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ANNUAL LECTURE

Regional worlds: from related variety in regional diversification to strategic coupling in global production networks

Henry Wai-chung Yeung

ABSTRACT

This annual lecture paper bridges two influential but parallel literature strands on evolutionary economic geography (EEG) and global production networks (GPN). It argues that both strands are premised on their different conceptions of 'regional worlds' of production – a more endogenous view in EEG and a more relational view of 'interconnected worlds' of production in GPN studies. Drawing on EEG's core concept of related variety in regional diversification, the paper theorizes how regional strategic coupling with GPN can serve as a causal mechanism for realizing related diversification by highlighting the importance of extra-local/regional linkages and production network dynamics.

KEYWORDS

regional worlds; related variety; regional diversification; strategic coupling; global production networks; evolutionary economic geography

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INTRODUCTION

About three decades ago, the academic field of regional studies was mostly preoccupied with the heated debate on regional transformation in relation to the episodic shift in production systems from Fordism to post-Fordist flexible specialization (e.g., Amin, 1994; Harrison, 1992; Scott, 1988; Scott & Storper, 1986). By the early 1990s, this debate had settled on a broad notion of high-performance regions as social–institutional ensembles of industrial specialization characterized by learning-based clusters or agglomerations. In his influential *Regional Studies* paper on the regional 'worlds' of production in France, Italy and the United States, Storper (1993) examined regional-level social relations, conventions and institutions that constituted such 'worlds' of learning-based innovation and drove technologically dynamic and export-oriented production systems (see also Storper, 1997; Storper & Salais, 1997). To him and then other leading scholars of regional studies (e.g., Amin & Thrift, 1994; Asheim, 1996; Cooke & Morgan, 1998; Morgan, 1997; Saxenian, 1994; Scott, 1998; cf. Hudson, 1999; 2004; Lovering, 1999), localized conventions and institutions could facilitate collective learning and innovation and therefore serve as the core relational assets underpinning regional specialization, geographical concentration and technological performance. In such conventions-based regional worlds of production, Storper (1997, p. 137) argued that '[t]he existence and persistence of these region-specific relational assets permits a compelling account of their ongoing agglomerative character, as well as their organizational specificities and absolute technological advantages'.

Since the mid-2000s, two influential strands of the literature in regional studies have built upon and developed further this localized learning and conventions-based view of regional growth and transformation. In what is commonly termed 'evolutionary economic geography' (EEG), the first major strand of the literature focuses on the importance of knowledge and innovation in regional evolution and path development, and the role of related variety in regional diversification. While Storper (1997, chs 3–4) has considered the evolutionary process of region-specific relational assets, it is in the pioneering works of Boschma and Lambooy (1999), Boschma (2004), Boschma and Frenken (2006), Boschma and Martin (2007) and Frenken and Boschma (2007) that the EEG school is firmly established in the field of regional studies and the adjacent social sciences (for recent reviews, see Boschma & Frenken, 2018; Hassink et al., 2019; and Zhu et al., 2019). In the second and relatively smaller strand of the literature linked to the global production

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networks (GPN) approach, researchers in economic geography (Coe et al., 2004; Coe & Hess, 2011; Henderson et al., 2002; Yeung, 2009a, 2015) and development studies (Giuliani et al., 2005; Humphrey & Schmitz, 2002; Parrilli et al., 2013; Pietrobelli & Rabellotti, 2011; Schmitz, 2004) are concerned with how regional actors and assets can be strategically coupled with the competitive dynamics of GPN in order for regions to achieve better industrial upgrading and value-capture trajectories (for recent reviews, see Coe & Yeung, 2015, 2019; Kano et al., 2020; and Yeung, 2018a, 2021). While both strands of the literature have gone much further beyond Storper's (1997) original work on the regional worlds of production, they have not engaged directly with each other and have inadvertently become 'parallel tracks' of the literature in regional studies and the wider social sciences (for a few exceptions, see Barratt & Ellem, 2019; Dawley et al., 2019; MacKinnon, 2012; and Trippl et al., 2018).

This paper intends to serve as an initial and sympathetic attempt to bridge these two strands of now highly influential literature in regional studies. There is much for both epistemic communities to engage with and learn from each other. Given space constraints, the focus here is more on what GPN studies can offer to EEG scholars and leave the 'reverse flow' to future work and other well-meaning researchers (e.g., Boschma et al., 2017; Gong & Hassink, 2018; Hassink et al., 2019; Trippl et al., 2018). In particular, one key, and perhaps best known, *new* concept is selected from each literature strand: *related variety* in EEG (since Frenken et al., 2007) and *strategic coupling* in GPN studies (since Coe et al., 2004). While path dependence (EEG) and governance/upgrading (GPN) are equally, if not better, known concepts in both literatures, they are not new and developed by economic geographers (e.g., path dependence in evolutionary economics since David, 1985; and Nelson & Winter, 1982; and value chain governance/upgrading in development studies since Gereffi, 1994; Gereffi et al., 2005; Giuliani et al., 2005; and Humphrey & Schmitz, 2002). To make this two-way dialogue meaningful, 'regional worlds' is reconceptualized as a central analytical platform in regional studies. It is argued here that both strands of the literature are premised on their different conceptions of 'regional worlds' of *innovation* and *production* – a more endogenous view of regions as 'specialized worlds' of innovation in EEG and a more relational view of regions as 'interconnected worlds' of innovation and production in GPN studies (and its predecessor in the much earlier work on the corporate and spatial divisions of labour by Allen et al., 1998; Dicken, 1976; and Massey, 1979; 1984; see also Fröbel et al., 1980; Hymer, 1972, 1979).

Since Frenken et al.'s (2007) initial work, the concept 'relatedness' or 'related variety' has formed a core tenet in EEG for explaining regional growth through diversification. But as critically noted in Boschma's (2017, p. 357) recent *Regional Studies* annual lecture (see also Content & Frenken, 2016, p. 2108), much of:

> the literature on regional diversification has primarily focused on the role of local capabilities, showing that relatedness at the local scale is a crucial driver of diversification. … However, a current weakness of this prime focus on national and regional capabilities is that it has neglected the role of extra-regional linkages and actors that might affect regional diversification.

While Boschma advocated a micro-perspective on local and non-local firms, his suggestion has concentrated specifically on the role of transnational corporations (TNCs) and their foreign direct investment (FDI) and intra-TNC divisions of labour in regional diversification (e.g., Ascani et al., 2016, 2020; Crescenzi & Iammarino, 2017; Elekes et al., 2019; Fuller & Phelps, 2018; MacKinnon, 2012; Neffke et al., 2018; Zhu et al., 2017). This narrower focus on TNCs and their region-specific subsidiary operations, however, tends to underestimate the significance of *non-TNC* extra-regional actors and linkages that are part of the wider GPN coordinated by lead firms (likely TNCs). In short, extra-regional linkages vis-à-vis these GPN can be established through the geographical fragmentation of production processes (e.g., from research and development (R&D) to manufacturing, sales and distribution) and the development of cross-regional strategic partnerships and interfirm collaborative relationships, with or without TNCs and their FDI in specific regions.

To fill this conceptual gap in using relatedness to account for regional diversification, the EEG literature can benefit from GPN studies that examine both *intra-firm/TNC* and *interfirm networks* of production and the organizational mechanisms for regional actors to 'plug' into these GPN. As advocated recently (Hassink et al., 2019, p. 1639), 'EEG frameworks could benefit from a stronger integration of insights from the literature on global production and innovation networks and multi-scalar innovation systems'. More specifically, the key concept 'strategic coupling' in the GPN literature might be usefully deployed to theorize how related regional diversification can take place through regional actors coupling with the strategic and yet complementary (i.e., related) imperatives of extra-regional lead firms and partners in GPN. Grounded in the recent GPN 2.0 theory developed by Coe and Yeung (2015, 2019; see also Yeung & Coe, 2015; Yeung, 2018a), my reconceptualization of 'regional worlds' can allow analytically the possibility of strategic coupling with GPN as a *new causal mechanism* for realizing related variety in regional diversification by highlighting the importance of extra-local/regional linkages and complementary interfirm network dynamics.

This paper theorizes 'regional worlds' as territorialized networks of interconnections that capitalize on region-specific assets and yet tap into extra-regional markets, production capabilities, and flows of people, capital and technology. Strategic coupling can serve as a new mechanism for achieving related variety in regional diversification by enabling firms in regions to diversify into related products or functional segments in similar industries through new

production and market opportunities associated with these regional actors participating in GPN. By relating related variety to strategic coupling, this synthetic view can potentially reconcile the coexistence of endogenous and exogenous sources of regional change and transformation, much like in the broader social science debate on the role of domestic political economy versus international processes in engendering industrial transformation at the national scale (Hamilton-Hart & Yeung, 2021; Neilson et al., 2014; Yeung, 2016). That said and as argued elsewhere (Yeung, 2021), this GPN approach is never meant to represent all the possible uneven geographical development trajectories in contemporary capitalism. It is simply a meso-level theory for analysing the industrial–organizational dynamics at the levels of firms and their networks – respectively, actors and organizational platforms – that underpin regional transformation. Other more macro-approaches are better able to account for broader value chain struggles and socio-spatial inequalities within capitalist development (e.g., Harvey, 2006, 2014; Sheppard, 2011, 2016).

The remainder of the paper is structured as follows. The next section reconceptualizes 'regional worlds' as territorialized networks of interconnections embedded in a highly globalized world economy. The third section takes this relational conception of regions further by examining critically regional evolution through 'related variety' in regional diversification – the key concern of the EEG literature in regional studies. The fourth section extends the existing EEG understanding of related diversification by considering how regions can diversify through strategic coupling with GPN. In do so, actors in a region can tap into a new form of 'related variety' in which key resources and complementary assets are located elsewhere outside the region. The concluding section offers some future agenda for theory and practice in regional studies.

