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Co-evolutionary Policy Processes

Understanding Innovative Economies and Future Resilience

Abstract

The great debates of most fields associated with economic development rest on emergence versus intention and the interplay between the two. The “residual” of unexplained divergence between goal and outcome, in this sense, can be ascribed in part to the interplay, or co-evolution, between policies (intention) and self-organizing (emergent) development. Do public policy and economic development co-evolve in technologically innovative economies, and if so, how? This paper discusses the basic premise that the gap between economic development strategies and their poor implementation cannot simply be removed by creating better-intended strategies, tools or institutions. The analysis uses evolutionary thinking for an analysis of economic development, and ends with some postulates for future study on innovative regions and the concept of resilience.

1 Point of departure: Policy and Economic Development

Our research questions are directed at the concepts of intention and emergence of innovative industrial concentrations: Do public policy and economic development co-evolve in such economies, and if so, how? How do localized adaptation processes, institutions and intention of a policy-network drive strategic renewal of such technologically innovative economies? What we aim to do here is to investigate how policy influences or (merely) witnesses

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development, how development feeds policy, and how this plays out in technologically innovative areas. The practical and philosophical focus of this paper is the link between emergence and intention for economic development, specifically as it relates to the development of technologically innovative economies. The great debates of most fields associated with economic development rest on emergence versus intention and the interplay between the two. This paper discusses the basic premise that the gap between economic development strategies and their poor implementation cannot simply be removed by creating better intended strategies, tools or institutions. More specifically, we contemplate how evolutionary thinking, when linked to emergence, might serve empirical analysis of economic development. The “residual” of unexplained divergence between goal and outcome, in this sense, can be ascribed in part to the interplay, or co-evolution, between policies (intention) and self-organizing (emergent) development. This paper analyses how policy co-evolves, or not, with economic development in regions where technological innovation is seen as an important component of identity.

Many practitioners, and scholars too, see promotion of economic development as more or less a rational endeavor, and the typical story-line is “there were problems and/or opportunities, then we organized a strategy making process, defined a new vision for the region, and began to implement our policy, but unanticipated things happened and the outcomes were not what we envisioned”. In this kind of thinking strategy is seen, idealistically, as more or less artful design, the basic premises treating strategies as explicit, consciously and purposefully developed and made in advance and without debate. [see 1, 2, 3, 4]. Moreover, there is nothing inevitable about the path of technological innovations at a micro-level, and it requires deliberative interpretations and efforts, as many scholars have written about (more than can be simply cited here) from the standpoint of scientific and

³ Both authors would like to express their gratitude to Richard Lester of MIT for his support and comments and to colleagues within the Local Innovation Systems project for fruitful discussions.

technological history and nation building [for example, 5, 6, 7, 8, 9, 10], industrial and economic development (typically, for developing economies, from scholars such as [11, 12] and more recently [13, 14, 15, 16, 17]), or specifically on technological capabilities for development [such as 18, 19, 20, 21]. The idea of shaping economic outcomes is nicely described by the literature on functional (not directed at specific activities with the economy) versus selective interventions in industrial development, which are more directed [15, 16, 20]⁴. However, critics of the social shaping of scientific and technological innovation would argue that despite policy efforts, there is a clear momentum for broader technological impacts on society that cannot always be resisted [typically 17, 21, 22, and in the development context 23, 24 and many others] and may not always pull in the same direction as desired economic development)

Many practitioners and scholars do not appreciate the emergent nature of economic development and therefore they continue their efforts to better implement designed strategies or to design more “implementable” strategies. This approach allows no space for learning from developmental mistakes, nor does it recognize that policy is as much about action as it is about analysis. Therefore, distinguishing forms of development that are relatively spontaneous from those that have taken shape with considerable conscious policy formulation and co-ordination is an important task because it provides us with clues as to what we can direct and how, and to what extent, and under what circumstances. Clearly, both policy and localized emergent development have some interplay and adapt to each other, but this interplay is understudied as a two-way process.

We assert that in localized contexts emergence and directed development take separate forms and require more study. Throughout this paper “economies” will be used as a guide to different scales of localized, identifiable geography. Thus, nations are one type of economy,

⁴ The idea of emergence as developed in this paper is fundamentally different from the neo-liberal doctrine of free markets and/or individual rationality, but we do not explore the differences here.

but many of our examples will be drawn from city-regions, which sometimes bear policy and innovation histories that are distinct from the nations in which they are situated.⁵

A variety of definitions of innovative economies, nations or regions have been proposed, such as those in which many innovative firms have relocated, or where innovative firms already exist, or where such firms have been able to reinvent themselves. Here we assume that an “innovative economy” is one where novel goods and services are generated, and where such clear and mutually reinforcing roles exist for government, universities, firms and other actors that enable continuous adaptation to changing environment from its own standpoints. Innovative economies of this type can thus be interpreted as resilient economies, at national, regional or city-levels.⁶ We see our exercise as complementary to those who have studied the co-evolution theory, both for development, for innovation, and for policy [for example, 25], and hence we continue the efforts to provide bridges between the predominantly descriptive concerns of evolutionary theory and the prescriptive analysis of strategies at various levels [26, 27].

