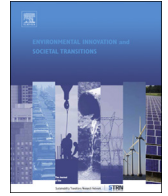




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Unrelated diversification in latecomer contexts—The emergence of the Chinese solar photovoltaics industry

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ABSTRACT

New industries emerge in increasingly complex spatial patterns that challenge existing explanations of industrial path creation. In particular, the case of latecomer regions building up industries in fields that are unrelated to their previous industrial capabilities is not well understood in the literature. This paper aims to address this gap by expanding on an analytical framework that draws on innovation studies and catching-up literature to characterize unrelated diversification processes in latecomer contexts. A case study in the Chinese solar photovoltaics (PV) sector reveals an industry formation process that differs from traditional models of industry formation. The PV industry emerged from a highly internationalized entrepreneurial project in which Chinese latecomer firms directly mobilized knowledge, markets, investment and technology legitimacy developing outside China and combined them with the country's generic capabilities in mass-manufacturing. In some industries, globalization thus enables a new model of industry formation that heavily draws on extra-regional system resources.

1. Introduction

The question how new industries emerge and locate in specific places is gaining renewed interest by scholars and policy makers, not the least in ‘cleantech’ sectors like renewable energy, electric transportation or water recycling. The sustainability transition literature in particular has highlighted that the diffusion of ‘cleaner’ industries plays an important role in wider transition trajectories away from unsustainable production patterns (Markard et al., 2012). Still, to date our theoretical understanding of the industry formation process – in cleantech sectors and more broadly – remains limited at best (Martin, 2010). Existing theories have particular problems explaining why cleantech industries increasingly take root so quickly in latecomer countries like China, Brazil or India when the relevant knowledge, firms, (subsidized) markets, and value chains are already well established in industrialized countries (Binz et al., 2017; Fu et al., 2011; Lee and Lim, 2001; Schmidt and Huenteler, 2016).

To date, industry formation in latecomer regions is commonly understood as a learning process in which firms gradually upgrade their technological capabilities (Lee and Lim, 2001; Morrison et al., 2008)¹ in close interaction with regional and national support

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¹ Technological capabilities are the “skills—technical, managerial or organizational—that firms need in order to utilize efficiently the hardware (equipment) and software (information) of technology, and to accomplish any process of technological change. Capabilities are firm-specific knowledge, made up of individual skills and experience accumulated over time” (Morrison et al., 2008: 41–42)

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structures (Evans, 1995; Lundvall et al., 2009; Wade, 2004). Two theoretical perspectives have been most influential in explaining how this upgrading process works. Capabilities may be upgraded either in a gradual learning process fueled by state-driven development initiatives and the integration of latecomer firms in global value chains and production networks (Gereffi, 1999; Morrison et al., 2008; Yeung and Coe, 2015), which we refer to from now on as *catching-up*, or in a branching process out of a region's pre-existing related technological capabilities (Hidalgo et al., 2007; Martin and Sunley, 2006; Neffke et al., 2014), which we refer to from now on as *related diversification*.

Both perspectives provide influential explanations on why and how new industries develop in non-core regions, but may be overly deterministic when assessing the potential of latecomers to develop radically new industrial paths. In general, both perspectives emerged from the analysis of processes of slow and gradual industrial upgrading, while more unlikely – but arguably important – ‘jumps in the product space’ (Hidalgo et al., 2007) or ‘path-creating catching-up’ processes (Lee and Lim, 2001) were left underexplored. This gap is particularly relevant as latecomer regions in emerging economies were recently identified as the places in which unrelated diversification is most pertinent (Pinheiro et al., 2018). In addition, it seems particularly relevant for many recently emerging cleantech industries like wind power, solar power or electric mobility, which have been shown to develop in dynamic spatial trajectories that are influenced by key actors from latecomer economies (Gosens and Lu, 2013; Quitzow, 2015a,b; Sengers and Raven, 2015).

