



Cumulative causation in regional industrial path development – A conceptual framework and case study in the videogame industry of Hamburg and Shanghai

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ABSTRACT

While broad evidence has been generated on the forces leading to divergent regional industrial path development, we still do not fully understand how initial structural differences between regions are dynamically attenuated in industrial path development processes. In other words, the cumulative causation processes instigating such differences are not well explored. In this paper, a process model is developed, which conceptualizes industrial path development as an iterative build-up of innovation system resources, which is conditioned by firm- and system-level agency. We argue that the specific configuration of system resource stocks, as well as firm- and system-level agency jointly condition the further evolution of a path each time a regional industry reaches a “critical moment”. Unpacking the cumulative system building process across development phases allows exploring how positive or negative cumulative causation patterns emerge in the path development process and how early interventions in the system building process may have knock-on effects at later stages.

1. Introduction

Why and how industries develop differently in space is a fundamental research question in regional sciences and economic geography (Boschma and Lambooy, 1999; Martin, 2010; Storper, 1989). Two generic schools of thinking can be distinguished that address this question from diverging, yet complementary theoretical vantage points. The first focuses on the path dependent nature of industrial development in space, and highlights the influence of pre-existing industrial capabilities, knowledge specializations, as well as cultural and institutional structures on divergent industrial development and diversification patterns (e.g., Boschma and Martin, 2007; Boschma and Frenken, 2006; Dawley, 2014; Frenken et al., 2007). The second type of explanations puts more emphasis on dynamic industrial path development processes and the role of actors and their strategic agency in adapting the above mentioned structures to an evolving industrial path (Garud and Karnøe, 2001; Grillitsch and Sotarauta, 2020; Isaksen et al., 2019; Trippel et al. 2020).

Both approaches have provided important frameworks for thinking

through the factors that explain differentiated regional path development in space. However, their explanatory traditions have also stood somewhat apart and only few have tried to integrate their approaches into explanations on regional industrial evolution that constructively integrate structural and agentic factors in more integrative frameworks (Boschma et al., 2018; Trippel et al., 2020). As a result, we lack well-articulated process models that unpack the ‘inner working’ of path development processes and which explain how seemingly small differences in initial structural conditions get amplified or attenuated through agentic interventions over the path development process. In this paper, we argue that a deepened exploration of how supportive innovation system resources emerge around an evolving industrial path and how firm- and system-level agency co-evolve during the path development process is central to answering the question at hand.

This paper accordingly aims at developing a conceptual framework that unpacks the cumulative causation dynamics during regional path development processes in more detail. Its main research question is how do virtuous and vicious cumulative causation patterns emerge in path development processes and how do they condition divergent regional

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development patterns? In addressing this question, we combine recent writings in the regional industrial path development and innovation systems literature. We construct a framework that conceptualizes industrial path development as cumulative sequences of system resource formation and reconfiguration processes. In particular, we argue that the specific configuration of system resources accumulated in prior phases, as well as firm- and system-level agency, influence the path development process each time a regional industry reaches a “critical moment”. Through a cumulative process of system resource formation and reconfiguration, small differences in initial resource endowments may lead to strongly diverging regional development paths. Our model is illustrated and validated with the divergent development trajectories of the online game industry in Shanghai and Hamburg. The different development patterns and actions taken by relevant agents in both city regions provide a unique setting for elucidating cumulative causation mechanisms in regional path development processes.

2. Regional industrial path development and cumulative causation

Since the “evolutionary turn” in economic geography, scholars in regional studies have highlighted the role of path dependence, regional structural preconditions, and lock-ins in contributing to divergent path development outcomes (Boschma and Martin, 2007). While the path dependence argument and the ‘principle of relatedness’ have emerged as powerful heuristics in this line of thinking (Martin, 2010; Hidalgo et al., 2018), the seminal work by Martin (2010) suggests that regional preconditions do not invariably lead to path dependent development outcomes. They may also provide sources of change, and if used properly, even enable local actors to mindfully deviate and thus initiate new path creation trajectories (ibid.). Inspired by this central argument, in the last decade, various studies have been carried out to investigate how regional structural preconditions can be smartly leveraged and adapted by actors developing a new industry in a region (Dawley, 2014; MacKinnon et al., 2019; Trippel et al., 2020).

In parallel and complementing the emphasis on structural explanations, there is also a burgeoning work on ‘agency-related’ factors in regional path development processes (Dawley, 2014; Grillitsch and Sotarauta, 2020; Isaksen et al., 2019; Trippel et al., 2020). While the early writings on regional path developments put strong emphasis on agency (e.g., Garud and Karnoe, 2001; Simmie, 2012), more recent research efforts explicitly connected agency with structures and explored the opportunities for change in a particular space–time nexus (Grillitsch and Sotarauta, 2020; Hassink et al., 2019; Trippel et al., 2020). Very recently, inspired by the work from neo-institutionalism, the interest on institutionalization, legitimation and the structure–agency dynamics therein has been further strengthened (Gong et al., 2022). For instance, in contrast to the conventional view of regarding regional structures as either enabling or constraining for certain forms of industrial change, recent literature argues that a more nuanced understanding of the hindering and enabling role of regional structural conditions for transformative change is needed (Miörner, 2020).

A growing body of studies and conceptual approaches now exists that explores structure–agency dynamics in industrial path development. While insightful, the growing conceptual plurality has also made it difficult to engage in cumulative knowledge development and theorizing in this vibrant sub-field of economic geography. One key gap in this literature is that - even though process models are not uncommon in economic geography - the field lacks process-focused heuristics that explain the dynamic accumulation (or loss) of momentum in regional path development trajectories (see e.g. Baumgartinger-Seiringer et al., 2022; Shi and Shi, 2022).

Influential work such as the cluster lifecycle model (Menzel and Fornahl, 2010), the “path as process” perspective (Martin, 2010), recent work exploring asset modification and reconfiguration processes in regional path development literature (Chen, 2021; Trippel et al., 2020),

or studies conceptualizing path development as a strategic coupling process (MacKinnon et al., 2019), all have provided important insights into certain aspects of the ‘inner workings’ of regional path development trajectories. However, these studies have remained either rather selective in their validity claims (e.g. Baumgartinger-Seiringer et al. (2022) focus only on path transformation dynamics, Menzel and Fornahl (2010)’s version of cluster lifecycle approach emphasizing firm-level processes and agglomeration economies, etc.) or have not specified the key phases and sequencing of path development processes in much depth. We thus still know little about how differences in structure–agency interactions in different regions are amplified or attenuated during industrial path development processes. In other words, we still lack a comprehensive understanding of how cumulative causation patterns unfold during regional path development processes and how they explain divergent regional development patterns.

This is somewhat surprising given that interests on cumulative causation have been existing for a long time in the social sciences more broadly, especially in economics and sociology (for a comprehensive review, see Berger, 2009). Key authors such as Gunnar Myrdal, Thorstein Veblen, Nicholas Kaldor, Adam Smith and Allyn Young (O’Hara, 2008; McCombie and Roberts, 2009), as well as Paul Krugman (in new economic geography) have all contributed to better understandings of how cumulative causation works in different socioeconomic fields. For instance, Krugman’s prize-winning core-periphery model works with a mechanism of self-reinforcing causation to explain migration from agricultural to industrialized regions and thus also reflects what Myrdal (1957) had discussed much earlier in his analysis of cumulative causation. Based on Myrdal’s methodology of ‘explicit value premises’ (equality between races, countries and regions as the goal), he recognized the ‘virtuous circle’ in developed countries and the ‘vicious circle’ in underdeveloped countries (ibid.). Economic development in developed countries tend to operate as positive feedback processes, magnifying and multiplying the combined impact of the interactions through historical time, while it tends to form negative feedback effects working in the opposite direction. More recently, innovation system scholars have explored cumulative causation processes, especially in relation to the emergence of clean-tech industries (Hillman et al., 2008; Suurs and Hekkert, 2009). However, the translation of their concepts like ‘motors of innovation’ into regional industrial path development literature has remained very scant.