The cases are deliberately drawn from a disparate sample of countries -- Finland, India and the USA -- to explore how public policy at national and sub-national levels co-evolves with economic development in perceived innovative areas of the economy. We draw especially on the Finnish cases of the Local Innovation Systems project⁷ and other research on India partly funded by the Industrial Performance Centre at MIT. From successful economies, ideas and models proliferate to others, perhaps none as dominantly as Silicon Valley. We therefore use

⁵ There are clearly some differences, for example, legal frameworks within a nation are often constant, but local incentives differ between city regions. This is a topic explored elsewhere. We use “region” here to develop some insights into varied localized histories, which are often glossed over in national analyses. For technological innovation, national institutions are very important, but we also witness distinct spatial concentrations and local idiosyncrasies.

⁶ Clearly, political and social relationships in which these economic relationships are embedded may be quite different for cities versus nations but our basic observations in this paper are, in fact, strengthened by these differences since resilience (and policy) is quite varied across the settings.

⁷ This paper is based on research carried out under the auspices of the Local Innovation Systems (LIS) Project, based at the Industrial Performance Center (IPC) at MIT, and conducted in cooperation various worldwide universities. Financial support was provided by Sloan foundation and the Finnish Technology Agency (Tekes).

it as a shadow case for discussion. The discussion is largely theoretical in nature, the aim being to open some new pathways of enquiry for future studies. We highlight our conceptual discussion with the cases, but the analyses are illustrative and descriptive in nature. We do not elaborate the cases here but the discussion is based on elaborate and rigorous empirical work carried out in both Finland and India. [see 28, 29, 30, 31, 32].

2 Framing the concept of emergence

Emergence is one of the core concepts in complexity theories [e.g. 33, 34, 35] and is alluded to in theories of criticality [e.g. 36, 37, 38]. These theories view systems and organizations as “complex adaptive systems (CAS)” that co-evolve with each other and with their environment and identify points (times) at which a transition occurs while criticality has been used predominantly in the physical sciences (e.g. studying sand piles), but has some conceptual utility for development [35, 39, 40].

Complexity refers to the intricate relationships that arise from the interaction of agents that are capable in adapting in and evolving with a changing environment. Complexity provides an explanatory framework of how various agents behave; how they interact, relate and evolve with a large social ecosystem. Especially important for development is the notion that micro-agent change leads to macro system evolution, i.e. before change at a macro level can be seen, it is taking place at many micro-levels simultaneously [34, 40, 41]. This is usually the case in local development; prior to any sign of changes at the regional level many of the individuals and individual organizations may have gone through major changes that in time lead to changes also at local level; often development surprises “the developers” - sometimes the surprise is pleasant and sometimes it is less so.

Emergence refers to such qualities that are born as if from nowhere as a result of self-organizing processes and if looked at from the point of view of the “whole” it seems as if

“things simply happen” [42]. Emergent properties or qualities are by their very nature unpredictable. Emergence can be defined as an overall system behavior that comes out of the interaction of many participants and it cannot be predicted or “even envisioned” from knowledge of what each component of a system does in isolation [43, 44]. Chris Langton describes emergence in complex systems as order arising out of complex dynamical systems, in which an understanding of the interaction of ‘the whole’ and ‘the parts’ is essential. Langton states that from the interaction of the individual components -- the parts -- emerges some kind of global property, the qualities of the whole, something that was impossible to predict from what is known of the parts. The global property, emergent behavior, feeds back to influence the behavior of individuals and local interactions (figure 1) [45].

The perspective provided to us by emergence also opens up an interesting view on the selection vs. adaptation issue. Quite often it is seen that both organizations and individuals act within an overall framework of the whole, i.e. institutions, organizations, etc., and they adapt and design strategies within the whole. Emergence stresses the fact that the global structure is actually produced by local interaction and thus agents at the same time create their environment and adapt to it. The influence of individual agents is, of course, minor, but in our research, emergence (and complexity) opens up fresh insights on economic development [46]. Emergent complex systems develop organically and without any predestined goals. This does not suggest that change occurs without any general laws. The capacity of emergent complex systems to learn, experiment and grow is not, however, based on the general laws governing the behavior of the whole but general laws directing the parts [42].