REGIONAL WORLDS: TOWARDS A RECONCEPTUALIZATION

The notion of 'regional worlds' in the field of regional studies owes its existence to Storper's (1993) original work. Developed more fully in his *The Regional World* (1997) and, with Salais, *Worlds of Production* (1997), this conventions-based conception of regional worlds offers an endogenous view of regional specialization and evolutionary change. Grounded in then the French conventions theory (for reviews, see Biggart & Beamish, 2003; Thévenot, 2001), Storper (1997, p. 136) argued that high-performance regions are characterized by a qualitatively distinct set of political–economic cultures, social institutions and behavioural routines of collective agents. Together, these qualitative elements in regions constitute local worlds of conventions. Drawing upon Nelson and Winter's (1982) evolutionary theory of economic change, Storper (1997) theorized further that such regional worlds of production are distinct because of their technological dynamism and conventions in favour of localized learning and collective action. These region-specific elements constitute evolutionary properties different from other regional worlds characterized by weaker orientation towards collective learning and technological innovation. By analysing these underlying differences in regional worlds of production and collective choices, Storper argued that we might be able to observe better distinct sources of learning and regional evolutionary outcomes, such as industrial specialization, increasing returns to scale and economic performance:

> In order for a region to be fundamental to the evolution of a technological field or space, that region – a geographical space – must contain some of the key interdependent choices that make a technology evolve. The region must be a place where technological variety is created and then limited, where the pathway is traced out.
>
> (p. 65)

While it has helped much in the ensuring debates on post-Fordist flexible specialization in localized production systems found in California, the Third Italy and other innovative regions in Western Europe, this specialization model of regional worlds has two main drawbacks. First, it offers a mostly inward-looking conception of regional worlds in which regions are viewed as *territorial containers* of relational assets and social conventions. This 'container' view of regional worlds tends to foreclose the possibility of crucial interactions between regional actors/assets and the wider global economy. It does not consider how such regional worlds can be co-constituted through dynamic interactions between localized conventions and extra-regional relations embedded in *other* regional worlds in the global economy (for earlier critiques, see also Amin, 1998; Bathelt et al., 2004; Bunnell & Coe, 2001; MacKinnon et al., 2002; Yeung, 2005). Second, this specialization conception of regional worlds places too much explanatory power on what Storper (1997, p. 136) termed 'absolute advantage based on superior localized technological learning'. When pushed to its extreme such as in the 'new regionalism' literature (for earlier critiques, see Hudson, 1999; Lovering, 1999; MacLeod, 2001; Ward & Jonas, 2004), it can perpetuate an almost mythical geography of hierarchical world regions in which some 'learning' and 'smart' regions are seen as perpetually superior than other 'laggard' regions that do not enjoy such absolute advantage and therefore have no chance of catching up with the former – a view certainly not shared by leading scholars of technological change and economic catch-up (e.g., Lee, 2013, 2019; Malerba & Nelson, 2012; Mathews, 2006).

During the past 15 years, a broader debate has emerged focusing on regional change and industrial transformation in an interdependent world characterized by deep global economic integration through cross-border production networks or 'global shift' in Dicken's (2015) definitive work. The key question here is: How do regions evolve and develop by pursuing different value-capture trajectories in tandem with their participation in these geographically fragmented GPN? In Coe and Yeung's

(2015, pp. 1–2) GPN 2.0 theory, these networks are defined as 'an organizational arrangement, comprising interconnected economic and non-economic actors coordinated by a global lead firm, and producing goods or services across multiple geographical locations for worldwide markets'. This firm-cum-network approach acknowledges the multi-actor and geographically complex contemporary global economy comprising multiple 'regional worlds' stitched together through GPN. The focus of GPN 2.0 is thus on the different economic and non-economic actors who constitute GPN, with a lead firm being a central and necessary prerequisite, and on the multiple localities and regions that are interconnected through the economic relations among those actors (see also Yeung, 2018a; Yeung & Coe, 2015). Instead of reiterating the nature and characteristics of inward-looking economic specialization in regional development pathways, this new debate since the mid-2000s has been about 'globalizing' regional development (Coe et al., 2004, 2008; Dicken et al., 2001; Yeung, 2009a, 2010, 2015) and new and perhaps 'smarter' forms of regional development in a world of GPN and global value chains (GVCs) (Martins, 2018; Organisation for Economic Co-operation and Development (OECD), 2012; see also McKinsey Global Institute, 2019; United Nations Conference on Trade and Development (UNCTAD), 2013, 2020; World Bank, 2020; World Trade Organization (WTO), 2019).

Extending my earlier work on the theory of GPN, what is argued for here is a relational view of regions as *interconnected worlds* that bring together and integrate multiple worlds – the earlier world of highly specialized regional production *and* the new world of globalized production in diverse localities and regions. In this GPN 2.0-inspired view, a region is conceptualized not as a tightly bounded container of localized conventions and relational assets, but rather as a porous territorial formation whose notional boundaries are straddled by a broad range of localized and extra-regional network connections. In these regional worlds of interconnections, regions are 'microcosms' internalizing diverse local and non-local flows and linkages that make up different worlds of production. These translocal/regional connections, flows and linkages go well beyond intangible knowledge and information (e.g., in innovation and cluster studies); more importantly, they include material inputs, intermediate goods and advanced business services. The unit of analysis is therefore not exclusively at the regional level, but also at the firm and network levels (i.e., production networks coordinated by global lead firms) that, taken together and in aggregate terms, constitute the collective performance of regions. Ultimately, these interconnected regional worlds provide both the competitive innovation and production platforms and the end markets to engender the critical success of regional actors and institutions.

To be fair, this relational view of regions is not entirely new (Allen et al., 1998; Amin, 1998, 2002; Bathelt & Glückler, 2011; Jones & Paasi, 2013a; Yeung, 2005). As argued in Jones and Paasi's (2013b, p. 2) editorial for their special issue of *Regional Studies*, 'regions are seen to "stretch" in space so that their social contents and relations are networked across borders and this networking indeed constitutes both regions and their borders – regional boundaries and identities need not be exclusive'. In fact, we have previously learnt much from Massey's classic *Spatial Divisions of Labour* (1984) that the fortunes of regions are shaped not only by what is going on within them but also through wider sets of relations of control and dependency, of competition and markets (see also Dicken, 1976; Massey, 1979). In my conception of regions as 'interconnected worlds', GPN are not merely the context or situation for local actors to act and make choices in these regional worlds. Rather, regional worlds are territorialized networks of interconnections that capitalize on region-specific assets and yet their key actors and institutions tap into extra-regional markets, production capabilities and flows of people, capital and technology. While regional actors may achieve superior knowledge, innovation and technological dynamism through localized learning and conventions, they may also do so through deepened participation in cross-regional or cross-border production networks that connect these actors to knowledge and innovative hot spots in other regions within and beyond the national economy. In short, GPN emanate from and co-constitute regional worlds of interconnections and cannot be separated analytically as a context from the very territorial entities that create and nurture them. Regional worlds are therefore not just the distributed context for GPN, and vice versa.

As Storper (2009, p. 16; original emphasis) asked rhetorically:

> If Hollywood were a global production network with no local core, would it be the same industry as it is with its present organization and geography? A producer of different but better outputs? A producer of worse, less welfare-enhancing outputs? A fair guess is that *the situations of its actors would have changed* and with them the processes of framing, emulation, cognition, learning, and choice.

The question is not whether Hollywood is a GPN without a local core: it is *both* a territorialized constellation of *multiple* GPN in the motion picture industry *and* a highly innovative 'regional world' well blessed by a superior 'local' core comprising creative talents who are admittedly multinational in origin. Through the globalization of their production networks, motion picture majors or lead firms in Hollywood have not only strengthened their local core in Hollywood but also integrated *other* regions and localities elsewhere (e.g., Vancouver, Paris, Hong Kong and Shanghai) into its 'regional world' of production. This same process of worldwide integration among the regional worlds of interconnections is also taking place in many other global industries, such as the information and communications technologies production networks between Silicon Valley and high-growth regions in East Asian economies (for major empirical studies, see Lüthje et al., 2013; McKendrick et al., 2000; Saxenian, 2006; Yeung, 2010, 2016, 2022).

Figure 1 illustrates this relational view of regions as 'interconnected worlds' through their leadership, coordination and participation in GPN. In earlier work (Coe et al., 2004; Yeung, 2009a), regional development in a highly globalized world economy requires the necessary co-presence of three interrelated sets of conditions:

- The existence of economies of scale and scope within specific regions.
- The possibility of localization economies within GPN.
- The appropriate configurations of regional institutions to 'hold down' GPN and unleash regional potential.

Theorized by Storper (1997, figs 2.1, 2.3) as the 'holy trinity' of relational assets in regional economies, these necessary conditions relate to the unique sets of *technology*, *organization* and *territories* in each regional world. In regional world A – a high-growth region characterized by highly competitive technological dynamism (e.g., Silicon Valley in the United States), well-established local conventions define such strong relational assets in technology, industry and institutions. In an emerging regional world B in another national economy (e.g., Hsinchu in Taiwan) or within the same country (e.g., Oregon or Texas in the United States), distinct conventions may emerge that in turn nurture such relational assets. But in these regions as interconnected worlds, the causal role of localized assets in accounting for dynamic change in regional worlds A and B depends on another crucial set of intra-firm and inter-organizational relations embedded in GPN (Figure 1, centre box), rather than intra-national production networks (e.g., the Silicon Valley–Texas nexus). Through their respective roles in these cross-border networks – coordinated by dominant lead firms from regional world A and participated by major partners and suppliers from regional world B – these two regions in different national economies become closely intertwined and co-evolutionary in their shared trajectories. Over time, regional world A may specialize further in its existing path and capture more benefits from related value capture trajectories because through these GPN; its lead firms are supported by actors with lower cost and high capability and new markets in regional world B. Meanwhile, regional world B may evolve and diversify into new industries through new windows of opportunity embedded in GPN coordinated by lead firms from regional world A.