Based on this short discussion, we thus aim at strengthening work in economic geography that employs process theories, which “do not explain variance in the dependent variable as ‘caused’ by independent variables, but instead explain outcomes in terms of event sequences and the timing and conjunctures of event-chains” (Geels, 2011, 34). The next section will thus elaborate a process model that specifies how industrial and territorial innovation dynamics interact in ‘cumulative causation’ patterns during the path development process.

3. Conceptual framework: Cumulative causation in regional path development

Following the ‘developmental turn’ in evolutionary economic geography (Martin and Sunley, 2015), regional industrial path development can be conceptualized as the interconnected buildup (or reconfiguration) of territorial and technological/industrial/sectoral innovation system structures (Binz et al., 2016; Gong et al., 2022). While firms play a key role in regional path development processes, their activities are intimately linked to other actors and the build-up of supportive innovation system structures and system resource stocks that evolve both inside the region and in wider, industry-specific networks (Martin and Sunley, 2015; Musiolik et al., 2012; Heiberg and Truffer, 2022).

We accordingly conceptualize regional path development trajectories as processes of cumulative system building or reconfiguration, which depend on the mobilization of key system resources from different spatial scales (Binz et al., 2016; De Propriis and Crevoisier,

2011; Heiberg and Truffer, 2022). System building” is understood here as the creation or modification of institutional or organizational structures in an innovation system carried out by multiple actors (Musiolik et al., 2012). System building can be regarded as a *resource-driven* process: actors start from the resources they possess or control and continuously extend them by engaging with other stakeholders (Musiolik et al., 2012, 2020). The aim of such system building is to construct an environment that provides various system resources that support the further development of the focal industry. System resources can thus be understood as an emergent outcome of intense networking and interaction among key actors, which become broadly available to the stakeholders in a regional path development process and which are a necessary (though not sufficient) condition for local industry emergence.

The key concept of “cumulative causation” means that there are dynamic feedback mechanisms between the resource stocks developed in a system, which may serve to reinforce or weaken the development of those same resources in a cumulative manner (Martin, 2016). By ‘reinforce’, we mean that certain dynamics (e.g., resource creation and mobilization) tend to operate as positive feedback processes, magnifying and multiplying the combined impact of system resource stocks and system building activities in a region, thus leading to positive path development outcomes (O’Hara, 2008). If such feedback effects work in the opposite direction (i.e., a negative feedback), then a ‘weakening’ process can be observed, leading to poorer system resource stocks and system building dynamics over time, which may slow down or even destroy path development processes. These two contrasting processes are labeled as “virtuous dynamics” (or “a build-up sequence”) and “vicious dynamics” (“a break-down sequence”) according to Hillman et al. (2008).

In path development literature it remains rather ambiguous how and under what conditions cumulative virtuous or vicious cumulative causation occurs, and how actors can trigger and maintain virtuous cumulative development patterns over several phases of development. In the rest of this section, we will accordingly sketch a generic process model that further unpacks the key elements and mechanisms that condition cumulative causation dynamics in regional path development processes.

In our framework outlined in Fig. 1, regional path development

processes can be decomposed into several iterations of three key elements, namely, 1) the structural preconditions (i.e. system resource stocks available at the beginning of a development cycle), 2) a dynamic resource formation and system building process, and 3) the resource stocks available at the end of each development phase, which in turn denote the structural backdrop for the next iteration. As we will outline in more detail below, the specific configuration of preexisting system resource stocks, as well as the speed and quality of firm-level and system-level agency will jointly determine the cumulative causation processes and thus the overall path development outcomes.

Regarding *structural preconditions*, an emerging industry usually draws on a combination of region-specific and industry-specific resources (Gong et al., 2022; Miörner, 2022; Boschma et al., 2018). Region-specific resources have been in the focus of path development literature for a long time. At a most general level, they have been defined as the regional assets that the actors can draw on/mobilize when developing a new industrial path. They are typically typologized into natural resources, infrastructural/material assets (roads, ports, IT infrastructures, etc.), historically-formed industrial assets, human assets (knowledge and skills), as well as institutional assets (regulations, norms, and routines) (MacKinnon et al., 2019; Trippl et al., 2020). Industry-specific resources have in turn been more in the focus of innovation and transition studies and in the literature on technological, sectoral or global innovation systems (Bergek et al., 2008; Breschi and Malerba, 1997; Binz and Truffer, 2017). Here, the focus lies on system resources, which the actors developing an emerging industry (or reconfiguring an existing industry) need to jointly mobilize to keep path development processes moving forward (Farla et al., 2012; Musiolik et al., 2020; Bergek et al., 2008). While several characterizations of those resources exist, we here draw on the four system resource types suggested by Binz et al. (2016) including knowledge & capabilities, market access, financial investment, and technology/industry legitimacy. First of all, knowledge & capabilities relate to the R&D competencies of companies and technological capabilities of other relevant regional stakeholders like regulators, universities or various intermediary actors. They include both knowledge creation capabilities (firm-internal innovation dynamics) and absorptive capacity (knowledge diffusion between companies and other relevant actors) (Bergek et al., 2008). Second, market access constitutes another essential resource for

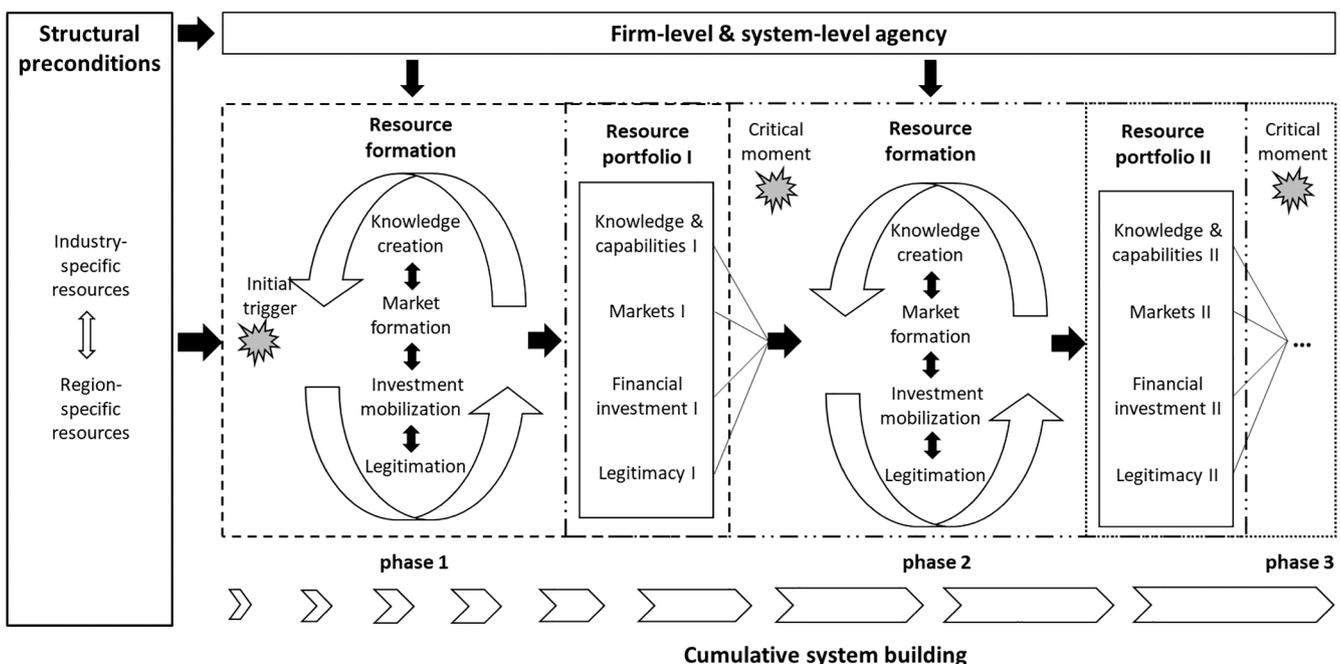


Fig. 1. Cumulative causation framework for regional industrial path development. Source: own elaboration.