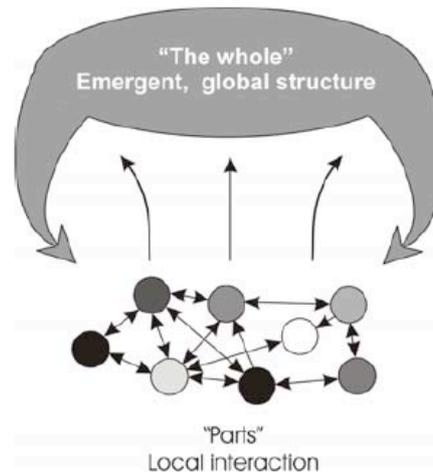


FIGURE 1. Chris Langton's view on emergence on complex systems [45]

3 An evolutionary approach to economic development

3.1 The nature of evolutionary approach - limitation of current approaches in development and management

According to Boschma [47, p. 1002] “evolutionary economic geography approach aims to understand actions of economic actors and paths of change in the context of time and space. It explains how behavior of agents is situated and conditioned, but not determined, by structures accumulated at the level of organizations and the environment.” Actions and interaction of agents adapt, transform, upgrade, or lock-in areas of development, and often the result may be unforeseeable. This kind of approach aims to understand and analyze change processes and their dynamics instead of classifying the outcomes of those processes. Many of the development studies do not recognize confusion, ignorance and chance as forces causing and directing development. In evolutionary thinking systems are seen to be consisted of people who do not always know what it is that they do not know, and therefore they do not know how they will react when they will know “it” [48, p. 569], and hence in this thinking ambiguity may be a source of innovation and development [see 49, 50].

Any system under scrutiny is partly a memory of its past [51, p. 110], and all evolution of human communities is an ongoing and imperfect learning process that is driven by the differences between expectations and experiences [49]. In evolutionary thinking, the past provides systems with a range of possible states of the present, and in a way the choice is made in interplay of agents and environment. Each of these evolutionary phases appears as a final state of the system. This, however, proves to be a misconception as evolution continues its journey, and the "final state" proves to be one chain in an endless chain of events, in a journey without a purpose [52, p. 138-139]. In this kind of complex and evolutionary understanding of reality, it is not possible for agents to fully analyze their own situation or the environment, and based on those analyses to design optimal strategy. This does not mean that agents could not direct their own actions, shape the environment and influence the course of events. They can, but they always face certain restrictions. As Axelrod [53] states, agents reconcile their strategies to those strategies that has been successful in the past, and to what and how the other agents are doing, and they also reconcile their actions with their selection environment.

The evolutionary approach stresses adaptation, and as also with most ecological studies, it tends to ignore strategies and intentions of individual actors or collectives. On the other hand, studies focusing on management, policy-making and strategies tend to ignore evolutionary forces. In management and economic development studies evolution is usually comprehended as a constantly progressing force [54], and in strategy literature evolution is often simply used to describe the development path. In recent strategy literature, however, by evolution is meant a unique development path shaped by learning, routines, practices, codifications, mistakes and competitions [55]. But by necessity, most selecting events can only be recognized as such after the fact, not as strategic events for planned future responses. We mix the "adaptation – selection" soup with a new ingredient by approaching it from economic development's point

of view. If economies, and city-regions among them, are seen as complex constantly evolving systems that are nexuses and platforms of many coevolutionary processes, then it may be possible to develop new understandings of intentionality and the role of policy-making in economic development too.

3.2 The key processes of social and economic evolution

In a social setting evolution is driven and occurring critical events are generated by four generic processes: variation, selection, retention, and the struggle over scarce resources [56, p. 21]. Any departure from routine, competencies or tradition is here seen as variation, and it is important to note that variation may be intentional or blind, in other words an actively generated alternative and solution to a problem or independently occurring and driven by environmental selection pressures. [56, p. 22].