In essence, we cannot fully understand regional change if our analytical optic remains too myopic and focused only on endogenous factors and/or territorialized endowments within each regional world (A or B). The interactive effects of these regional assets and extra-regional production networks can generate new pressures and opportunities for transformative change that cannot be predicted a priori by an endogenous 'container' view of regional worlds. Equally, a globalist analysis of value chains and production networks (e.g., Baldwin, 2016, 2019) without careful attention to local specificities in regional worlds will likely fail to appreciate diverse regional outcomes through related specialization and unrelated diversification initiatives (Figure 1, lower boxes). Over time and due to unexpected change in the global context (e.g., great power conflicts, episodic technological shifts or global environmental change), some of these specialization/diversification initiatives may accentuate the 'dark sides' of strategic coupling with GPN, leading to possibly crisis tendencies in one region (A) and greater ruptures and frictions in another region (B) (Coe & Hess, 2011; Ibert et al., 2019; MacKinnon, 2012; McGrath, 2018; Phelps et al., 2018; Yeung, 2015, 2021).

To sum up, a necessary and sufficient condition for analysing regional transformation needs to take into account both internal dynamics for change and extra-regional opportunities embedded in GPN. This integrative approach requires regional studies scholars to examine regional evolution through tracking related and unrelated diversification initiatives *and* their strategic coupling or 'fit' with the competitive dynamics of relevant GPN. The following two sections integrate the concepts of 'related variety' in EEG and 'strategic coupling' in GPN 2.0 in order to operationalize better this conception of regions as interconnected worlds of production.

EEG: RELATED VARIETY IN REGIONAL DIVERSIFICATION

In their highly influential *Regional Studies* paper, Frenken et al. (2007) first identified two important sources of regional growth that are related to the variety of knowledge spillovers within regions. Grounded in new growth theory in economics, their view refers 'related variety' to within-sectors knowledge spillovers among firms, whereas 'unrelated variety' is measured by a portfolio of knowledge flows between firms in different sectors. Since these spillovers are geographically bounded within regional economies – known as Jacobs externalities, the qualitative composition of existing industrial sectors within regions becomes an important source of regional growth. In regions with highly complementary composition of sectors, related variety in regional diversification (shortened as 'related diversification') tends to take place and higher regional growth rates are expected. Unrelated variety, however, can also contribute to regional resilience because a highly specialized region is more vulnerable to external shocks in market demand (and, from the GPN 2.0 perspective, high risk from disruptions in GPN). As such, regional diversification through a high sectoral variety (i.e., many but not necessarily complementary sectors) may enhance regional capacity to withstand external shocks.

Since Frenken et al. (2007), this EEG view of regional evolution through related diversification has led to a significant departure from the earlier specialization view of regional worlds during the 1990s and the 2000s that focused primarily on explaining *existing* regional specializations. The key question for regional studies has now become: How does one explain regional evolution by analysing the changing variety of its firms and sectors and understanding the creation of new

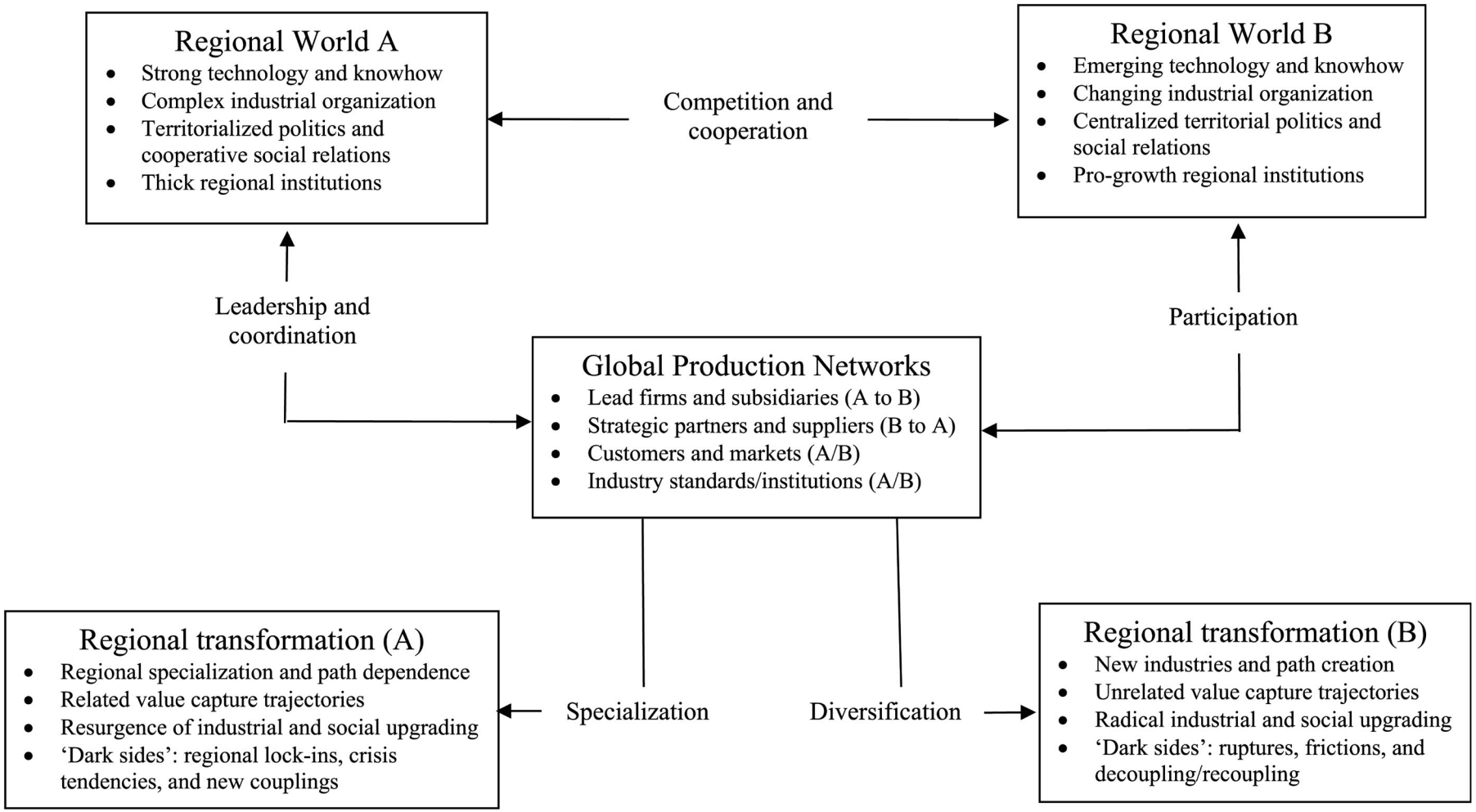

Figure 1. Relational view of regions as 'interconnected worlds' of production.

specializations and pathways? In particular, regional diversification through related and unrelated variety has been theorized as one of the most significant mechanisms for regional economic growth (for reviews, see Content & Frenken, 2016; Whittle & Kogler, 2020). In his *Regional Studies* lecture, Boschma (2017, n. 2, pp. 360–361) offers a clear distinction between regional specialization and regional diversification. To him, regional diversification refers to

> the creation and development of a new specialization in a region, which may result in regional specialization (in the case of the absence of any other specializations in the region) or not (when other specializations in the region are already present).

A region can 'diversify' into related sectors that may benefit more from knowledge spillovers among firms in these related sectors. Regional diversification through unrelated variety is also possible, but the Jacobs type of localized knowledge spillovers is expected to be more limited among firms in unrelated sectors.

While in theory both related and unrelated variety can contribute to regional diversification, much of the EEG research in the past decade has focused on related variety in regional diversification. Related variety is also defined more broadly beyond simply knowledge spillovers to include technological relatedness, product relatedness, product market relatedness, skill relatedness, input–output relatedness, etc. (Boschma, 2017, p. 354; see also Whittle & Kogler, 2020). This relatedness is understood and measured in terms of the similarity and complementarity of categories (products and markets) and activities (technology, skill and input–output). And yet, Boschma (2017, p. 355) argued that 'there is clearly no single measure of relatedness as it encompasses many dimensions. Some studies on regional diversification have used broad measures of relatedness, while others have applied more narrowly defined relatedness measures'. Interestingly and two decades earlier, Storper (1997, p. 80) had recognized this broad conception of related or 'close down' variety in regional change:

> The region is one organizational level (among others) where processes of information spillover and development work to create technological and technical variety. The region is also a place where proximity facilitates the 'contagion' of cognitive frameworks and knowledge, hence aiding region-specific imitation and evolution. It pushes toward region-specific selection among alternatives, hence the tendency to close down variety. At an interregional level, of course, competition between products and technologies also operates to open up and close down variety. There are, then, geographical contributions to this major evolutionary development dynamic of capitalism.

As observed by Boschma (2017, pp. 352–353) and Boschma et al. (2017, p. 32), related diversification is the rule, whereas unrelated diversification is the exception. Couched in EEG terminology, related diversification refers to path renewal through which local firms switch to new but related activities. Unrelated diversification refers to new path creation and the possible emergence of entirely new sectors or products (see also Dawley et al., 2019; Frangenheim et al., 2020; Harris, 2020; Hassink et al., 2019; MacKinnon et al., 2019; Trippl et al., 2018). For example, a region diversifying from apparel manufacturing to new industries, such as semiconductors or pharmaceuticals, requires completely new capabilities and thus represents a high-risk and high-cost approach to regional transformation.