any industrial development (Dewald and Truffer, 2012). Especially in newly emerging industries, regional players need to be actively involved in creating first niche markets or in supporting local firms in competing with established players in mature markets. Financial investment, thirdly, refers to the various forms of financial capital that actors have to raise to start and expand their business activities. Technology/industry legitimacy, finally relates to the embedding of a novel industry with pre-existing institutional structures (Binz et al., 2016; Gong et al., 2022). If an industry is well-aligned with taken-for-granted societal values, beliefs and cultural-cognitive frames, it will appear as legitimate. If it contradicts certain of these structures, it will appear as illegitimate and will thus be met with opposition from the public or other key stakeholders (Markard et al., 2016).

The core of our framework then lies in the *cumulative causation* mechanism that propels a regional path development process forward. This process starts from the 'latent path development potential' existing in the region as defined by the pre-existing stock of system resources. This portfolio will be a combination of knowledge, market, financial investment and legitimacy derived from regional and extra-regional (industry-level) sources (Binz et al., 2016; Heiberg and Truffer, 2022). Triggered by endogenous or exogenous events or activities (e.g., a technological breakthrough, new policy, or shift in market demand), regional entrepreneurial actors (e.g. firms, individual entrepreneurs, governing bodies, intermediaries, or some combination of them) will start developing a new industrial path and building up a first portfolio of supportive system resources. After this initial trigger, strategic and collective agency is key to the cumulative causation process. Drawing on the work by Isaksen et al. (2019), we distinguish between firm-level and system-level agency here. Firm-level agency refers to how firms restructure internally and initiate new activities that push the emerging path forward. System-level agency, on the other hand, refers to actions or interventions by various firm and non-firm actors present in the region that create or modify system resources, which become available to other actors in the same region and thus propel the path forward.

As Fig. 1 outlines, *resource stocks* then refer to the total amount of (or: the 'portfolio' of) the four key system resources that are available at a certain point in time and that regional actors can mobilize to further develop the industrial path. These resource stocks will be updated iteratively throughout the regional industrial path development process. To propel the focal industrial path forward, each of the four resource types (knowledge, finance, market, legitimacy) will have to be built up in an iterative, experimental process, in which new configurations of technological/institutional/organizational variants are tested out and then selected and retained in the system in an evolutionary way (cf. 'resource formation' processes in Fig. 1). Resource formation processes refer to the processes through which the four key system resources are built up over time either through endogenous creation in the region or by anchoring resources available elsewhere to the emerging path (Bergek et al., 2015; Binz et al., 2016). Relating to the four key resources outlined above, and in line with Heiberg and Truffer (2022), we label such processes as 'knowledge creation', 'market formation', 'investment mobilization' and 'legitimation' respectively (see Fig. 1). As outlined in quite some depth in TIS literature, feedbacks within and between these four resource formation processes will create important multiplier effects on the overall system building outcomes (O'Hara, 2008). I.e. strong investment mobilization in one phase may lead to increased knowledge development in a next development phase or the creation of industry legitimacy (e.g. through a successful lobbying and advertising campaign) may induce a new niche market in a next phase (Suurs and Hekkert, 2009).

In our model in Fig. 1, this continuous, cumulative system resource formation process is punctuated every now and then by 'critical moments', i.e. endogenous or exogenous crises and shocks, windows of opportunity, perturbations, etc., which push local actors to radically re-orient their prior strategies and collective system building efforts (True et al., 2019). Each time a regional industry faces such a critical moment,

the previous incremental resource formation process needs to be re-oriented more radically, which creates opportunities for strong firm- and system-level agency (Grillitsch et al., 2022; Isaksen et al., 2019; Duygan et al., 2020; Yuana et al., 2020). Following a critical moment, the resource stocks built up in prior phases need to be radically updated or reconfigured. The breadth, depth and diversity of the resource portfolio built up prior to the shock then plays a crucial role in determining local actor's options for strategic agency in a next phase: If a comprehensive and diversified resource portfolio is available, which covers all four system resources and interconnects them in mutually supportive ways, more options for reconfiguring them in a next development phase and adapting firm- and system-level strategies exist than if one or several resources are missing. A broad resource portfolio thus leads to more options for adapting, re-orienting or reconfiguring the emerging industrial path, which means that positive cumulative causation patterns are more likely in a next phase. In contrast, if actors have not yet built up a well-diversified resource portfolio when a critical moment occurs, they will have fewer strategic options for re-orienting the path, which means that vicious cumulative causation patterns are more likely to occur.

Based on this model, cumulative causation dynamics in regional industrial path development can thus be assessed through a configurational style of theorizing (Furnari et al., 2021), which traces the interplay of three key conceptual factors. In each critical moment, the specific configuration of 1) firm-level agency, 2) system-level agency and 3) resource stocks developed in prior phases, will influence how fast and easily local actors can adapt to shifting circumstances and expand or re-direct the path's overall development trajectory. Exploring cumulative causation in system building thus means tracing how configurations of these three key elements change over time and how pre-established resource stocks, firm-level and system-level agency interact after each critical moment in a given industrial path. Ultimately, the initial structural preconditions combined with the (virtuous or vicious) cumulative causation process evolving through several stages will lead to observed (divergent) regional path development *outcomes*. In the remainder we will validate and illustrate this generic process model with two empirical cases that exemplify industrial path development with virtuous vs. vicious cumulative causation dynamics, respectively.

4. Research design and methods

4.1. Case selection

To empirically illustrate and validate our conceptual framework, we apply it to a comparative case study of the online game industry in two city regions (Hamburg and Shanghai). A comparative case study design was chosen because this approach allows the analyst to elucidate a process in depth, and to capture process differences across cases with deep contextual detail (Eisenhardt, 2021). In essence, we follow an abductive approach here, in which a conceptual framework derived from the literature is iteratively specified and validated by juxtaposing it with empirical evidence.

In terms of the case selection rationale, we followed a theoretical sampling logic (Eisenhardt, 2021; Yin, 2016) that draws on cases that promise particularly rich information on the main issues of theoretical interest. Although both Shanghai and Hamburg are not first-tier regions in the global gaming landscape (Cohendet et al., 2018) they are still highly interesting for exploring why industries develop differently in space. In particular, they represent a matched pair with similar antecedent features (global latecomers, initially weak supportive system structures) but distinctive process dynamics and outcomes (dynamic gaming industry in Shanghai vs. sluggish path development in Hamburg) (see Table 1) (Bechky and O'Mahony, 2015).

Table 1 shows that the game industry in Shanghai and Hamburg both started from relatively weak structural preconditions—their home markets were dominated by foreign games, and the capabilities of local firms were rather weak. Also, no targeted support policies existed at

Table 1
The Shanghai and Hamburg online game industry in comparison.