The selection of new ideas and products is determined by the interplay between entrepreneurial competencies and certain environmental factors [57, p. 1021], and all those forces that lead to differential selection or selective elimination of certain types of variations. Selection, a second essential evolutionary process, is generated by these together. As Lambooy states, new varieties that do not fit in to the perception sets of people and into the environment are bound to disappear, or raise potentially disrupting conflicts. The success of new varieties depends on the combined effects of cultural values and institutions, and opportunities to make profits in market environment. [57, p. 1022]. Underlying the selection pressures and the search for effective variations is the scarcity of resources within organizations and between them, [56, p. 26–33] and also between and within economic regions. Struggle occurs within organizations as their members pursue individual goals, and within economies as various organizations pursue their own goals, and between economies each pursuing their own goals. We propose that the struggle over scarce resources may lead to

new varieties, to an overly heated “war” between agents and/or to new kinds of collaborative entities agents trying to generate more power into their own activities. Overall, the most important question in the light of co-evolution is what roles struggle and co-operation play in the emergence of new societal and economic directions that is in the processes of selection, variation and retention.

Retention, a third evolutionary process, involves the mechanisms for the retention of positively selected variations. Retention occurs when selected variations are preserved, duplicated, or otherwise reproduced so that the selected activities are repeated on future occasions or the selected activities appear again in future. According to Zollo and Winter [58, p. 343], also replication is needed in the evolutionary tool-kit. It refers to the process in which new selected variations are replicated elsewhere, in another organization or in another location, i.e. in those populations that may utilize them.

The concept of the selection environment directs attention to the fact that the intentional adaptation or a decision not to adopt often involves firm and inhabitant preferences, government policies and/or a wide set of market factors that range from macroeconomic conditions to the leadership of individual companies [7]. Selection environment consists of market, a set of non-market factors (especially institutions) and spatial structure [57, p. 1021]. The selection environment is not a static entity, but it is constantly changing in the interplay with actors that either consciously or unconsciously aim to change it. Actors seeking to enhance their selection environment are often involved in the process of “negotiating with, convincing or placating regulatory authorities and the legal system” [59]. The firms and innovations emerge and expand in economies where the local selection environment happens to be right, i.e. where it fits into the particulars of global selection environment of respective industry and the need of firms and other organizations. On the other hand, as we discuss later,

it is possible to influence the local selection environment so that it supports the emergence of firms and innovations.

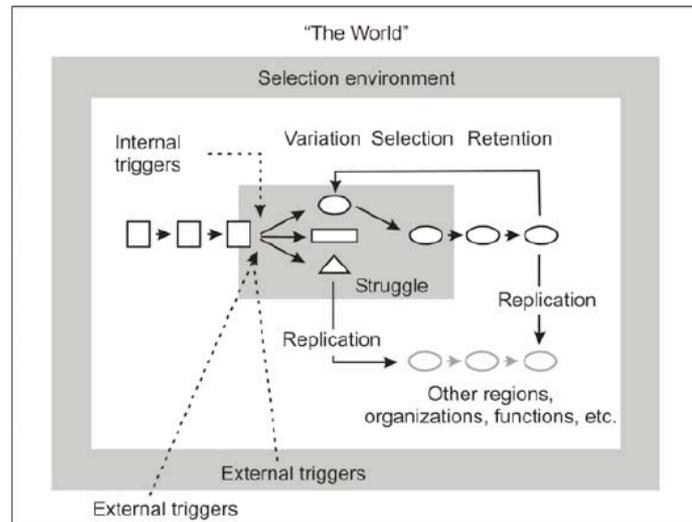


FIGURE 2. The basic conceptual frame of evolutionary approach [60]

3.3 From evolution to co-evolution

In evolutionary studies competition has been seen as an essential component, and thus evolutionary studies did not earlier pay much attention to mutualism. These studies have not appreciated the fact that many entities do not struggle over scarce resources alone but in co-operation with other agents. The concept of co-evolution aims to fill this gap [60]. As has already been noted above, the co-evolutionary view suggests that both environment and agency are important in the course of evolution. On the general level, we see co-evolution taking place if two or more agents and/or their environments influence each other's selection and/or retention processes and if a series of variations takes place in time in the respective agents. If an agent is merely responding to another agent's presence or activities by adaptation, that is not seen as co-evolution, because co-evolution consists of a series of responses and can therefore be seen as a reciprocally induced evolutionary change between two or more agents and their environment in time [60, 61, 62, 63]. Originally co-evolution

was confined to co-evolution of two populations, but it has later been used also in the analysis of co-evolution between various levels [64].

We suggest it is useful to distinguish between two processes embedded in a broader selection environment: the co-evolution of policy with technological innovation and the co-evolution of policy with economic development. Our thesis is that within innovative economies, these two co-evolutionary processes come together in resilient economies, which are able to mediate their own futures for greatest local gain. One of the most crucial issues in any co-evolutionary study is how to differentiate co-evolution from simultaneous development from the standpoint of “knowing when seeing it”. A part of this is the issue correctly raised by some authors of the fact that the “final” population of firms can be used as evidence of both adaptation and selection, and thus the metrics become difficult to use uniformly in support of one or other hypothesis [62]. This also suggests that the “survival as proof” plagues evolutionary studies in all fields.

