Technological Forecasting & Social Change xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

How to measure technological distance in collaborations — The case of electric mobility

Nicole vom Stein *, Nathalie Sick, Jens Leker

University of Münster, Institute of Business Administration at the Department of Chemistry and Pharmacy, Leonardo-Campus 1, 48149 Münster, Germany

ARTICLE INFO

Article history:
Received 21 December 2013
Received in revised form 30 April 2014
Accepted 2 May 2014
Available online xxxx

Keywords:
Absorptive capacity
Cross-industry collaboration
Electric mobility
Technological distance

ABSTRACT

Innovation collaborations experienced a substantial growth during recent decades, so that research interest in factors contributing to successful collaboration increased. One proposed success factor is technological distance, which determines the probability of receiving new knowledge from a partner as well as the ability of absorbing it. The methodology for measuring this distance is receiving broad attention in current literature. Therefore, we compare well-established measuring methods based on Euclidian distances with the recently introduced method of the min-complement distance.

Collaborations along the entire value chain are seen as a way to overcome technological deficiencies associated with battery development for electric mobility, which implies collaboration of partners with different technological distances. Hence, we specifically focus on cross-industry collaborations comprising partners from the chemical and automobile industries.

Our results show that the methodology used highlights different aspects of the approximation of technological distance in the examined collaborations. The use of the min-complement distance seems to be reasonable due to the intuitive property of the independence of irrelevant patent classes in cross-industry collaboration settings.

1. Introduction

The common ground in literature on technological distance in collaborations is that it influences knowledge transfer between the affected partners and, consequently, all factors that are associated with knowledge transfer [1–3], like innovation collaboration success or technological spillovers [1,4–7]. The influence of technological distance on the innovative performance of collaborations is driven by two factors, i.e. absorptive capacity and knowledge novelty. While absorptive capacity, as introduced by Cohen and Levinthal, describes the restricted ability of firms to integrate and use new knowledge [8], knowledge novelty determines the extent to which degree a firm can learn new things from a partner [4,6]. As Fig. 1 depicts, the relationship between technological distance and innovative performance of collaboration is inverted u-shaped.

Here, Cowan et al., for instance, conclude that if ‘firms are too close together, their knowledge overlaps too much and there is little point in sharing; if they are too far apart, they have difficulty understanding each other, and so sharing is too difficult’ [9]. Various studies have empirically shown the inverted u-shaped relationship between technological distance and the innovative performance of collaborations [5,10]. These studies applied various approximations of technological distance, such as the cosine angle or correlation measures between knowledge vectors which led to a recent discussion on the suitability of technological distance measures [6,11–13]. One stream of literature criticizes technological distance measures with a focus on the influence of different sample sizes while others advocate weighting factors to better represent real knowledge distributions [7,14,15]. The findings provided there demonstrate that small sample sizes can substantially bias technological

* Corresponding author.
E-mail addresses: nicole.vomstein@uni-muenster.de (N. vom Stein), nathalie.sick@uni-muenster.de (N. Sick), leker@uni-muenster.de (J. Leker).

http://dx.doi.org/10.1016/j.techfore.2014.05.001
0040-1625/© 2014 Elsevier Inc. All rights reserved.

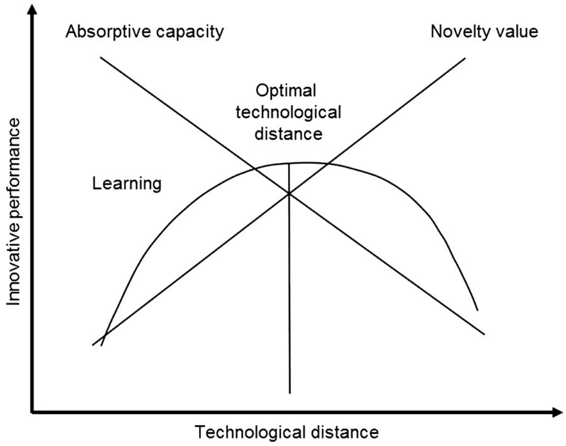

Fig. 1. Inverted u-shaped course of innovation success based on the theories of absorptive capacity and novelty of knowledge [4,6].