More broadly, this EEG mode of analysing regional evolution focuses on explaining the adaptive transformation of the economic landscape and the uneven process of regional development (Boschma & Martin, 2007; Frangenheim et al., 2020; Grillitsch & Sotarauta, 2020; MacKinnon et al., 2009; Martin & Sunley, 2015; Sheppard, 2016). Industrial change and regional transformations occur when economic actors and social institutions break out of the existing 'lock-in' through a related path creation process known as 'branching' in product variety (Frenken et al., 2007; Frenken & Boschma, 2007; Neffke et al., 2011). Frenken and Boschma (2007, p. 642) and Frenken et al. (2007, p. 687) considered gains from related variety in product diversification at the firm and urban levels as the central 'feedback mechanism' of regional development. These mechanisms may be product diversification or 'branching' at the collective firm level or convergence and increasing returns to capability development at the institutional level (Martin & Sunley, 2006, 2015). Inter-organizational networks are also important meso-level mechanisms for regional growth (Huggins & Thompson, 2014). Despite a large body of work on relatedness and regional diversification since Frenken et al. (2007), the issue of regional path evolution through related diversification remains underexamined. As critiqued recently by Hassink et al. (2019), MacKinnon et al. (2019) and Frangenheim et al. (2020), the specification of regional path development is far too narrow in the EEG work on related variety. Boschma (2017, p. 356) thus points to the need for more geographical wisdom to understand the 'conditioning factors' that facilitate related and unrelated regional diversification. These factors range from the local capabilities and non-local linkages of firms to economic and socio-institutional agency within regions, such as bricolage and institutional entrepreneurship (see also Boschma et al., 2017, p. 34; Grillitsch & Sotarauta, 2020, p. 708; Yeung, 2009b).

Even if we take into account difficulties in modelling regional change and obtaining time-series data sets in EEG work, its existing understanding of related diversification is constrained by two conceptual and methodological issues: endogeneity and discrete units of analysis (for a critique, see Sheppard, 2016, pp. 90–92). First, most EEG studies of related diversification remain rooted in a 'container' view of regions. Taking such a conception of regions as closed systems, measures of relatedness are construed primarily among existing capabilities and firms *within* the region and any deviation over time is analysed

for its related or unrelated nature. As stated explicitly in Boschma et al.'s (2017, p. 37; original emphasis) theory of regional diversification:

> In EEG, the notion of novelty is spatially defined and treated: looking from the perspective of a region, scholars distinguish between related and unrelated diversification. The more a new industry is unrelated to the capability base already built up in the *region*, the more a new industry marks a radical departure from a region's own past.

In what Sheppard (2016, p. 82) describes as 'methodological territorialism', EEG tends to reduce capitalist dynamics to local firms and their capabilities *in* regions and neglect the broader politics of production dynamics and institutional governance.

While EEG studies do not explicitly preclude the possibility of extra-regional linkages in driving regional diversification, most of them tend to assume implicitly that only intra-regional capabilities matter, irrespective of these potential external influences. To EEG critics, this endogenous conception of new industry and/or local capability can be misleading in the interconnected worlds of regions in which regional formations are not, and cannot be, defined as if they were entirely encapsulated within a closed and self-contained system. As theorized further in the next section, the existing base in the region can be co-constituted and transformed through ongoing extra-regional network relationships at the intra- and interfirm levels such that localized capability is never a completely 'local' and 'closed' base without any exogenous influences and interactions.

In summary, no region is an 'island' devoid of connectivity to the wider national and global economy. This is particularly true for high-performance regions whose key firms inadvertently play critical roles spearheading diverse GPN in many industries and sectors, and their leading products, platforms and services have enormous global market reach.

Second, the above endogenous view tends to prevail when EEG scholars focus on individual actors (e.g., scientists, inventors and entrepreneurs) and firms within regions as discrete units of analysis. As strongly argued in Frenken and Boschma's (2007, p. 637) defining theoretical framework for EEG:

> the firm rather than the locality is the unit of analysis. The shift from territory to firm resonates a more general reorientation in economic geography from territorial analysis of endowments or institutions to firm analysis of routines and competencies and their embeddedness in the local and global economy.

While individuals and firms are clearly important constituents of regional formation, the interrelationships between these individuals and firms and their extra-regional partners and competitors are perhaps as critical in understanding regional diversification.

To overcome these twin constraints of methodological territorialism (regions as containers) and methodological individualism (firms as discrete entities), the idea of *networks* as a meso-level unit of analysis for explaining regional change is indispensable. Taking more seriously this network view in their recent work, Boschma et al. (2017, p. 35) proposed a bricolage approach that (see also Grillitsch, 2019; Hassink et al., 2019):

> alludes to the consideration of a multiplicity of actors embedded in networks who collectively draw on a broad set of distributed resources such as money, material components, discourses, knowledge, legitimacy and skills, organizational arrangements and political regulation in order to create new industrial pathways through processes of mindful deviation.

As well reviewed by Boschma and Frenken (2010, 2018), the EEG literature has to a certain extent examined the role of networks and gatekeepers in knowledge diffusion and innovative activities *within* industrial clusters and regional economies. Often premised on Boschma's (2005) five notions of proximity – cognitive, organizational, social, institutional and geographical – most of these EEG studies have analytically focused on *local* or *localized* interpersonal or inter-organizational dyadic relationships within specific knowledge domains in clusters and regions (see also Balland et al., 2021; Davids & Frenken, 2018). Other studies have examined extra-cluster knowledge links in the innovative capability building of 'home' clusters or cities (e.g., Ascani et al., 2020; Barzotto et al., 2019; Breschi & Lenzi, 2015; Lema et al., 2018; Morrison, 2008), but their extra-local links are often from other 'host' clusters and cities within the same regions or countries. These studies are also neither grounded in the core EEG conceptual framework nor in its key concept of related variety in regional growth, such as Boschma and Iammarino (2009) and Miguelez and Moreno (2018). As observed recently by Miguelez and Moreno (2018, p. 691):

> While the external dimension [of knowledge flows] is crucial to understand regional growth, it has been generally neglected by the related variety literature. … [I]n the ongoing globalized world characterized by predominantly open economies, it is naïve to assume that agents in regions source their knowledge inputs only from their local environment.

In both the EEG and cluster literature, though, even fewer studies have examined this complex and *networked process* of knowledge production at *both* the extra-regional points of origin and the 'recipient' home regions of knowledge flows, as in the literature on global innovation networks (e.g., Ascani et al., 2020; Cooke, 2013; Parrilli et al., 2013).

This paper's GPN approach therefore offers a qualitatively different network conception and methodology by virtue of its analytical focus on *multi-actors*, *transregional/national couplings*, and *industrial production* of goods and

services in these firm-specific networks. As argued in Yeung (2018a), the logics of these production networks extend well beyond EEG's narrower foci on dyadic relationships between individuals/entrepreneurs or organizations in knowledge/innovation networks. In economic geography, the network approach has been developed for almost three decades since the early work of Camagni (1991), Cooke and Morgan (1993, 1998), Grabher (1993) and Yeung (1994, 1997), contrary to Boschma and Frenken's (2010, p. 120) claim that 'Only recently, geographers have jumped on the empirical study of the spatial dimensions of networks in innovation processes, following the vast literature on national and regional innovation systems developed in the 1990s'. As reviewed by Yeung (2000), this geographical literature on networks emerged in the 1990s in parallel with the national innovation systems literature popularized by Lundvall (1992) and Nelson (1993) and the regional innovation systems literature by Cooke (1992), Cooke et al. (1997, 1998) and Braczyk et al. (1998). The idea of *extra-local networks* beyond clusters and industrial districts, however, has emerged only after 2000 (e.g., Bathelt et al., 2004; Bunnell & Coe, 2001; Coe et al., 2004; MacKinnon et al., 2002). Bathelt et al.'s (2004) well-known work evokes the idea of 'global pipelines' to denominate this possibility of extra-local networks in knowledge flows and creation (see also Bathelt & Li, 2020; Morrison et al., 2013).

This influential metaphor of 'pipelines', nevertheless, is not only too linear and mechanical (as what pipelines should be!) but also devoid of the material specificities of what is 'transferred' and 'transformed' through these global pipelines (e.g., interfirm transactions and value-adding innovative or production processes). Just like the earlier positivist notion of networks as nothing more than a value-free organizational form or device connecting different actors within and between firms and non-firm actors, the concept of pipelines in itself does not necessarily inform the actually existing material flows and intangible processes that constitute network relationships between actors/firms on both ends. Unlike production networks and actor-specific coupling mechanisms in GPN studies, these earlier conceptions of knowledge networks and global pipelines in cluster and EEG studies focus mostly on dyadic inter-organizational knowledge and information flows and do not examine economic transactions and value transformation *within* and *between* firms in production networks that are constituted and organized beyond specific clusters and regional economies. Originating in Yeung (1994), this multi-actor/dimensional conception of intra-, inter- and extra-firm networks has been further developed in Coe and Yeung's (2015) recent theory of GPN. Taken together, the stage is now set for a more *translocal* network conception of regions and regional diversification that calls for the theorization of causal mechanisms connecting actors and firms within regions and extra-regional organizational platforms co-constitutive of the interconnected worlds of production. In particular, economic geographers in the GPN literature have developed an original concept, known as strategic coupling (Coe et al., 2004; Yeung, 2009a, 2016), to theorize such an extra-regional mechanism for regional change.