4 Discussing the cases in the light of evolutionary approach

In discussing each case, a complication is that the mantle of success or failure is invariably tagged on to high GDP growth rates or population growth combined with numbers of start-up firms etc. There are few alternative development indicators linked to numbers of technological innovations, their type, their measurable impact, if any, number of people working towards these individual innovations, types of institutions involved in the history of the innovations, which policies preceded the innovation and which arose afterward. Furthermore, the extent to which innovation and technology policy and its outcomes are linked to the overall economic development of the average citizen would disqualify many cities worldwide from being considered as economically developing, even if they are considered to be technologically innovative. Innovation refers here to the generation of

products and processes new to the region, if not to the world [6, 65, 66]. The hypothesis is that an assumed learning process takes place which has broader implications for learning in the economy (national or more localized).

In the US case of Silicon Valley, new forms of organization emerged linking professional identities [67], but drawn from early state investments in defense R&D and local contractors and university links to the defense industry. The secret of Silicon Valley is not in any “grand design”, but in the general laws directing individuals and individual organizations. We do not suggest any particular laws here but instead raise some features that affect the behavior of many actors. One of those features is a tolerance of failure, secondly, tolerance of ‘treachery’, or the sense that entrepreneurs expect today’s collaborator to be tomorrow’s competitor, and quite likely the following day’s partner again. Also such features as reinvestment in the cluster, a ‘civic interest’ in bringing on new disruptive entrepreneurs and earning profits from ‘angel’ investments in the process; meritocracy where due acknowledgement is given to the quality of knowledge, ideas and innovation rather than status group membership, and product obsession or a mentality that seeks continuous improvement and discounts excessive working time as the means to secure permanent innovation, are worth mentioning. [see more about Silicon Valley 67, 68, 69, 70, 71, 72]

4.1 The Finnish cases – Tampere and Turku

The guiding features of Silicon Valley are different from Finland where government, often in collaboration with firms and universities, heavily aims to influence the innovation activity of “the parts”, firms and universities, by developing an ‘innovation system’ and seeking new directions by various foresight and strategy processes at every level, and thus, at every level organizations are engaged in more or less collective strategy processes where an attempt is made to anticipate global developments. Whether these operations are effective or not, they

are a sign of an accepted need for collective and proactive action to survive and prosper in the global economy. It is obvious that both in Silicon Valley and in Finland the whole and the parts are in a constant dynamic interaction. But this example highlights how differently innovation activity and economic development can be approached in two different parts of the world. The dynamics of this vary from region to region within countries too as shown below for some of Finland's innovative cities.

4.1.1 Tampere case

Tampere is a city-region consisting of seven independent municipalities and its population is approximately 300,000 (the City of Tampere itself has a population of 205,000). It is the second city-region in Finland. In Tampere, three major transformation processes have taken place. First, the textile industry declined. The recession of Tampere industry can thus be characterized as a recession of the textile industry in particular, because it was the textile industry that had been so massive and which, ultimately, lost most of the jobs. Second, of the traditional Tampere industries, only the engineering industry managed to retain its significant role. Against a background of industrial recession, it succeeded in renewing and developing technology of an increasingly high level [see 30]. However, several mergers and rearrangements of ownership took place that resulted in ownerships being shifted to international corporations that are among the largest in the world. The engineering industry also knew how to exploit the possibilities that the technical university offered in its development work. Today a dozen of the engineering companies operating in Tampere are global market leaders in narrow business segments.

Third, new and rapidly growing business sectors have also emerged; particularly in the 1990's, the information and telecommunications technology clusters have grown rapidly, in less than five years, the ICT sector more than doubled in size in Tampere. In 1996 there were a total of 170 firms, employing 5,200 people, by 2000, the ICT sector employed

approximately 10,000 people. If the media and new media sub-sectors and the related service and commerce sub-sectors are also included, employment rises to 15,500 people [Statistics Finland, 29, 73, 74].

In Tampere, development has fed into policy-making in a calculated way, while at other times policy-making has clearly been reactionary. During the industrial recession in particular, heavily influenced by the restructuring of the most important industrial sectors, policy-making appeared relatively powerless at that time. Nevertheless, it would be a crude simplification to state that Tampere has only been at the mercy of external triggers and simply adapted to changes in its selection environments.

