 5. Section 6 presents and discusses the results from the multivariate wage regressions along with the results of alternative specifications and robustness checks. Section 7 concludes with a summary of the implications and limitations of our study.

## 2. Definition of spin-offs

There are many different definitions of spin-offs used in the literature. In their typology of spin-offs, Pirnay et al. (2003) point out what most definitions have in common: Spin-offs are new firms with a distinct legal status that originate from research institutions in order to commercially exploit knowledge produced by academic activities.[3] Apart from these commonalities, Pirnay et al. (2003) characterise spin-offs by two dimensions in which existing definitions differ from each other: the academic status of individuals involved in the new business venturing process and the nature of knowledge transferred (see also Djokovic and Souitaris, 2008).

The ZEW High-Tech Start-Up Survey that is used to identify spin-offs in our data set applies a definition developed by Egeln et al. (2003a,b), who extensively investigated spin-offs in Germany. The founders (or at least one member of the team of founders) of a spin-off either must have studied or must have worked at a university. The latter group comprises not only university researchers but also academic and non-academic staff members, e.g., lecturers or technical staff (Rappert et al., 1999; Smilor et al., 1990). The formation of spin-offs by former university employees further involves at least a partial employment transition of the university employee from academia to the spin-off, although the university employee may remain affiliated with the incubator university. Thus, the definition used by Egeln et al. allows for spin-offs set up by former students (Bathelt et al., 2010). However, in contrast to the definitions of Nicolaou and Birley (2003) or Pirnay et al. (2003), the definition by Egeln et al. does not include firms where the academic inventor is not part of the team of founders.

With respect to the nature of the knowledge transferred from the university to the spin-off, Pirnay et al. (2003) show that the type of knowledge transferred influences a spin-off's growth potential or its access to financial resources (see also Bathelt et al., 2010; Clarysse et al., 2011). In this study, we define two types of spin-offs according to the nature and the level of the knowledge transferred (Egeln et al., 2003a,b):

- **Transfer spin-offs:** Either new research results the founders themselves developed during their employment at the university or new scientific methods or techniques the founders acquired during their time at the university were essential to the creation of their firms.
- **Competence spin-offs:** Specific skills the founders acquired during their time at the university were essential to the formation of the new firm.

The differentiation between transfer and competence spin-offs shows parallels to the taxonomy provided by Hindle and Yencken (2004), which also classifies spin-offs according to the type of knowledge commercialised. Transfer spin-offs encompass both so-called direct research spin-offs and technology transfer companies (Hindle and Yencken, 2004). Direct research spin-offs commercialise intellectual property (IP) generated at the incubator institution involving, e.g., licensed patents or copyrights. Technology transfer companies are based on tacit knowledge of the founder(s) that is not protected by formal IP rights. De Cleyn

[3] Strictly speaking, the study of Pirnay et al. (2003) is restricted to spin-offs that originate in universities, excluding other research institutions. In this paper, we apply the same characteristics to spin-offs from universities and other publicly funded research institutions.