GPN: STRATEGIC COUPLING AS A CAUSAL MECHANISM FOR REALIZING RELATED DIVERSIFICATION

While EEG's conception of related variety in regional diversification tends to be endogenous in its analytical orientation, related diversification can also be achieved through extra-regional linkages that provide a new organizational platform for innovation, production and market. Consistent with my conception of regions as interconnected worlds, this section theorizes how strategic coupling with GPN can serve as a new mechanism for realizing related diversification. This search for different causal mechanisms to account for related diversification is both necessary and important, whether it is in the EEG strand or the GPN genre of the literature in regional studies. These mechanisms are the necessary building blocks of any causal theories of regional evolution (Yeung, 2019a, 2019b). This diversity of mechanisms and the search for them in causal theory building is recognized in Martin and Sunley's (2015, n. 3, p. 728) reappraisal of EEG that calls for the eschewing of 'any belief that there is a single superior all-embracing framework to be discovered'. In their bricolage-based theory of regional diversification, Boschma et al. (2017) identified four different mechanisms for regional diversification (Table 1):

- Replication: branching into related industries.
- Exaptation: creating new niches based on existing and related knowledge.
- Transplantation: developing new industries unrelated to existing knowledge base and institutions.
- Saltation (or leap): radical or breakthrough innovations that lead to completely new industries.

Among these mechanisms for regional diversification, the role of *extra-regional linkages* seems most relevant for the first three mechanisms. These linkages are less useful for understanding saltation because its radical and unpredictable nature deviates from both path and place dependence (i.e., global to global spatial logic). Unrelated breakthrough innovations may occur unexpectedly in a region without any pre-existing external linkages (e.g., innovation by a lone inventor or entrepreneur). Before it is explained further how these extra-regional linkages work in related diversification (replication and exaptation) and unrelated diversification (transplantation), it is necessary to revisit the key GPN concept of 'strategic coupling'.

In geographical political economy (Sheppard, 2011, 2016), there is an influential strand of the literature that theorizes regional development in the global economy. In what is generally known as the GPN perspective (Coe et al., 2004, 2008; Coe & Yeung, 2015, 2019; Yeung, 2009a, 2018a), geographers have conceptualized

Table 1. Mechanisms of related and unrelated variety in regional diversification.

Mechanism	Relatedness	Sector/ level	Risk	Institutional work	Key actors	Spatial logics
Replication	Related	Regime	Low	Maintenance	Regional incumbents	Localized
Exaptation	Related	Niche	Moderate	Creation (globally)	New entrants	Regional to global
Transplantation	Unrelated	Regime	Moderate	Creation (regionally)	Regime incumbents/ governments	Global to regional
Saltation	Unrelated	Niche	High	Creation (all levels)	Broad range	Global to global

Source: Adapted from Boschma et al. (2017, tab. 2, p. 39).

the spatial connections between 'globalizing' processes, as embodied in geographically dispersed production networks coordinated by global lead firms, and regional development in specific territorial formations. In particular, the *strategic coupling* of regional firms and institutions with complementary or related actors in GPN is seen as a territorially embedded mechanism that drives regional development through the processes of value creation, enhancement and capture. Despite Coe et al.'s (2004, p. 476; original emphasis) claim in GPN 1.0 that this 'explicitly comparable approach to regional development helps us appreciate better the critical mechanisms through which *some* regions gain developmental momentum whereas other regions miss the opportunity', they offered limited elaboration on what these coupling mechanisms might be. Sunley (2008, pp. 3, 15) thus critiqued that this earlier GPN approach 'suffers from the failure to offer analytical models that prioritize causes and identify causal mechanisms'. While Sunley does not provide a theory of causal mechanisms, his call for more causal analysis in network approaches in human geography is a valid one (see also Yeung, 2019a, 2019b, 2021).

In my earlier attempt (Yeung, 2009a, tab. 2) that developed further in GPN 2.0 (Coe & Yeung, 2015, tab. 5.2) and my in-depth empirical study of East Asian industrial transformation (Yeung, 2016), three such dynamic modes of strategic coupling have been explicitly theorized to explain the role of transregional mechanisms in shaping development trajectories in core, emerging and peripheral regions. As reworked further with EEG ideas in Table 2, these dynamic modes of strategic coupling operate through the following:

- Indigenous coupling in core regions premised on localized innovation and extra-regional linkages.
- Functional coupling in emerging regions via interfirm partnership and extra-regional linkages.
- Structural coupling in peripheral regions through the provision of transregional production platforms.

Core regions tend to engage in indigenous innovation and an 'inside-out' mode of spearheading and coupling with GPN by retaining substantial control and autonomy of economic activities. These regions tend to be the home base of global lead firms and/or platform leaders in brand name goods, highly specialized products (e.g., proprietary components) or services (e.g., software). Emerging regions, on the other hand, experience both inside-out and outside-in flows of capital, technology, intermediate goods and market access through strategic partnership with their lead firm customers in core regions. In peripheral regions, there are limited inside-out possibilities due to weak local capabilities and spillovers. In all these regions, the role of exogenous sources and actors in GPN is much more critical in new path development (e.g., Barratt & Ellem, 2019; Dawley, 2014; Dawley et al., 2019; Fuller & Phelps, 2018; Harris, 2020; Isaksen & Trippl, 2017; Kleibert, 2016; Pickles et al., 2016). Taken together, these territorially embedded mechanisms can enable the strategic coupling of regional actors and institutions with lead firms in GPN. Drawing on Martin and Sunley (2006), MacKinnon (2012, p. 234) linked this notion of strategic coupling with the process of path dependence and creation in EEG analysis. In particular, the evolutionary mechanisms of transplantation of new technologies or organizational forms from elsewhere outside the region and diversification into technologically related industries and the upgrading of existing industries are seen as the conceptual equivalence of new forms of strategic coupling for value creation and enhancement in the regional economy.

Yeung (2016) demonstrated in great empirical detail how this theory of strategic coupling as a new mechanism for industrial transformation can work out in specific national and regional economies (e.g., in East Asia). Suffice it to say that such a theory must start with firm-specific actions and initiatives constitutive of this dynamic network mechanism of strategic coupling that is attentive to temporality and historical emergence in specific regions. Developmental outcomes, such as industrial transformation and regional diversification, occur through particular actions of firms and regional actors that enable these firms to initiate and/or connect with each other through different GPN and to compete in the global economy. As a dynamic mechanism, strategic coupling embodies both firm-specific actions and meso-level network dynamics (e.g., competitive drivers of production networks and increasing degree of network ties). Firm initiatives are efficacious because they establish both material and intangible connections between the region and the global economy; these network connections in turn allow 'local' firms to access new markets,

Table 2. Dynamic modes of strategic coupling, global production networks and regional diversification.

Strategic coupling	Core regions: indigenous coupling	Emerging regions: functional coupling	Peripheral regions: structural coupling
Regional nature	Inside-out, autonomy and control	Either inside-out or outside-in, some degree of autonomy	Outside-in, dependency
Regional diversification			
Related variety	Replication Exaptation	Replication Exaptation	–
Unrelated variety	Saltation	–	Transplantation
Relatedness in variety and localized spillovers	High complexity in knowledge, technology, market, products, skills, and input–output linkages; highly localized spillovers	Quite complex knowledge, products, skills, and input–output linkages; some localized spillovers	Standardized products and input–output linkages; limited local spillovers
Global production networks (GPN) dynamics			
Organizational fix	Dynamic competition and new firm formation	Vertical specialization and the rise of partnership	International outsourcing and subcontracting
Technological fix	Related or new product and process technologies	Modularization and faster time to market	Enabling transport technologies and logistical capabilities
Spatial fix	Public subsidies and institutional thickness	Cost-capability efficiency	Lower production costs
Coupling initiatives			
Industrial organization	Rise of regional champions and global lead firms	Rise of strategic partners and localization of global lead firms	Export processing zones, weakly embedded TNC subsidiaries and externally owned subcontractors
States and institutions	Implicit and explicit role: industrial policies	Explicit role and policy led: upgrading of labour, technology, and infrastructure	Explicit role but limited capacity through fiscal and financial incentives
Transnational communities	Key nodes in transnational knowledge communities and high-skill migrant flows	Transactional links, business intelligence and market knowledge	Managerial competence and intermediaries
Dark sides			
Friction and tensions	Hollowing-out and uneven resource allocation	Crowding-out, lock-ins, and uneven value capture	Massive exploitation of labour and environment. Limited social and economic upgrading
Disarticulations	Crisis tendencies and worsening inequalities	Social and class conflicts and environmental damages	Radical break and path uncertainty
Regional examples	Silicon Valley, USA; Cambridge, UK; Baden-Württemberg, Germany; Seoul region, South Korea	Hsinchu–Taipei and Taichung, Taiwan; Moravskoslezsko, Czech Republic	Kunshan and Chongqing, China; Penang, Malaysia; Ciudad Juárez, Mexico

Sources: Developed based on ideas from Yeung (2009a, tab. 2, p. 338;2015, pp. 9–11), Coe and Yeung (2015, tab. 5.2, p. 184), and Boschma et al. (2017, tab. 2, p. 39).

information, resources, technology and production sites, etc., outside their home regions. These initiatives are strategic because firms choose certain courses of action but not others, all with an eye on particular economic and other objectives such as acquiring new knowledge or capabilities, increasing market share and developing

new product/service niches. Without these firm-specific initiatives – sometimes facilitated by state policies and other institutionalized forms of collective action (e.g., transnational communities and entrepreneurship discussed in Grillitsch, 2019; Hsu & Saxenian, 2000; Saxenian & Sabel, 2008; Yeung, 2009b), such globalized opportunities might not be translated into regional developmental outcomes. In other words, particularity arises from strategic firm initiatives at the local and regional level that create specific type of multiscalar ties with extra-regional lead firms and partners in different GPN. Even firms from the same industry and/or regional economy may therefore engage with *different* mechanisms to couple with extra-regional lead firms and partners in GPN.