Drawing from the data without elaboration here, the main selection environment for Tampere has been global economic change (oil crisis, collapse of Soviet Union etc.). In mechanical engineering firms emerged as important actors forced to reinterpret their core competencies, and to integrate new technology into traditional engineering domains. We might conclude that Tampere's engineering industry was not selected out for three reasons: a) there was a long tradition and very good pool of engineering capabilities in the city, i.e. a good basis for variations to emerge to be selected by the market forces, and yet retained locally, b) institutions created by the City and other major players were the foundation where new individual strategies had a possibility to grow, i.e. a good local selection environment that was responsive in times of change, and c) intense collaboration among firms, the city government and educational institutes made it possible to launch many important processes to enhance adaptation, and thus to affect also the evolutionary processes. Crises thus acted to force actors together.

In these processes Tampere University of Technology has played an important role, and the university and the firms were able to evolve together in a continuous reciprocal learning process [30]. But chronology is important. Despite the fact that economic development

policies of Tampere seemed powerless during the recession, policy-makers had already earlier (in the 50's and 60's) planted very substantial and proactive seeds for future policies. Without decisions to relocate two universities from Helsinki, it would have been more difficult to react to external changes of the 70's, and without the universities and technology centre founded in the mid 80's, it would have been more difficult to adapt to the rapidly changing selection environment and national policies in the 90's. Thus policy had a role to play in setting the stage for local institutions to respond during the crisis.

Further, the rapid emergence of the ICT-cluster was made possible because the educational and research institutions provided the institutional basis for it, Nokia decided to locate many important R&D activities to Tampere (because of education and research in the city), and the extremely rapid growth in the field both in Finland and beyond created such a tornado that both eagles and ostriches flew. Thus, after creating earlier the institutional foundation for ICT⁸ (perhaps not actually knowing how far-reaching the decisions would be), the policy-making could later only witness the rapid developments and try to manage the rapid growth in the city.

4.1.2 Turku case

Our second Finnish case, Turku, has many surface similarities with the Tampere case [see 32, 75, 76]. Turku is the third city-region in Finland, and is a contrasting case to Tampere in its response to recession and in its lack of obvious political organizing. It consists of 17 independent municipalities and has a population of approximately 285,000 (the city of Turku has a population of 175,000). Throughout history, Turku has been one of the major ports in Finland and as the first capital city of Finland has long history in academia, culture and government. The city's traditional industries have been metalworking, shipbuilding, real estate services and construction, food and pharmaceuticals and graphics and printing.

Compared with other cities in Finland like Oulu and Tampere, Turku became active in proactive local economic development policy quite late. This was partly a consequence of the local industrial structure; Turku did not face industrial crises as severe as those confronted by Tampere and Oulu for example. But in the 1990's, due to national recession and fiercer global competition that resulted in a slow decline in its economic base, attention turned to the emerging biotechnology cluster that is supported by strong university research activity in the fields of natural and medical sciences and the old pharmaceutical and diagnostic industry. Indeed, its lack of an ICT base allowed it to find a new identity in a "high-technology" arena by merging various sub-fields of R&D using biotechnology such as food, materials and pharmaceuticals. Turku is thus less "new" in terms of its emergence, and more intentional through the creation of a new identity [32, p. 3-4].

As in Tampere, the decline of traditional industries forced also policy-makers of Turku to identify new clusters and to forge new links between universities, the public sector and firms. The difference is that institutional policy-making in Turku seems to have been significantly more reactionary than in Tampere. Turku, however, did not experience such industrial crises in the 70's as Tampere did, and hence it did not have external triggers to force it to move into new policy-making regimes as rapidly. Only in the 1990s, when the economic base of Turku began to deteriorate while other major Finnish cities were rebounding from the recession, did Turku's policy-makers step in more decisively. However, it seems that rather than creating new strategies the city of Turku, in co-operation with other important actors, city identified *existing* capabilities, aimed to create new horizontal interactions between firms and universities and thus make better commercial use of old capabilities. So, it could be stated that the new local economic development strategies of Turku were actually programmed descriptions of the current state that had not yet been identified, analyzed and internalized by

⁸ Two universities and more specifically, for example, the first Chair in computing in the Nordic Countries

the policy-makers, and thus the development strategies were collective reinterpretations of the economic base of the City and roles of major organizations. Therefore, in this case development initially fed more to policies than the reverse, but because policies have not merely been plans to be implemented but have acted as arenas for collective sense-making, they have substituted for new initiatives and collaborations, and therefore policies have fed back to development both directly and indirectly.