		Shanghai	Hamburg
Initial conditions	Time of entry	Early 2000s	Early 2000s
	Related industries	Some related creative and IT industries present	Some related creative and IT industries present
	R&D capabilities	Weak	Weak
	Market charac.	Strong dominance of foreign games	Strong dominance of foreign games
Status quo	Position in global value chain	Latecomer; engaging in downstream, low-value-added activities	Latecomer; little engagement with global lead firms
	Turnover	\$9,889 million (2017)	€500 million (2017)
	No. of firms	Circa 1670 (2017)	Circa 200 (2020)
	No. of employees	70,000 (2019)	2,500 (2020)
	Industry structure	Diversified mix of large, medium-, and small-sized firms	Small and medium-sized firms dominate
	Overall assessment	Large industrial cluster serving both domestic and global markets with diverse firms covering the whole value chain; relatively strong R&D, publishing and marketing capabilities	Small industrial cluster with relatively weak position in both domestic and global markets; strong focus on game development, publishing and marketing capabilities remain weak

Source: Compiled by the author based on secondary data.

regional or national levels and the gaming industry was struggling with legitimacy issues in both focal countries. Both cities are furthermore large metropolitan areas with diversified economies and related capabilities available in local creative or cultural industries. Despite these similarities, the two local industries have developed divergently: in Shanghai, a well-diversified mix of large, medium-, and small-sized firms along the industry's full value chain has emerged, and the local industry has developed into a sizeable industrial cluster with sophisticated local support structures, serving both domestic and global markets. The industry in Hamburg, in contrast, is dominated by small and medium enterprises, and the cluster remains small with a relatively weak competitive position in domestic and global markets (cf. Table 1). Tracing and comparing the evolution of system building and resource formation based on our analytical framework will be used to explain this diverging development pattern in more detail.

4.2. Research methods

This study adopts a process-focused approach (Langley, 1999), which aims at disentangling the complex cumulative causation patterns in both focal path development processes. It draws upon two main data sources: 63 semi-structured interviews (21 in Hamburg, 42 in Shanghai) and a systematic review of secondary material, such as industry reports, newspaper articles, websites, etc. First, secondary data was collected and compiled chronologically from intermediary organizations, mainstream media, professional magazines, and industry reports. This desktop research enabled us to generate a first timeline of key events, which served as a backdrop to define key phases of development and critical moments separating them (Grillitsch et al., 2021; Langley, 1999; Suurs and Hekkert, 2009). In the primary data collection phase, the first author conducted site visits and collected data using semi-structured expert interviews complemented with observations and archival data. Interviews were conducted face-to-face from 2016 to 2019 and structured along the four key system resources, as well as different forms of firm- and system-level agency as identified in our conceptual framework. On average, each interview lasted for one and a half hours. Interviewees included founders and managers of local companies, policy makers, managers of industry associations, industry experts, scholars, etc. (cf. Appendix 1 for a detailed list of interviewees).

In the analysis, we follow Langley (1999)'s suggestion to combine narrative strategy with temporal bracketing strategy. The former involves construction of a detailed storyline from the raw data, which establishes a chronology for subsequent analysis. The latter indicates that different 'phases' in the sense of a predictable sequential process are identified. The decomposition of data into successive adjacent periods "...enables the explicit examination of how actions of one period lead to change in the context that will affect action in subsequent periods"

(Langley, 1999, p. 703), thus enabling the process-based theorizing envisioned in this paper. The emerging narratives of the relevant resource formation dynamics in both cases were then again triangulated with secondary data and grey literature.

5. Distinct regional path development trajectories in Shanghai and Hamburg

Before diving into the two path development processes, it is important to provide some contextual information on the development of the global gaming industry. In the past three decades, this industry has gone through three phases of development characterized by shifts in the mainstream gaming platforms. Before the mid-2000s, PCs and consoles were the main platforms, and the market was dominated by U.S. and Japanese games (Wolf, 2008). Between the mid-2000s and the early 2010s, new online technologies such as Java and Adobe Flash flourished. This led to the rise of browser games, which featured genres such as casual games or social networking games with limited complexity and short play sessions. After 2010, when Apple introduced in-app purchases (IAPs), a number of developers found ways to monetize their mobile games (Hjorth and Richardson, 2014). Mobile games like *Candy Crush Saga* and *Puzzle & Dragons*, both from 2012, subsequently established this approach as a third, highly profitable business model in the global gaming industry.

The development of the game industry in Shanghai and Hamburg followed these generic development trends. In the remainder, we will thus consider the change of game platforms as decisive critical moments in their path development trajectories and split the case storyline into the same three phases (PC game era before the mid-2000s; browser game era between the mid-2000s and the early 2010s; mobile game era since the early 2010s).

5.1. Phase 1: Building resources as latecomer regions in the PC game era (before mid-2000s)

5.1.1. Initial resource stock in both city regions

As discussed above, both local industries entered the global gaming industry as latecomers in the PC game era and suffered from rather constraining initial conditions and a lack of industry-specific system resources.

Both regions clearly suffered from weak industry-specific knowledge and capability endowments. While some knowledge was available from related cultural industries (i.e. media, marketing and design), firms and non-firm actors in both cities had to proactively develop strategies for mobilizing and recombining such knowledge with early gaming firms in the frontier regions. Regarding *financial investment*, the initial conditions for raising funds were also quite restrictive in both cases, as venture

capital was not interested in this new cultural industry and the risk-averse banking systems in Germany and China were largely biased against supporting firms in emerging industries with unclear future development potentials (Castendyk and Müller-Lietzkow, 2017; Zhang, 2016).

Also in terms of *market formation* and *legitimacy*, both local industries suffered from rather hindering preconditions and widespread social stigmata (AUTHORS). In China, video games were commonly referred to as “electronic heroin” (Tencent Institute of Games, 2018) with youth problems such as poor school performance, physical incapacity, or aggressive behavior, getting directly linked to excessive gaming (SHIR15). In Germany, gaming had a dubious reputation as the industry was suspected of causing violence. In this early phase, discussions about “killer games” were very present in German media, especially after two shootings in German schools, which significantly hampered domestic market formation (Zweites Deutsches Fernsehen (ZDF), 2016).

5.1.2. Firm- and system-level agency in resource formation

In both cities, the initial impetus for game development thus came from rather unexpected sources. The first phase in Shanghai started with the unexpected success of some local firms (e.g., *Shanda, The9*) as operators of foreign PC games in the domestic market. In Hamburg, early developments began when entrepreneurs started developing games in an auto-didactic way as a ‘hobby business’. Actors in both cities subsequently engaged in resource formation processes through different forms of firm- and system-level agency.

1) Shanghai

In Shanghai, *knowledge creation* depended strongly on learning from subsidiaries of global media conglomerates and multinationals (e.g., *Ubisoft, TOSE, Konami, Activision Blizzard*) (SHEX3). Another important channel for knowledge creation was publishing and operating foreign (especially Korean) games. This kind of global learning was supported by the increased number of graduates from Chinese universities who were capable of absorbing the advanced technologies from foreign game studios.

To address the lack of domestic *financial investment*, Shanghai-based companies pro-actively began attracting foreign investors in the early 2000s (SHIR1). For example, *Shanda*, the largest gaming company in China at the time, successfully got listed on Nasdaq in 2004 (SHGO2). Two other Shanghai-based companies, *The9* and *Giant*, got listed on U.S. stock exchanges shortly thereafter (SHEX4). The unexpected success of those forerunners in raising international capital triggered a local e-game boom. Subsequently, the local government also began providing funding for game startups in Shanghai, hoping to develop a new local industrial path (SHGO3, SHIR13). This proactive engagement of entrepreneurs, investors, and local governments contributed decisively to early successes and subsequent resource formation patterns in the Shanghai game industry.

However, in this first phase, the nascent industry was subject to intense censorship by the national government, which significantly limited the (legally allowed) *market formation* of Shanghai-based companies (SHIR5, SHIO1). To address this bottleneck, those studios developed a strategy for serving the thirsty domestic market with “below the radar” or “grey market” business strategies. One former game designer from *Shanda* recalled that

“...it was like walking a tightrope [...] on the one hand, our game was very successful on the market, but on the other hand, we never knew when the visible hand [of the government] would intervene. [...] We tried to keep everything low-key, and distributed our game through informal channels and worked directly with Internet cafes around the country by pre-installing our game on their computers and encouraging them to sell point cards to get a share.” (SHIR3).