This actor/agency-centric view of strategic coupling with GPN is relevant for the more recent EEG work focusing on the agents of path creation and diversification in regions (e.g., Elekes et al., 2019; Frangenheim et al., 2020; Grillitsch & Sotarauta, 2020; Neffke et al., 2018). It not only helps identify the sort of firms and entrepreneurs within a region that push for a particular kind of industrial transformation and regional diversification (e.g., shifting from low- to high-tech specialization within related industries), but also contributes to a better understanding of the differentiated positionality of these firms and entrepreneurs in specific GPN – be they lead firms, platform leaders, strategic partners, specialized suppliers, generic suppliers, etc. Yeung and Coe (2015) have theorized how firms can serve as different actors in GPN and engage in diverse network strategies to produce different organizational outcomes. This dual positionality of agents of change – within regions *and* beyond regions in GPN – can offer a more complete analysis of regional development pathways. A firm may be central to a peripheral or emerging region (e.g., the largest 'local' employer by revenue or employment), but simultaneously occupies a relatively weak position as an assembly supplier in a GPN coordinated and controlled by a brand name lead firm in a core region. Its strategy for capability-building and industrial diversification can be understood better if we consider it together with this global lead firm and other key agents in the same GPN. In this sense, while Grillitsch and Sotarauta (2020) have considered the relevance and interdependencies of the three types of regional agents – Schumpeterian innovators, entrepreneurial institutions and place-based leaders – the power of this 'trinity of change agency' in shaping regional development paths is likely to be constrained by, and therefore needs to be understood in relation to, their positionalities and other extra-regional agents in respective GPN.

Over time, the competitive dynamics in these coupling mechanisms may accentuate the 'dark sides' of regional diversification through replication, exaptation or transplantation depicted in Table 2. As 'GPN trouble' has been termed (Yeung, 2021) and discussed at length (Yeung, 2015, pp. 9–10; see also Ibert et al., 2019; McGrath, 2018; Phelps et al., 2018; Sheppard, 2016), these negative regional consequences of firm-specific coupling in GPN may result from the politics of production and the conflictual value dynamics in strategic coupling and/or the competing logics of global and regional imperatives. First, different negative attributes of regional development, such as uneven resource allocation, social and class conflicts, and labour/environmental exploitation, may take place even without the coupling of local firms with GPN. These tensions and frictions, however, can be substantially increased when regional institutions devote excessive attention and resources to securing firm-specific couplings in GPN. Second, regional institutions may find their developmental imperative (e.g., economic and social upgrading) in conflict with the competitive logics of global lead firms (e.g., seeking the lowest cost-efficiency). In Table 2, this is particularly likely in the transplantation mode of unrelated diversification because some of these global logics may reduce the benefits of transplantation to be captured by actors in the host region. The peripheral region may end up in a radical break of network coupling and subsequent path uncertainty when regional actors seek higher order developmental goals and/or respond to serious political and social unrests. Even in related diversification through replication or exaptation (e.g., in indigenous and functional coupling), regional economies may suffer from the hollowing out of domestic manufacturing activities and/or the crowding out of local firms that push even core or emerging regions into crisis tendencies.

With these analytical cautions in place, it is now possible to examine how regions as interconnected worlds of production in Figure 1 evolve in tandem with GPN. While the following illustrative example might seem to privilege the agency or actions of firms, it is not the same as EEG's narrower analytical focus on firms within regions as discrete units of analysis. The GPN analysis here examines *both* intra- and interfirm network relationships that constitute coupling mechanisms and underpin extra-regional linkages. As argued elsewhere (Dicken et al., 2001; Yeung, 2005; Yeung & Coe, 2015), networks do not inherently have agency and power, unlike such ontological assumptions in social network analysis. Rather, network power is exercised relationally through the initiatives of actors whose relationships constitute networks. GPN analysis must consider both firms as actors and their network relationships. Extending Figure 1, Figure 2 illustrates two regional worlds in which the mechanisms of related variety can be realized through strategic coupling with GPN, and knowledge and technology can be organized through intra- and interfirm network spillovers and externalities. For simplicity, Figure 2 depicts only one global lead firm and its strategic partner in two regional worlds of electronics production based in Silicon Valley in the United States and Hsinchu–Taipei in Taiwan. Its core purpose is to illustrate how these two regional worlds emerge and evolve *together* vis-à-vis the cumulative relationships embedded in a large number of such cross-regional network couplings and the broader competitive dynamics in global industries.

In both worlds bounded within national economies 'N' of the United States and Taiwan, there are regions 'R' and

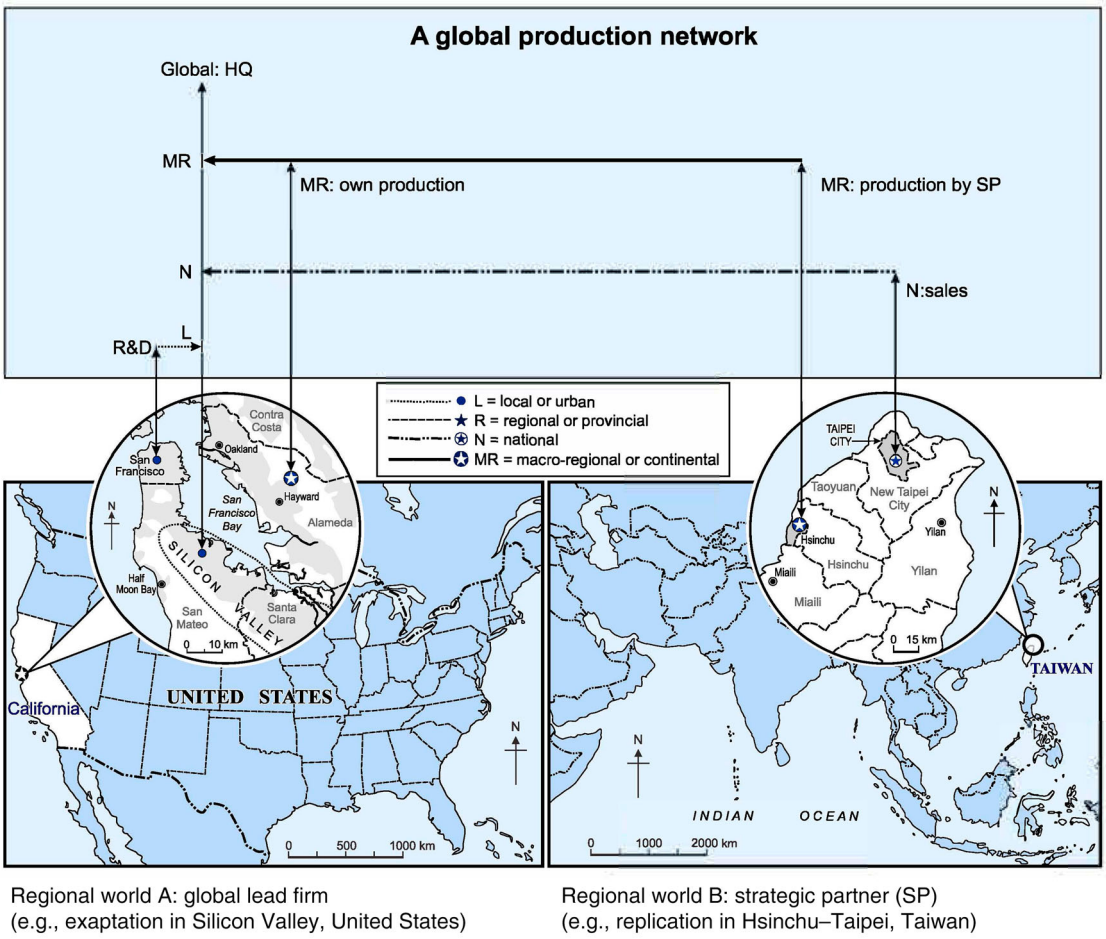

Figure 2. Regional worlds: related variety through strategic coupling with global production networks.

localities 'L' that host the location of firm-specific functions, such as the headquarters (HQ), R&D, manufacturing production and sales. These functional activities within a global lead firm and among other firms (e.g., its strategic partner) in the same production network can be organized in various territorial configurations – some are highly localized (e.g., R&D in software and process and product technologies), whilst others are more macro-regional (MR) and global in nature (e.g., headquarters functions and production activity). The organization and flow of value activity can be conceived at multiple scales, from the local to the global. Each scale, however, can be embedded within any national territorial formation, aggregating from localities to regional ensembles and from these regions to the national economy (i.e., the United States or Taiwan). This conception incorporates both organizational relationships of network actors and their territorial embeddedness. The two are necessarily mirror images of each other because irrespective of their functional scales, firms in GPN must eventually 'touch down' or locate in specific territorial ensembles – be they local, regional or national. Once this touching down occurs, value activity tends to spread across different localities and regions through their coupling with GPN, leading to different pathways of regional change (e.g., related diversification). Such value-capture mechanisms can include geographical spillovers in technological innovation, the spatial diffusion of management and marketing practices, and the spatial integration of production activity (including different material inputs, intermediate goods and modules, and services). In Gong and Hassink's (2018, p. 1349) recent co-evolutionary theoretical framework, these mechanisms of related diversification are also manifested in local incumbent firms acting as knowledge-transfer channels and building both production and non-production connections to firms and industries at higher geographical scales, for example, national or global scales (see also Bathelt & Li, 2020; Henn & Bathelt, 2018; Trippl et al., 2018; Zhu et al., 2017).