Thus, in the case of Turku, as in Tampere, the foundation for innovation is significantly thinner than in Silicon Valley but the global pressures are significant. As in Silicon Valley new innovations emerge in Turku too, but the quantity and quality has been somewhat low compared to major biotechnology centers of the world. In Turku, universities have been slow to take on the mandate of more direct influence on regional development, pursuing instead individual technology programs and projects with some success. Technology projects funded by the National Technology Agency (Tekes) and the creation and implementation of the Centre of Expertise Program⁹ (among other relevant development policies), have sought to induce innovation by persuading, through conditioned resources, universities and firms to work together and thus to strengthen the foundation for variation and increased innovation activity. They have had mixed success [32].

In Turku, selection has acted in three major ways: (a) through national economic recession affecting all Finnish cities, (b) through global mergers and acquisitions specific to the pharmaceutical industry, so concentrated in Turku, and (c) through international changes to the science of biotechnology. The local implications of these major changes in the selection environment on local capabilities both in university departments as well as small firms, were multiple, with implications for the growth of small and medium companies and their subsequent international migration, retention of larger pharmaceutical firms in the area, and

⁹ Co-ordinated by Ministry of the Interior (see http://www.oske.net/in_english/)

regrouping of various biochemical and gene-based sub-sectors into a consolidated industrial base of new biotechnologies for a new Turku identity.

In Turku, the pressures to form new coalitions have been relatively recent dating to mid 90's, spurred more, one could argue, by external economic forces than internal political ones. The collective institutional responses of Tampere, then, appear more resilient.

4.1.3 Some concluding remarks from the Finnish cases

From a policy perspective the implications of varied local, national and international developments may seem unmanageable; the impacts of wider selection environments are not usually controllable. In our Finnish cases, the national recession of the early 90's acted in a selective manner and its effects played out differently across the country.

Reflecting more or less the national discourse and reacting to the gradual deterioration of industries in Turku, and the more pervasive industrial crisis of Tampere from 70's onwards, the development policies of both of these cities have aimed to strengthen the institutional foundation for variation and hence to create such a local selection environment that firstly helps to make sure that there is something in the city-region that can be selected by the market forces in the future too, and secondly to create an institutional setting that retains important functions, firms and people into respective cities as much as possible. In Turku and Tampere, a local perspective has thus focused on capability-building (or creating institutional foundations for new capabilities), i.e. on creating both educational, innovation and technology policies that focus on skills at individual, organizational, and network levels. This focus on enhancing skills by strengthening institutions and networks deal both with selection (selecting few clusters to be made strong enough against an international weeding out process) and with retention (keeping firms local because skills are to be developed abundant).

The economic development policies of these cities have more or less followed both global economic changes and national policy discourse, but a substantial amount of time and energy

has been spent in creating new local interpretations of development and their industries. The question is therefore not one of the control of global resources, as is sometimes suggested [Merenne-Schoumaker according to 77], but of the development of the cities' own ability to act as part of global networks and flows [29], and hence improve their adaptive capacity as a whole. In a way, in all our cases, the question is about creating a local selection environment that acts as buffer between local actors and changes in the global selection environment.

4.2 Indian cases - an unsustainable balance: seeking the third leg of the stool¹⁰

India is hugely different from Finland, with a population of over a billion, a mix of agriculture, industry and services, and with some recent visible advances in the computer services sector and in pharmaceutical and biotechnologies. The march from nationhood beginning in 1947, and the years preceding it, created a legitimizing language for science and engineering as the vehicle for modernity and statehood [for example, see 24, 78, 79]. Indeed, prestige had been associated with these disciplines since the previous century and woven into the discourse on independent India by leaders such as Nehru [see 80]. Thus, the professionalization of the disciplines, elite universities and technology as a direct means for development and personal success became embedded in society.

However, despite the deliberate wedding of the rhetoric of science and technology to the uplifting of the masses, the outcomes have been mixed and new visions are necessary (for diverse viewpoints, 81, 82, 83, 84, 85]. Most Indians still live in conditions of poverty, ill-health and lowered longevity. India remains a dichotomy of highly skilled professionals on the one hand, and illiterate citizens on the other. Understanding how policy co-evolves with development in innovative sub-economies of the country is especially useful, and we discuss two Indian cities here, Bangalore and Hyderabad.

Bangalore is a city of approximately 5 million people and is growing rapidly, with various projections estimating 10-12 million people in the next 15 years [for a critique of the planning process for high-tech identity, see 87]. Hyderabad is equally dynamic in terms of its output from computer services and biotechnologies. Both cities face considerable industrial pressures with their growth rates, with barely adequate infrastructure for slums, roads, water and electricity in Bangalore and its immediate surroundings, and with Hyderabad coping somewhat better. Both have premier national research institutes and universities, such as the Indian Institute of Science, Indian Institute of Management, Indian Space Research Organisation (Bangalore) and the Indian Institute for Chemical Technology, and Centre for Cell and Molecular Biology (Hyderabad). Both cities also have large public sector companies which were pioneers in building national capabilities in pharmaceuticals, electronics, electrical engineering and telecommunications.