We argue that this gap of understanding stems from two shortcomings in existing theorizing. First, catching-up and diversification theories do not fully reflect the increasing influence of complex transnational linkages on industry formation dynamics. Cleantech is a case in point for industries that are not only influenced by regional path-dependencies and Western lead firms anymore, but increasingly by distributed networks of firm and non-firm actors in global innovation networks (Chaminade and Plechero, 2015; Coe and Bunnell, 2003), global (technological) innovation systems (Binz and Truffer, 2017; Quitzow, 2015b; Wieczorek et al., 2015), global epistemic and professional communities (Coe and Bunnell, 2003; Wenger, 1998), or the interpersonal networks of transnational entrepreneurs (Drori et al., 2009; Saxenian, 2007; Yeung, 2009b). Second, especially related diversification theories tend to emphasize firm- and knowledge-based dimensions, while downplaying the role of non-firm actors, markets, policy making and institutional contexts in a broader systemic context (Binz et al., 2016b; Boschma et al., 2017; Dawley, 2014). To better capture the industry formation dynamics in a globalizing knowledge economy, a more systemic and internationalized perspective is thus needed.

This paper addresses these gaps by expanding on recent conceptual proposals from transitions and innovation studies that developed such systemic perspectives (Binz et al., 2012; Gosens et al., 2015; Huang et al., 2016; Quitzow, 2015b; Wieczorek et al., 2015). In particular, it aims to specify the process behind unrelated diversification in the early industry formation phase. To that end, this paper adapts and applies a recent framework by Binz et al. (2016b) to unrelated diversification in latecomer regions and describes the dynamic interrelationship between the generic ‘absorptive capacity’ of a latecomer region, the internationalized processes of the formation of system resources, and the processes anchoring international resources to domestic capabilities. Industry formation is conceptualized as a *systemic* innovation process, in which technology innovation, demand side dynamics, policy intervention, and shifts in user and investor preferences co-evolve (Bergek et al., 2008; Choi and Anadon, 2013; Dawley, 2014; Surana and Anadon, 2015; Tanner, 2014).

Our framework is validated with the case of the Chinese solar photovoltaics (PV) industry, which arguably represents an instance of unrelated diversification. A comprehensive literature review and expert interviews with 26 key stakeholders in the Chinese PV sector reveal that the industry formation process in China is not fully explained by conventional related diversification and catching-up theories, because: (a) Chinese companies mostly operated outside the global value chains of Western and Japanese PV lead firms; (b) capabilities in closely-related sectors emerged only after the PV industry took root in China; and (c) the central government initially did not support this particular industry with a traditional export-oriented developmental state-type policy approach, as opposed to other high-tech industries. We rather find successful industry formation to be the outcome of a complex international entrepreneurial process in which Chinese pioneers directly mobilized system resources from various places around the world and successfully combined them with (initially unrelated) generic absorptive capacity, like mass-production capabilities available in the Yangtze River delta region.

This argument is elaborated in the following structure. Section 2 summarizes existing explanations of industry formation and identifies gaps in their theorizing of unrelated diversification processes. We then formulate an analytical framework that specifies the main characteristics of the generic absorptive capacity of a latecomer region and four key system resources for early industry formation. We subsequently discuss how the four system resources and the generic absorptive capacity might be connected through processes and actors working across and between regional and national borders. Section 3 justifies the empirical case and describes the methodological approach. In Section 5, we apply our framework to solar PV manufacturing in China, illustrating the need to further explore the role of unrelated diversification processes in the catching up strategies of latecomer countries. Sections 5 and 6 discuss the generalizability of our framework, summarize our contributions to transitions and innovation studies, and derive lessons for policymaking.

2. Towards an analytical framework for unrelated diversification

In the remainder, we will first critically review the most influential theories on industrial path creation from the catching-up and related diversification literatures and then discuss the contours of an updated analytical framework for unrelated diversification in latecomer contexts.

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