Figure 2 is now further illustrated with an empirical example of notebook computers (PCs) whose GPN span multiple regional worlds in the United States and East Asia. Within a specific locality such as Silicon Valley, a lead firm can locate its global headquarters function (e.g., Hewlett-Packard in Palo Alto, California). Another locality within the same or nearby region hosts the local R&D activity of this particular GPN, for example, in-house component design services for its manufacturing plant in Santa Clara, California, or external proprietary vendors for its microprocessors (e.g., Intel or AMD in Santa Clara) and operating systems (e.g., Microsoft in Seattle, Washington). Thinking regionally, we can also envisage the diffusion and spillovers of value activity to adjacent localities and

clusters. This lateral intra- and interfirm expansion of value activity within the same regional economy in California can serve as an important possibility for industrial upgrading and related diversification *within* regional world A (e.g., replication and exaptation in Table 2).

Over time, the Silicon Valley lead firm (i.e., Hewlett-Packard) develops horizontal interfirm relationships at the extra-regional scale with its strategic partner in design and manufacturing elsewhere in regional world B (e.g., Compal or Quanta in Taiwan), driven by key considerations such as lower cost-capability ratios, expanding market imperative, and financial and risk mitigation theorized fully in GPN 2.0 (Coe & Yeung, 2015; Yeung & Coe, 2015). In this *strategic partnership* relationship – known as functional coupling in Table 2 – Hewlett-Packard's strategic partner starts to produce Hewlett-Packard notebook PCs in a locality in Taiwan (e.g., Hsinchu or Taipei) for sales within Taiwan or nearby markets in the Asia-Pacific (e.g., Japan and China). We begin to witness an interregional/continental integration of value activity associated with the horizontal interfirm expansion of Hewlett-Packard's production network in notebook PCs. Production activity within this network is located in the high-growth regions of national economies in two contrasting continents – one performed by the lead firm's own manufacturing facility (e.g., in California) and another by its strategic partners (e.g., in Taiwan's Hsinchu or Taipei). There is no FDI by either the global lead firm (Hewlett-Packard) in Taiwan or its strategic partners (Compal or Quanta) in Silicon Valley. Instead, extra-regional linkages are developed through functional coupling relationships that do not entail direct equity investment, unlike EEG's focus on TNCs and their region-specific subsidiary operations (e.g., Crescenzi & Iammarino, 2017; Elekes et al., 2019; MacKinnon, 2012; Zhu et al., 2017). Both regional economies are drawn into an intricate set of competitive and cooperative relations – competitive between these in-house and external manufacturing plants and cooperative between the lead firm Hewlett-Packard and its strategic partners (e.g., Taiwan's Compal or Quanta). What was previously 'distant' and self-contained regional worlds of electronics production are now interconnected or coupled through horizontal interfirm relationships specific to Hewlett-Packard and its 'global' production network spanning Silicon Valley and Hsinchu–Taipei (for more detailed case studies of notebook PCs, see Yeung, 2016, 2022; for a similar case study of the global diamond knowledge network spanning Belgium's Antwerp and India's Surat, see also Henn & Bathelt, 2018).

Revisiting Boschma et al.'s (2017) theory of regional diversification in Table 1, related diversification has taken place in both regions through their strategic couplings in GPN – exaptation in Silicon Valley and replication in Hsinchu–Taipei. As illustrated further in Table 2, Silicon Valley has benefitted from a mode of indigenous coupling and its related diversification has taken place through *exaptation* or new niche development when Hewlett-Packard and other system houses moved into higher value functions (e.g., software and enterprise services) and niche products (e.g., mission-critical servers and advanced medical equipment) through vertical specialization. This form of related diversification requires high complexity in knowledge, technology, market, products and skills. New firms in software (e.g., Google in 1998) and chip design (e.g., Nvidia in 1999) have also emerged in Silicon Valley to create new niches in related industries (e.g., digital platforms, gaming and entertainment systems, and advanced automotive) and to further related diversification through exaptation.

Meanwhile, Taiwan's Hsinchu–Taipei region has experienced related diversification through *replication* when its domestic manufacturers of previously calculators and PC peripherals went into related industries by engaging in the original design manufacturing (ODM) of notebook PCs through a mode of functional coupling. As discussed in depth by Yeung (2016, ch.4), this coupling mechanism for related diversification demands from these ODM firms quite complex product and technology knowledge (i.e., moving from calculators to notebook PCs) and input–output linkages (e.g., availability of localized suppliers of large thin-film transistor-liquid crystal display (TFT-LCD) displays and more efficient power systems). Without understand this extra-regional coupling relationship between Hewlett-Packard in Silicon Valley and Compal/Quanta in Hsinchu–Taipei through their ODM-based interfirm production network, it is not possible to comprehend fully the dynamic path transformation through related diversification in both core and emerging regions. Over time, these Taiwanese ODM firms have relocated their notebook PC assembly work to China's Kunshan and Shanghai (eastern region) and, later, Chengdu and Chongqing (western region), leaving their home region (Hsinchu–Taipei) to engage in further related diversification through *replication* (e.g., R&D in notebook PCs) and *exaptation* (e.g., the development of most advanced semiconductor foundry manufacturing). These latecomer regions in China also experience a structural mode of strategic coupling in GPN and realize regional diversification through the *transplantation* of new labour-intensive assembly platforms established by these ODM firms from Taiwan, in consultation with their lead firm customers in Silicon Valley (Hewlett-Packard and Apple) and elsewhere in the United States (e.g., Dell in Austin, Texas), Taiwan (Acer and Asus) and China (Lenovo).

In reality, such interconnections and integration of different regional worlds of electronics production are far more complex than depicted in Figure 2 (Yeung, 2022).

First, the same lead firm, Hewlett-Packard, can have multiple network partners in Taiwan and elsewhere in East Asia even in the same or related product category (e.g., its notebook PCs made by Taiwan's Quanta, Compal or Inventec, and its desktop PCs by Taiwan's Foxconn in China). Its design and engineering interactions with platform leaders in PCs, such as Microsoft (operating systems and software) and Intel and AMD (microprocessors), are likely to be located in its home country (the United States). The location of its corporate decision-making centres also varies according to the global mandates of each product, for example, servers and PCs in the United

States, but printers and peripherals in Singapore. All these complicate the simple two-regional world map in Figure 2.

Second, the coupling dynamics in related diversification can be found in two regions within the *same* national economy. In China, for example, the relocation of labour-intensive notebook PCs assembly work from coastal localities (e.g., Kunshan–Shanghai and Guangdong) to inland regions (e.g., Chongqing and Chengdu in Sichuan province) in the early 2010s represents a significant challenge to relatively more developed coastal regions in Shenzhen, Guangdong, Fujian and Zhejiang (Gao et al., 2017, 2019; Liu, 2017, 2020; Yang, 2017). These latecomer regions seem to benefit from knowledge spillovers and technological learning through their couplings in different GPN.

Third, these interregional connections are not unique to developing countries. Intense interregional competition has also driven major technological innovation and employment shifts within and between regional economies in North America and Western Europe (Storper, 2018). In the United States, for example, different regions and states compete against each other for high value-added jobs and activities embedded in diverse GPN (e.g., Silicon Valley, Research Triangle and Route 128) (Block & Keller, 2011; Mazzucato, 2013; O'Mara, 2019; Saxenian, 1994). At the same time, lead firms in these respective states of California, North Carolina and Massachusetts face severe competitive pressures from other lead firms and their production networks in Western Europe (e.g., the UK and Germany) and East Asia (e.g., Japan, South Korea and China). This juxtaposition of intra-national regional competition within the United States and international competition among lead firms from the United States, Western Europe and East Asia represents perhaps the most intriguing geographical complexity of GPN that remains underexplored in the regional diversification literature.

CONCLUSIONS AND FUTURE RESEARCH AGENDA

Regional studies and *Regional Studies* have made great strides since the Fordism/post-Fordism debate three decades ago. This paper has made an explicit attempt to integrate two related but mostly independent strands of the literature in regional studies since the early 2000s: related variety in EEG and strategic coupling in GPN research. It has been argued here that the theory of regional diversification is incomplete without a careful consideration of the causal mechanisms through which regional firms venture into related or new industries through their strategic coupling with GPN. While the existing knowledge base within the region matters to related diversification through replication and exaptation, such a 'container' view of regions is rather inward-looking in the interconnected worlds of production. Taking a more porous and relational view of such regional worlds of interconnections, it has been postulated here that regional diversification can be realized through the involvement of regional actors in emerging GPN. This causal mechanism of strategic coupling can bring about related diversification in the home regions of global lead firms and, to a certain extent, those regions of their strategic partners. Related diversification through strategic coupling can take place via different component mechanisms, such as replication and exaptation, when lead firms in home regions build on their existing knowledge base to branch into related products (replication) and/or new niches (exaptation). The capacity of these lead firms to do so depends on their strategic partners in GPN that possess the necessary firm-specific capabilities to take care of the design, manufacturing, logistics and fulfilment needs of these lead firm customers. These networks partners and their home regions can also achieve diversification through similar component mechanisms for related variety (i.e., replication and exaptation) or new mechanisms for unrelated variety, such as transplantation.