distance estimations. Although this result is based on different measures of technological distance, a comprehensive discussion of whether one method minimizes the identified problem or what differences can be expected between one method and another is lacking. One reason for this might be that a simple comparison of absolute values is not straightforward due to quite different principles on which the methods define similarity or difference [16] and the non-availability of a true value as is given in distance approximations for geographic distances [17]. As indicated in other fields of distance measure applications, one overall right measure might not exist but different advantages and disadvantages of certain measures might occur in different research settings or practical applications [18]. In a knowledge or technology management context, an interpretation of resulting differences is of high interest, for both methodology and content. If practitioners, for example, want to use technological distance estimations to judge the potential of different collaboration partners, it would be beneficial to know how a certain method values certain firm characteristics like knowledge diversity and whether they emphasize a different aspect of technological distance. Here, the recently introduced min-complement distance measure by Bar and Leiponen attracts special interest [16]. Since the method claims to consider only technological fields in which both firms have knowledge, it may better relate to a given collaboration topic. This assumption is based on the thought that both collaboration partners have at least some knowledge on the collaboration topic while other fields of knowledge, especially in diversified firms, might not play any role in the respective collaboration. Additionally, recently conducted studies find a linear instead of an inverted u-shaped relationship between technological distance and radical innovation success [19,20]. Whereas radical innovations often result from combinations of former distinct knowledge, incremental improvements tend to derive from a continuous development of already existing knowledge [21–23]. This phenomenon lead to an increasing emergence of collaboration along the entire value chain and even beyond [21,24]. Here, it can be reasonably assumed that two firms that operate in different industries might exceed the optimal technological distance often found in intra-industry collaborations [6,11,12]. To further investigate e.g. this assumption and other problems associated with large technological distance, a deeper understanding of technological distance measures is needed to avoid methodological biases.

A prevailing and interesting field in which to apply technological distance measures to cross-industry collaborations is electric mobility. The success of electric vehicles depends on the development of improved batteries as their performance is restricted regarding lifetime, safety, range, and costs [25–28]. Hence, firms are challenged to develop and introduce radical innovations. In so doing, firms engage in a growing number of collaborations on battery research for electric vehicles, which span the entire value chain [29–31]. Here, we specifically refer to collaborations between the automobile and chemical industries. These collaborations are characterized by obviously distinct industries that are not strongly related to each other within the traditional value chain of combustion engines. Firms operating in the automobile industry possess relevant knowledge related to individual transport, combustion engines and component integration within cars. In contrast, chemical firms have in depth knowledge related to materials used within the battery that determine the electrochemical processes and thus performance of the battery [32,33]. Consequently, knowledge and technologies, that chemical and automotive companies' businesses traditionally rely on, are rather different and are marked by high novelty to the partner from the other industry [21,23]. Based on this discussion, we suppose that collaboration between chemical and automotive companies is marked by comparably large technological distance while other value chain partners, like battery producers, show less technological distance.

Identifying the best approximation of technological distance in this setting contributes to the discussion on technological distance approximations and thus aims at enhancing the knowledge on the influence of different technological distance measures to minimize their bias in further studies. Therefore, our study aims to answer the following research questions:

- How do approximations of technological distance change in cross-industry collaborations if different measures are applied?
- What implications can be derived for the choice of an appropriate measure to model technological distance in the setting of cross-industry collaborations?

In so doing, we examine the advantages and disadvantages of established technological distance measures within the field of electric mobility by referring to collaborations between automobile and chemical companies. Furthermore, we compare these established measures to the newly introduced min-complement distance measure [16].

The paper is organized as follows: In Section 2, we briefly review approaches in measuring technological distance based on patent data, and discuss the advantages and disadvantages in a setting of cross-industry collaboration. Section 3 describes the sample, data sources and methods. Section 4 covers the results and discussion while Section 5 concludes with theoretical and practical implications and an outlook on further research.

Please cite this article as: N. vom Stein, et al., How to measure technological distance in collaborations — The case of electric mobility, Technol. Forecast. Soc. Change (2014), http://dx.doi.org/10.1016/j.techfore.2014.05.001