To further improve *legitimacy*, early entrepreneurs and (political)

advocates in Shanghai also spoke out proactively in (social) media to justify the importance of developing a domestic game industry and its value as a cultural product. They pointed to the role of digital games as a respected art form in developed countries such as Japan, South Korea, and the US, and argued that without a culturally open attitude, China would continue to lag behind in the “creative economy” (SHEX4).

2) Hamburg

Also in Hamburg, *knowledge creation* was a key challenge in the first phase. Early startups were mostly hobby enterprises run by autodidacts, which could only indirectly draw on local education and training infrastructure (AUTHORS; Quinke, 2004). In order to improve the R&D capabilities, the early autodidacts and indie startups were engaging intensively in self-learning via online forums and peer sharing (HAMIR3).

In terms of *financial investment*, key bottlenecks could not be addressed as swiftly as in Shanghai. Getting listed at international stock exchanges was not considered a viable strategy for early game developers, which thus kept suffering from the restrictions of the conservative German corporate credit and venture capital system, as demonstrated by one of our interviewees:

“we had to invest our own money or borrow money from friends or relatives to start our company” (HAMIR2).

The absence of angel investors (and the inability of local actors in resolving this early system bottleneck) meant that the majority of the early firms could initially not grow as fast as their counterparts in Shanghai.

In terms of *market formation*, even though game developers in Germany in general were subject to much less regulatory constraints than their counterparts in China, they, however, did also not receive any sort of implicit or explicit market support from local and national governments. Game developers thus kept struggling with establishing a favorable domestic market environment. At the city level, the city-state was quite active in promoting its game scene, but

“...it has not been able to provide the resources that the local industry needed most - i.e., funding and market support” (HAMIR7).

The federal government also largely ignored the industry for a long time, as politicians maintained a critical stance towards videogames (HAMSC3). Game studios therefore decided to focus on developing niche products for small (inter)national “boutique” game communities.

Finally, to improve industry *legitimacy*, similar strategies like in Shanghai were employed. Initially, well-known local game developers and local politicians gave interviews in local newspapers to emphasize the creative nature of the industry (Gong, 2020). However, shooting events in the early 2000s led to social unrest and demands for a ban on so-called “killer games” (SHIR5; ZDF, 2016). Many gamers and journalists rebelled against such a ban, citing major players in France, the U. S., or Japan, among others, to justify the artistic freedom of game developers. As a result of these discussions, the German government passed a new *Youth Protection Act* in 2003 and called on industry representatives to create a mandatory, legally binding age labeling system, similar to the movies industry (HAMIR2).

5.1.3. Overall industry development and cumulative system building by the end of phase 1

In both cities, the system resource stocks had improved by the end of the first period, although to a different extent. In particular in terms of financial investment and market access, Shanghai studios were successful in gaining access to foreign stock markets and building a “grey” market. Some problems remained in terms of knowledge and legitimacy, but overall these did not hinder the further development of the local industry. In Hamburg, developers were struggling more strongly with building up first system resources for the local game industry. Especially

in terms of financial investment and early market access, although some limited firm-level and system-level agency could be observed, firms in Hamburg were facing more restrictions than Shanghai-based studios.

At the end of the first phase, some initial cross-influences between system resources could also be observed, especially in the case of Shanghai. For example, the use of various funding sources from home and abroad (financial investment) had a positive influence on knowledge creation, as Shanghai-based studios could invest more intensively in human capital and personnel training. In addition, the rapid development of the “grey market” boosted investor confidence in the market potential of the game industry, leading to better mobilization of financial investment by local companies. This market success also had a positive impact on the industry’s legitimacy, as the emerging industry created jobs and contributed to local tax revenues. In Hamburg, in contrast, the rather restrictive financing conditions slowed down the knowledge creation and market development of local studios and startups. The comparatively weak market performance of local gaming companies also made industry legitimation strategies less effective than in Shanghai, where proponents could base their storylines not just on the industry’s inherent creativity, but also on expected economic benefits such as job creation and tax revenues.

These differences by the end of the first phase proved to provide local actors in both cities with slightly, but decisively different pre-conditions for embarking on the next iteration of system building and resource mobilization dynamics.

5.2. Phase 2: Catch-up and fast growth in the browser game market (mid 2000s-early 2010s)

The second phase (mid 2000s to early 2010s) featured the boom of browser games at a global scale. Unlike PC and console games, browser games are played via the internet using a web browser. They are implemented via standard web technologies such as HTML, JavaScript, etc. Technologically, browser games are less sophisticated than PC games as they usually have fewer features or inferior graphics. However, they can be played without having to install the game on the computer, and they also offer short game sessions, so they were welcomed by people who wanted to take short breaks between tasks.

In both Shanghai and Hamburg, a quick take-off of local game businesses could be observed. In Shanghai, the listing of local firms at global stock exchanges and continued lobbying campaigns, led to a gradual change of the central government’s mindset from blocking the development of the industry to guiding its development. This policy shift and subsequent relaxation of national regulations created a window of opportunity for a rapid expansion of the online game market in China. Also in Hamburg, the global rise of browser games triggered a boom in local entrepreneurial activities. Hamburg companies such as *Bigpoint* and *Goodgames* quickly developed successful interactive browser games like *Farmerama* or *Goodgame Empire* that attracted millions of players worldwide. The success of Hamburg companies during this period established Hamburg’s reputation as the ‘Gamecity of Germany’ (HAMSC1).

5.2.1. Firm- and system-level agency in resource formation

1) Shanghai

In Shanghai, the PCgaming boom meant that new channels for creating and attracting cutting-edge *knowledge* and talent were urgently needed. While many of the pioneering firms kept operating and learning from imported PC games, many Shanghai-based studios now also sought to further improve their in-house innovation capabilities by developing their own games. In response to the increasing demand for highly skilled workers, several private training schools were established in Shanghai, and many local universities and colleges started game-specific education programs (SHIO3).

In terms of *financial investment*, the early success in accessing global financial markets and the legitimacy this conferred to local businesses proved a decisive asset in the second phase, when the relaxation of regulations by the central government also led to a quick diversification of locally available funding sources.

“We have benefited greatly from the relaxation of regulations by the central government, as also investor confidence in the industry has been boosted.” (SHIR4).

In particular, local companies mobilized a new major source of financial investment: Asset investors from unrelated industrial sectors like coal mining, who were looking for places to invest excess profits with higher returns on investment than in their core business (SHEX8). Local companies also successfully tapped domestic venture capital firms (SHEX7), as the game business was increasingly seen as a “cash cow”, in which various angel investors were eager to invest (SHIR11).

Also in terms of the industry’s surprisingly quick *market* diffusion in China, regional and national governments began to realize that it would be wiser to “... *guide the development of the emerging industry in a way that maximized benefits and minimized harm*”(SHEX3). As a result, policy-makers began to support market formation in a variety of ways. Support measures by the central and local governments included creating favorable conditions for domestic companies in China’s gaming market, strictly controlling the amount of foreign games in the Chinese market, or providing financial incentives for global market expansion (Gong and Hassink, 2019). Shanghai-based companies took advantage of these supportive measures and were able to increase their market shares at home and abroad in a very short time.

Finally, also in terms of *industry legitimacy*, the national government’s shift in attitude toward the industry proved decisive, which was due to the fact that the industry’s economic (and cultural) value being increasingly recognized (SHIR8). Industry representatives and local policymakers thus began to talk more openly about the industry’s benefits, thereby actively legitimizing the booming industrial path.