The above conceptual synthesis is clearly preliminary and much more theoretical and empirical work is required to specify better the dynamics of regional transformation in an interdependent world of GPN. In terms of theoretical agenda, the search for a more *integrative theory* remains quite elusive in both strands of the literature. While GPN 2.0 has developed a causal theory integrating network organization and firm-level strategies to account for regional development outcomes (Coe & Yeung, 2015, 2019; Yeung & Coe, 2015), the theory of regional diversification in EEG (e.g., Boschma et al., 2017) has identified the different *types* of diversification mechanisms rather than the industrial and organizational dynamics underpinning such a typology. There is therefore much more scope for further theory development that specifies the causal powers driving such mechanisms for regional diversification. As argued throughout this paper, such a renewed effort in theory development needs to eschew a 'container' view of regions so that it can account for *both* intra- and extra-regional dynamics in regional evolution and capability development. This call does not entail the end of theorizing region-specific assets and capabilities – they are important and will continue to serve as the 'holy trinity' of regional growth. Rather, our analytical optic needs to 'open up' the region and its 'trinity of change agency' described by Grillitsch and Sotarauta (2020), and account for all its internal/place-based dynamics and its interconnected activities with other regional worlds of production (see also Bathelt & Li, 2020; Gong & Hassink, 2018; Hassink et al., 2019; Henn & Bathelt, 2018; Pickles et al., 2016).

Moreover, the theory of regional diversification needs a more robust conception of the key *units of analysis*. The existing EEG studies of regional diversification have measured a wide range of parameters in order to examine the evolution of regional pathways. These measures include individuals, patents, products, plants/establishments, firms, industries, institutions, associations, etc. This rather diverse set of units of analysis deployed in the existing studies of regional diversification often makes it hard to define their comparability. We do not know for sure what regional diversification really means if the units of analysis are far too disparate (e.g., patents in technological classes versus

new products in related industries). Surely patent classes may eventually translate into new and innovative products, but the value creation and capture of these new products might not take place in the same regions that own such patent classes. Equally and as argued by Kogler (2017, p. 367), just because two related products are co-located in the same region does not mean their producers are directly connected and exchange expertise. These intra-firm (if both products by different plants of the same firm) or interfirm relationships need to be explicitly identified. My own preference, therefore, is to privilege *networks* as the primary unit of analysis in the study of regional diversification (see also Balland, 2012; Balland et al., 2013; Grillitsch, 2019; Huggins & Thompson, 2014; Iammarino & McCann, 2018). These networks include *intra*-firm relationships within multi-divisional and multi-locational firms (e.g., TNCs); *interfirm* relationships among lead firms, strategic partners and key suppliers; and *extra*-firm relationships between firms and non-firm actors, such as regional institutions, labour organizations, and business and industry associations.

Meanwhile, there is much for GPN studies to learn from the EEG literature. Primarily, GPN studies have been generally weaker in analysing technological shifts and innovative capabilities that remain the core tenet of EEG. Though many GPN and GVC studies have examined industrial upgrading in terms of changing value chain functions and labour skills in the *host* regions (for reviews, see Coe & Yeung, 2019; Kano et al., 2020; Ponte et al., 2019), very few have investigated the innovative activities of global lead firms in their *home* regions and their complex interrelationships with technological upgrading and knowledge accumulation in the host regions of their international partners and suppliers. If EEG studies can be (mis)characterized as mostly studying rich and innovative regions, then GPN/GVC studies seem to focus primarily on poor and laggard regions in the Global South! I believe strongly that GPN/GVC studies stand to gain by paying much more attention to related diversification in highly industrialized regions (e.g., 'smart regions' in Europe and the United States) because it matters much for understanding technological change in developing country regions that are coupled with lead firms from these advanced regions well studied by EEG scholars.

Second, most GPN/GVC studies tend to be framed as cross-sectional research of governance structures and network embeddedness rather than as evolutionary analyses of network dynamics and regional change (for exceptions, see Barratt & Ellem, 2019; Dawley et al., 2019; Gao et al., 2017; Horner, 2014; Yeung, 2016). As argued by Coe and Yeung (2015, p. 58) in GPN 2.0, 'The governance of GPN cannot simply be assigned solely to lead firms in a static and hierarchical manner, because of the often contested and evolutionary relationships between lead firms and other actors in inter- and extra-firm settings'. To overcome the sort of 'GPN trouble' due to our missing of the crucial question 'in what sense a GPN problem?' (Yeung, 2021), GPN studies can learn much from EEG's well-developed evolutionary thinking and dynamic conceptions to understand better evolutionary dynamics in the global space-economy and their causal consequences for regional development.

Finally, most GPN studies remain fairly qualitative and case study based, partly a result of the enormous methodological task of unravelling the complex and multiscalar nature of GPN in many industries. But there is no inherent reason why more quantitative analysis in the genre of EEG studies cannot be implemented in GPN research to capture broader production network and regional dynamics (Galanis & Kumar, 2020; G. Yeung, 2016). While EEG studies tend to favour R&D, patent and trade data, GPN studies can learn to handle better such data sets and develop new empirical insights into the innovative capabilities of key actors in GPN.

Lastly, the conceptual questions of *value* creation, enhancement and capture remain crucial in the theoretical agenda of GPN studies and cognate social sciences (Coe & Yeung, 2019; Kano et al., 2020; Neilson et al., 2014). But these questions seem to be less often raised in the existing EEG studies of regional diversification. As reflected critically in Kogler's (2017, p. 366) commentary on Boschma (2017), this gap is most noticeable in EEG because of 'the failure to explain how relatedness and resulting diversification processes are connected to economic progress and productivity gains, and how this potentially translates into an overall increase in wealth and prosperity'. Indeed, the primary concern of most regional diversification studies is often about the *kind* of regional capabilities that enable such diversification trajectories and whether such diversification is related or unrelated to the existing industries and/or regional capabilities (Boschma, 2017; Content & Frenken, 2016; Whittle & Kogler, 2020). Few studies have examined the agents of such structural change in regions (e.g., Elekes et al., 2019; Frangenheim et al., 2020; Grillitsch & Sotarauta, 2020; Neffke et al., 2018). Even fewer questions are raised about *who* exactly captures value from regional diversification and *why* such diversification might be good for the region in terms of sustaining its continual resilience and evolution. As noted recently by Hassink et al. (2019, p. 1641), the EEG literature

> only focuses attention on positive effects of relatedness between established paths. There is hardly any discussion of how several old paths located in a region may hinder each other in their development through competition over scarce assets and other forms of negative path interdependencies that operate through market or value chain linkages.

Following from this paper's core argument, future research on regional diversification should explicitly incorporate the value-capture question into its theoretical and empirical considerations. There are not only the questions of conflicts and power relations in such diversification trajectories, but also the normative concerns of what regional actors can benefit from these evolutionary changes (Ibert et al., 2019; Pike et al., 2017; Yeung, 2015, 2021). Over

time, regions may experience related diversification through strategic coupling, but its value capture may diminish such that a 'better' and more value-enhancing form of coupling might be preferred (e.g., unrelated diversification to avoid lock-ins). As argued by MacKinnon (2012), Yang (2013), Horner (2014), Coe and Yeung (2015), Yeung (2015, 2016), McGrath (2018) and Murphy (2019), these shifting coupling dynamics require regions to decouple from the existing set of GPN (e.g., low-value diversification through transplantation), with the possibility of recoupling with different and more value-capturing sets of GPN (e.g., related diversification through replication or even exaptation).

In the arena of regional policy and practice, one recent initiative in related regional diversification is the European Union's Smart Specialisation programme (Balland et al., 2019; McCann & Ortega-Argilés, 2015; OECD, 2012; Whittle & Kogler, 2020). The overall logic of such a major policy programme is clear, that is, regions should specialize 'smartly' on the basis of their *existing* place-based capabilities and knowledge base rather than diversifying into totally unrelated activities. This related variety conception is seemingly more applicable to European regions, partly because of the presence of non-market political–economic institutions in their unique 'variety' of coordinated market capitalism (Boschma & Capone, 2015). As lamented by Storper (2011, p. 342), related diversification 'is probably more adapted to "European" regions' tendency to move up quality ladders in related areas. "American style" innovation, however, has a higher proportion of more radical innovations, which are not well-explained by the related-variety concept'. In this context of regional Smart Specialisation (e.g., Yeung, 2018b), the value capture question can fundamentally disrupt its underlying comparative advantage logic. What might be 'Smart Specialisation' today for a core region or a laggard region may be highly problematic in a later time period when a region's existing specialization falls within the vicious cycles of declining value creation and capture – a phenomenon known as the 'race to the bottom' due to the reorganization of GPN in certain declining or sunset industries in which a region has 'smartly' specialized. Los et al.'s (2015) new input–output model of the world economy, covering 40 countries and 14 manufacturing product groups, shows that much of value added since 1995 has taken place *outside* the macro-region in which the country of completion (final assembly) is located (see also McKinsey Global Institute, 2019; World Bank, 2020; WTO, 2019). Within the EU, McCann and Ortega-Argilés (2015, p. 1296) observed that 'over time its regions are becoming both more interconnected within each other and also with wider global value chains, and much of this increasing interconnection also takes place via the increasing fragmentation of value chains'.

Ultimately, the existing capabilities of a region on the supply side need to be matched and coupled with the stringent demand by the changing competitive dynamics of production networks in different global industries. A more in-depth appreciation of value capture in regional specialization strategy, whether implemented through related or unrelated diversification, requires careful considerations of how production network dynamics at the global scale can complement territorial dynamics at the regional scale. Smart regions are those that have nurtured specialized niches and captured greater value in expanding GPN. This value consideration in regional specialization may lead to regional industry initiatives and policy choices that seek to attain better value-capture trajectories through different coupling possibilities in an interconnected world of GPN. Future research and policy agendas in regional studies should take into serious account such intersections between regional territorial dynamics (e.g., related diversification and Smart Specialisation) and coupling dynamics in GPN (e.g., new markets, technologies and production arrangements). As advocated here, this analytical approach integrating both the internal dynamics of regional change and the extra-regional/transnational network couplings is indeed the ultimate 'related variety' in analytical diversification vis-à-vis both the EEG and the GPN perspectives in regional studies.

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