2) Hamburg

Also in Hamburg, the boom in this second phase induced considerable *knowledge creation* activities. To meet the increasing demand for highly qualified workers, a regional educational project called “Game-cityLab” (HAMIO3) was launched in 2007, which was transformed into the master’s degree program in Games at the Hamburg University of Applied Sciences in 2009 (HAMSC1; HAW Hamburg, 2015). In addition, national and global talent recruitment became increasingly important for local firms. *Gamecity Hamburg*, the cluster organization for the local game industry, accordingly organized several booths at international game exhibitions to attract creative workers directly from such events. Moreover, it also organized several recruitment tours in Germany and other European countries to meet the rapidly surging demand for talents in the industry (Gong, 2020). The influx of talent from all over Germany and Europe contributed significantly to the prosperity of the local industry in this phase (HAMSC2). Some universities in other parts of Germany also began to offer game-related degree programs, and private schools emerged, which put a strong focus on game design (HAMSC5).

In terms of *financial investment*, in contrast to Shanghai, the confined funding conditions inherited from the prior phase remained sluggish also in the browser game era. The Hamburg companies still hardly received any investment from banks, angel investors or the stock market (HAMIR10). For them, the most common way to fund their businesses was finding an outside publisher that would produce their games. Yet, this fundraising model was problematic because

“...publishers usually do not give money without reference projects or prototypes” (HAMIR6).

To cope with this restrictive financial condition, local firms thus had to continue spending substantive amount of time, effort and money to

develop first prototypes, only after which they could mobilize financial investment to complete the game.

In terms of *market formation*, the Hamburg-based studios achieved some remarkable successes in the browser and social network game markets both at home and abroad (HAMIR9). For example, Bigpoint, the largest Hamburg studio at the time, experienced a massive market explosion in 2006 (surpassing the 1 million user mark) when the portal “[Bigpoint.com](#)” was launched along with the two browser games Seafight and DarkOrbit. The market for this new type of games developed rapidly over the subsequent years, and the games published by the company reached more than 100 million users in 2009 (Bigpoint’s official website).

Also in terms of *legitimacy*, the situation in Hamburg diverged from Shanghai. Local firms together with the German games industry association and other federal agencies still had to put strong emphasis on creating a basic understanding of digital games among parents, educators and policy makers. A series of media courses for parents and educators were organized by the national industry association to reduce prejudice and increase their knowledge about games (Die Zeit, 2018, HAMIO4; Gong, 2020). Yet, overall awareness about the economic and cultural value of the gaming industry remained at a considerably lower level than in Shanghai.

5.2.2. Overall industry development and cumulative system building by the end of phase 2

At the end of this second phase, the two industrial paths already featured increasingly divergent system resource portfolios. Shanghai-based actors with their diversified investment and market resources inherited from the prior phase, could swiftly use the second critical moment to diversify their product portfolio, further develop local training structures, lure additional investors into the field and expand market prospects and the overall legitimacy of the industry. Overall, by the end of this phase, a comprehensive and diversified system resource portfolio had been established locally. In Hamburg, in contrast, while system resources such as knowledge, market access and legitimacy were increasingly mobilized by local firms, a lack of financial capital and investment continued to be a major constraining factor for the local industrial development. Moreover, both firm strategies and supportive system structures were adapted in more incremental and slower steps than in Shanghai.

Also the interactions between resource types started diverging more strongly between the two cities. In Shanghai, the successful diversification of funding sources as well as the unexpected success in grey markets allowed quickly attracting more talent and improving industry legitimacy with the general public and local governments. The more diversified funding sources also led to stronger R&D investments by firms, thus increasing the indigenous knowledge creation capabilities of local studios. Moreover, the loosening market regulations resulted in a boost of investors’ confidence in the booming industry and thus the inflow of financial capital from other sectors. This strong local dynamism in turn significantly contributed to industry legitimization.

In Hamburg, in contrast, the lack of financial investment from Phase 1 hampered industrial legitimization strategies in phases 2. Within phase 2, some negative feedbacks among the resource formation processes could be observed as well. The rather limited financial investments from the private and public sectors led to slowing the knowledge development of Hamburg-based studios. Moreover, this restrictive financial situation also hindered industry legitimization, as the economic value of this industry was still not recognized by local investors.

Overall, the portfolio of system resources developed at the end of phase 2 and the feedback between them were clearly more advantageous for firms in Shanghai than in Hamburg. This difference proved decisive when a shift in the global industry toward mobile gaming created the next critical moment.

5.3. Phase 3: Divergent development trajectories in the mobile game area (early 2010s-)

The global industry’s shift toward mobile gaming after 2010 marked yet another phase shift in both local industries. In contrast to browser and PC games, which are played on a computer, mobile games are played on portable devices like smartphones, pads, tablets, etc. The relatively small size of portable devices and the need to maintain handheld posture while playing require optimization of the game interface and operation methods for these features. In addition, because the smartphone terminal’s operating mode is very diverse, it enables many interesting new standalone games that differ substantially from PC/browser games, which have a more fixed operating mode. This means that the knowledge needed to develop a sophisticated mobile game is very different from that needed for PC or browser games.

5.3.1. Firm- and system-level agency in resource formation

1) Shanghai

In face of the shift towards mobile gaming, firms in both cities profited from their already well-established *knowledge* and education structures, which further developed and diversified, yet at two different levels of speed and sophistication. In China as a whole, by 2018, the number of higher education institutions that had opened game development courses had reached 500 (CNG, 2018). Within Shanghai, about 40 universities and colleges were offering game-related courses (CNG, 2018). Collaboration between industry and academia further deepened (SHIR3), and many of the Shanghai-based companies (e.g., YooZoo, Shanda, Giant) started connecting the local knowledge base to global knowledge streams by establishing branch offices in Western countries (SHEX5, 6).

In terms of *financial investment*, while overall investment levels remained high in Shanghai, funding for new projects increasingly became an issue for startups as competition within the industry further intensified. In response, the local government started to provide more funds to local game studios. Moreover, various incubator organizations in Shanghai’s high-tech parks began investing in new game ventures (SHG02). In recent years, several Shanghai-based companies that were previously listed on the U.S. stock markets (e.g., Shanda, Giant, The9) began to delist (China Securities Journal, 2014) and were re-listed on Chinese stock exchanges to take full advantage of booming domestic financial markets (SHIR16, 23).

In this last phase of development, market formation dynamics reversed to some degree, as more restrictive national government interventions got re-introduced (SHIR23, SHEX7). In 2018, the central government announced a series of policy interventions to strictly control the number of games that could be released annually on the domestic market (SHIR20). Yet, given Shanghai’s strong knowledge capabilities and investment volumes, local firms could again adapt quickly to this unexpected market shock. Many Shanghai companies reverted to targeting foreign markets (The Paper, 2020), which prevented a slump in their overall market shares. As one interviewee put it,

“...Shanghai companies seemed to be good at ‘guerrilla warfare’ and were able to constantly switch between domestic and foreign markets depending on what kind of regulations were issued by the central government.” (SHIR5)

In terms of *legitimacy*, key stakeholders and governments have mostly continued emphasizing the economic and cultural value of the industry, while urging companies to keep a close eye on the negative impacts of gaming (e.g., by requiring to build anti-addiction systems into games) (SHIR21). Industry self-regulation thus got increasingly strengthened in recent years. In this way, some of the key legitimacy issues in the policy sphere could be somewhat dampened (AUTHORS), despite the central government and the public remaining concerned about gaming’s

negative impacts on left-behind children in rural areas (SHIR23, SHEX7).

2) Hamburg

In Hamburg like in Shanghai, the key channels for *knowledge* acquisition further diversified in this third phase, yet at a lower overall level of activity. Online learning and learning through intra-industry collaboration became key channels for knowledge generation and spillovers in this last phase (HAMIR6). By 2020 there were about 80 private and public colleges in Germany with game-related degree programs, 5 of which located in Hamburg (GAME, 2020).

In terms of *financial investment*, in contrast, a mobilization of global investment flows became possible only in the third phase and in a less effective way than in Shanghai, when the three largest local studios in Hamburg - Bigpoint, GoodGames and InnoGames - were acquired by foreign media conglomerates (HAMIO3, HAMIR6, 7). In parallel to these major studios, a number of indie-game studios continued developing in the city, which relied mostly on (quite limited) local or EU funds and on mobilizing their informal financing networks. Only in recent years, consensus started to emerge among game developers in Hamburg and other German cities, that a nationwide fund to support game development is urgently needed. Thanks to intensive and long-term lobbying by national associations such as BIU and GAME, the German government finally decided to launch a German Games Fund in 2020 (GAME, 2020). The overall investment volume of this fund however remains orders of magnitude below the financial investment available in Shanghai, and a vibrant venture capital community for game development remains to be established.

Also in terms of *market* formation, the industry in Hamburg experienced stronger fluctuation after the ascent of mobile gaming. As the capabilities accumulated in the browser games era were not easily transferable to the new mobile platforms, after 2015, Hamburg companies suddenly found themselves under strong international competitive pressure (Hamburger Abendblatt, 2017). It became increasingly difficult for domestic companies to survive, as competitors from all over the world offered a wider and more innovative range of games and started eating away local firms' market shares.

Finally, in terms of *legitimacy*, the game industry in Hamburg is by now also widely seen as an integral part of the local creative/digital economy. However, in the early days of the transition to the mobile gaming platform, the restructuring process of the local industry had led to the quick dismissal of several hundred employees in Hamburg (Hamburger Abendblatt, 2016). Thereafter, another round of active legitimization activities had to be initiated to convince the public that those job fluctuations were isolated and temporary occurrences, while the industry overall was a reliable source of employment.

5.3.2. Overall industry development and cumulative system building by the end of phase 3

This last phase makes the effects of diverging cumulative causation dynamics in both city regions very visible. When the global industry was struck by a shift to mobile games, actors in Shanghai could successfully cope by adapting their priorly accumulated local resource portfolio, and changing the strategies of the well-diversified local game cluster, which at this stage contained firms in the entire value chain from game development to publishing, maintenance, and operation (CNG, 2015). System resources accumulated in the previous phases proved key to the success of Shanghai-based studios during this period. For example, the enhanced knowledge capabilities of local companies prepared the industry for the transition to mobile games and also provided the skills needed for market expansion to foreign markets when restrictive regulations were introduced in the domestic market. In turn, the diversified portfolio of financial investors has been an important source of continuous investment in R&D by local companies and kept them independent from foreign lead firms in the industry.

In contrast, Hamburg-based game companies had more difficulties in reshaping their organizational strategies and overcoming key structural weaknesses in the supportive innovation systems. Hamburg by now hosts a less diversified industry and supportive innovation system structure than Shanghai with persistent gaps especially in terms of financial investment and market shares. While the success of the Hamburg studios in the second phase led to an inflow of investment and talent, those dynamics could not be retained in the region, as the knowledge acquired in the development of browser games could not be transferred to mobile games as quickly as in Shanghai. The shrinking market share of Hamburg-based companies in phase 3 led to job losses and mergers and acquisitions, which further called into question the reliability and legitimacy of the industry as an essential part of the creative industries.

Overall, due to the divergent cumulative causation in system building and resource mobilization dynamics explored over the three periods of development, the industrial paths in both regions are now set on largely divergent trajectories. In Shanghai, the originally weak local industry has developed into a sizeable industrial path with sophisticated support structures, serving both domestic and global markets. The industry in Hamburg, in contrast, is dominated by small and medium enterprises, and remains focused on a more restricted 'boutique' game market.

6. Discussion: cumulative causation compared between the cases

Fig. 2 (a & b) shows in detail, how supportive system resource portfolios were built up differently over time in the two cases. In the face of critical moments (i.e. technological revolutions in the main gaming platforms) both firms and non-firm actors had to change strategies and realign the development path (i.e. resource formation). In each critical moment, the specific configuration of resource stocks inherited from prior phases, combined with firm-level and system-level agency, decided whether positive feedback loops could form or not.

In Shanghai, we observed several virtuous feedback loops, in which the creation of one resource in an early phase, combined with strong firm- and system-level agency, led to an increased mobilization of other resources in subsequent phases (see Fig. 2a). One telling example is the successful listing of Shanghai's game companies at US stock exchanges in phase 1. This, combined with strong firm-level agency (e.g., doing business 'under the radar') and strong system-level agency (e.g., lobbying local policy makers to shift their attitude towards the industry), proved decisive for attracting more talent, mobilizing additional investors, and creating legitimacy with the general public in subsequent phases. Another example is successful lobbying strategies at supra-regional levels in phase 2 (based on market and financial successes in the prior phase) that led to various support schemes being announced by the central and regional governments in phase 2 and 3.

In Hamburg, in contrast, positive cumulative causation patterns remained scater (see Fig. 2b). One example is the strong success of Hamburg-based firms in the browser game era (market formation), which raised the interest of global media conglomerates, leading to international merges and acquisitions in phase 3, which in turn expanded the financial base of the local industry. In several other cases, however, instances of disrupted or even vicious causation loops could be observed. The lack of investment in Phase 1, combined with limited firm-level agency (e.g. incapability of raising financial investment for R&D) and system-level agency (e.g., lack of public funding, lack of legitimacy with the public and national government), hindered financial investment in phase 2, when quick scaling of local businesses would have been possible. Similarly, the lack of investor interest and government support (limited market formation and mobilization of financial investment) in phases 1 and 2, combined with rather constrained system-level agency by local actors hampered legitimization strategies in phases 2 and 3. Finally, the rather limited funding situation (low financial investments)

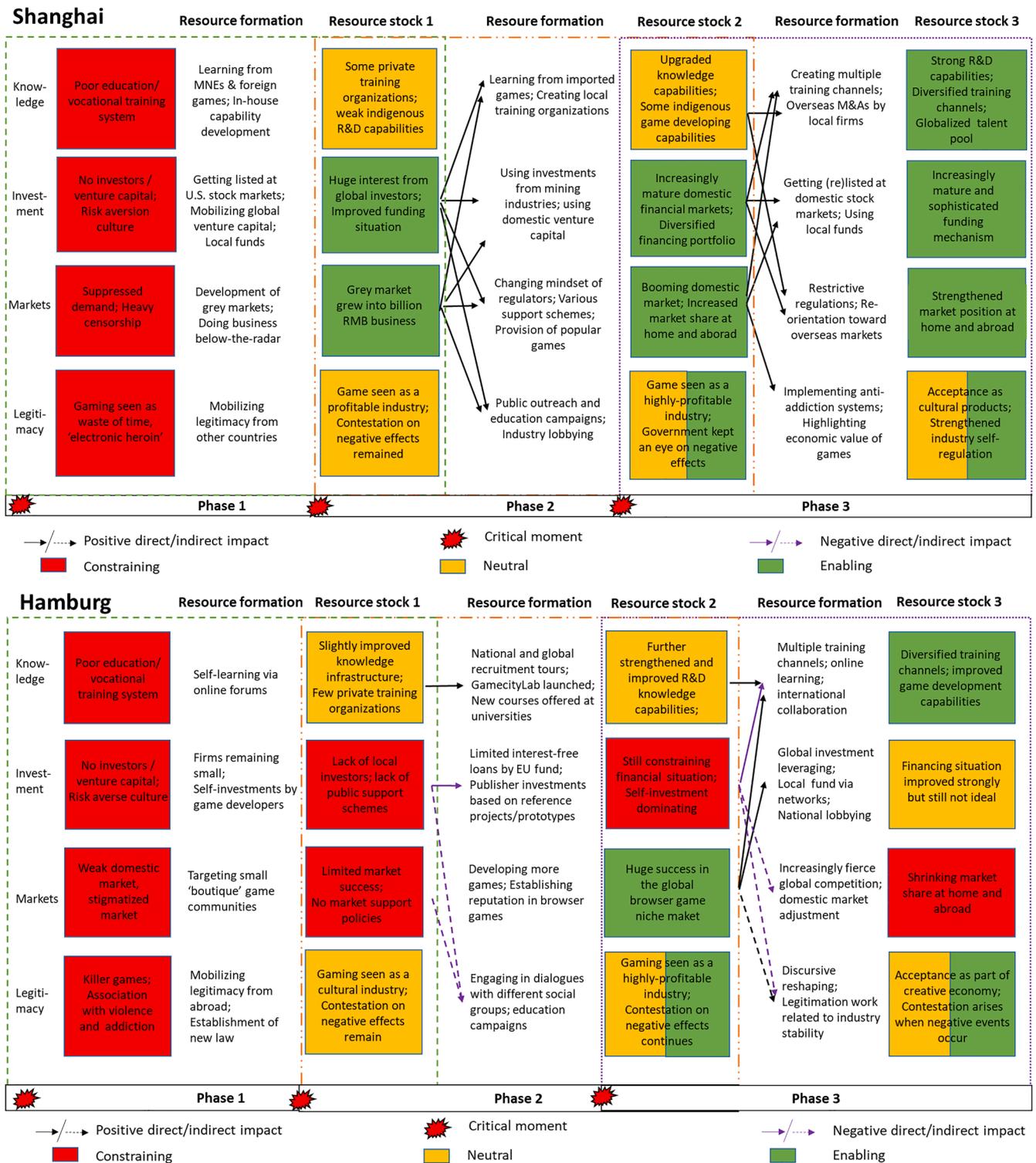


Fig. 2. a. Cumulative causation patterns in Shanghai. b. Cumulative causation patterns in Hamburg.

in phase 2 also led to limited investment in new knowledge and skills needed in phase 3 in the transformation to mobile platforms. Combined with low to medium firm and system level agency, this created difficulties of Hamburg-based companies in market development, and a massive layoff of key local companies, requiring additional legitimation work (see arrows of negative impact in Fig. 2b).

Moreover, our results also pointed to the importance of building up a comprehensive resource portfolio as early as possible for the cumulative causation processes. As we have shown in Fig. 2a, actors in Shanghai

were able to build a relatively comprehensive resource portfolio much earlier on than their Hamburg counterparts. This gave the local actors greater advantages over players in Hamburg in building up even more comprehensive and diversified resource portfolios in the later stages. In contrast, actors in Hamburg were unable to address the weaknesses in the initial resource portfolio, and failed to build up a comprehensive resource portfolio throughout the whole path development process. Even by the end of the third phase, several hindering conditions still existed, slowing down the path development process and preventing

cross-fertilization across different resource formation processes. Our results thus confirm that if a comprehensive and diversified resource portfolio can be built early on, more options for virtuous cumulative causation dynamics exist in later stages than if one or several resources are missing. A broad portfolio leads to more options for adapting, re-orienting or reconfiguring the innovation system and its resource stocks in a critical moment, which means that positive cumulative causation patterns overall are more likely. In contrast, if actors are unable to build a comprehensive resource portfolio before a critical moment occurs, they will have fewer strategic options for reconfiguring local support structures and re-orienting the path, which means that negative feedbacks between and within individual resource dynamics are more likely. Over time, small differences will get amplified by cumulative, evolutionary patterns, leading to divergent regional path development outcomes.

Overall, our comparative study shows the importance of a clear conceptual understanding of cumulative causation dynamics in regional industrial path development. In particular, we suggest a move toward a more configurational style of theorizing, which traces industrial path development trajectories not based on a set of static independent variables, but rather by analyzing the dynamic interplay of key mechanism that create positive or negative outcomes in complex and cumulative causation processes. Our framework essentially focuses on the configuration of 1) the system resource stock accumulated in previous phases, 2) firm-level agency, and 3) system-level agency. The ways in which they co-evolve over time determine the path development outcomes. If a major gap exists in one or several of the three aspects (as in the case of Hamburg), fewer options for system re-orientation exist, which is likely to induce vicious cumulative causation cycles. In contrast, if all the three elements are well developed when a critical moment appears, actors may have more options in adapting or reconfiguring them and keep the path striving.

7. Conclusions and outlook

This paper developed a novel conceptual perspective and analytical framework for assessing cumulative causation dynamics in industrial path development processes and used it for explaining why the same industry may show divergent development patterns in different regions. The presented framework provides two key contributions to the literature. First, as mentioned earlier, it offers a much needed specification for process-based theorizing in economic geography (Martin, 2010; Shi and Shi, 2022), which explain regional industrial path development outcomes through differences in dynamic system building and resource build up processes, rather than region's initial resource endowments. The cumulative causation framework allows one to explore how differences in initial resource endowments get amplified or disrupted over time by cumulative, evolutionary patterns. Second, we argue that the specific configuration of accumulated resource stocks, as well as firm- and system-level agency in a given phase influence how fast and easily local actors can adapt to shifting circumstances and re-direct an industrial path in a next phase. Developing a configurational and longitudinal perspective on the interplay of these three key building blocks arguably provides a fresh inroad for theorizing industrial path development dynamics.

While we are positive that the presented conceptual approach offers manifold inroads for targeted follow-up studies, various opportunities for further improvements of the framework exist. First, a deeper

elaboration of different 'motors' of cumulative causation (Suurs and Hekkert, 2009) would be warranted. This key concept from cumulative causation literature could be used to further typologize and theorize the different causal pathways that lead to virtuous or vicious cumulative causation patterns between phases of development. Second, systematically cross-comparing cumulative causation pathways between other geographic and industrial contexts would be needed to derive more generic taxonomies of sector- and/or place-specific cumulative causation patterns. Third, in this paper, we largely abstracted from how extra-regional and multi-scalar interdependencies condition the regional cumulative system building process. Yet, a complete explanation of cumulative causation in regional path development would have to layer this key aspect onto the analytical model developed here. Ultimately, if the three points above were addressed in a coherent way, our approach would enable the development of a sophisticated process theory around regional industrial path development dynamics. Somewhat related, as the main goal here was developing process-based theorizing, we consciously abstracted somewhat from the generic differences that undoubtedly exist in the socio-political contexts of Hamburg and Shanghai. I.e. in China, the local and national governments generally take on a more pro-active and entrepreneurial role in industrial development, which gets visible in our data especially in the breadth and depth of system-level agency by non-firm actors supporting the gaming industry. Further exploring how differences in the varieties of capitalism or initial institutional arrangements influence the cumulative system building process constitutes a promising avenue of further research.

CRedit authorship contribution statement

Huiwen Gong: Conceptualization, Methodology, Investigation, Visualization, Funding acquisition, Data curation, Formal analysis, Project administration, Resources, Software, Validation, Writing – original draft, Writing – review & editing. **Christian Binz:** Conceptualization, Methodology, Visualization, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix 1. Interview groups and number of interviewees

Interview groups	No. of interviewees
Shanghai	
Founders/managers of game companies (industrial representatives) (SHIR)	23
Directors of cluster organizations/intermediary organizations (SHIO)	5
Government officials (SHGO)	4
Experts with > 10 years experience (SHEX)	10
Total	42
Hamburg	
Founders/managers of game companies (industrial representatives) (HAMIR)	10
Directors of cluster organizations/intermediary organizations (HAMIO)	4
Government officials (HAMGO)	2
Scholars (HAMS)	5
Total	21

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