Since the 1980s, the nationwide economy has gradually been liberalizing, dispensing to various degrees with strict industrial licensing and ceilings on wealth, investment and industrial scale. Most popular discourse suggests that 1991 marked the start of the opening-up of the Indian economy. Indeed, this was a Balance of Payments crisis that forced the hand of the Indian government. This intentional liberalization is remembered more than the emergent nature of opening up that occurred earlier in the 1980s. Both occurred with policy intention of varying degrees, but the 1991 event precipitated a cascade of sorts.

Indian data shows a notable difference in development from that of the US and Finland that should be made explicit: a divergence between the co-evolution of policy with innovation/technology and the co-evolution of policy with economic development, per se. There is limited evidence of more recent advances in the third balancing leg of the stool: the

¹⁰ The discussion here is drawn from India's recent developments in the IT, pharmaceutical and biotechnology sectors and from primary research in Bangalore and Hyderabad [94] and various other writings on Indian

co-evolution of technology with economic development needs. India is a case that tells us a story about a system that was overly centralized -- the aim being to control and direct “the whole” and thus also the parts -- but that ended up lacking the dynamism of the parts. Although, many national policies had the early intention of ‘science and technology for development’, local interaction in the shaping of such policies remained at a relatively low level. In recent years, India has aimed to liberalize its economy, and there already are strong signs of an economic recovery, but continues to grapple with multiple economic identities and exclusions

While external mechanisms like the new multilateral trading rules, including changes in intellectual property regimes, had a selecting influence on specific technologies and S&T institutions, a more important potential selector is basic social needs. In India, the dialogues about innovation have been more reactive to the West, and there has been less of an exploration of local markets and local needs - for example, basic infrastructure, vaccines or disaster warning and relief systems [for pharmaceutical and biotech see 31, 106].

The multiple ways in which India has developed (or stayed undeveloped) as a nation-state since the 1950s are only partially correlated to the local attempts to develop within cities. An urbanite in one of India’s leading cities would see slums and struggling infrastructure, but could immerse oneself in a relatively insulated identity of a ”technopole”. However, the inability of this technological development to find a broader economic base to serve has some serious implications for how India comes to terms with its varied identities. The technologically innovative cities try to become more like Cambridge (UK or Boston, take your pick), all the while less connected to the harsh reality of the poorer Indian, while the rest of the country observes but does not participate in this development. The co-evolution of policy with technological innovation has occurred reasonably tightly in recent years, but the

development.

co-evolution of technology with development as needed in the local context has happened rarely, if at all [for uneven development from software exports, see 86].

The saleable identity of Bangalore as a composite high-technology ‘network city’ has been recently critiqued [87, 88]. The descriptions emerging from the pharmaceutical and biotechnology sectors are one of highly-qualified and well-intentioned islands of skills, set adrift in a sea of need. In Bangalore, research institutes have been insulated until recently from commercial enterprise or local applications. More recently, local policy makers, representatives of academia, local industry and research institutes have been meeting in new hybrid organizations to develop the state more substantially. Even those companies and universities that have had some need to be more locally embedded, have not generated a city-wide call-to-arms. Part of this apathy may be that Bangalore’s innovative components have weathered less of any major crisis. It would not be an exaggeration to say that for many Indian cities, the quality of life denominator is so low indeed that any technological or industry-wide progress seems like real development and there is a danger of forgetting that for many people development is still about getting one meal a day. Technologically innovative sub-economies and their development are thus unlikely to be a substitute for intelligent broader economic development policies. Lessons of development from other parts of India are also trickling in for the IT sector [see, for example, 89, 90].

Selection in Bangalore and Hyderabad can be thought about as follows: First, while overall capability levels in biopharmaceuticals are reasonably high, the early scientific selection of quality ventures into commercial ventures through start-ups continues to be challenging. Retention of capabilities and eventual return of individuals, on the other hand, appears to be increasing in the last decade, although few studies capture the numbers. Secondly, while everyone has concentrated primarily on the impending enforcement of the new product patent regime required by multilateral trading institutions, there has been little cohesion to policies

regarding skills, the role of the universities and little open discussion on how the growth of these industries might affect other related sectors or organizations such as the IT sector, chemical industry, local hospitals, primary health clinics or small instrumentation firms. Although local policy can rarely control external selection of the type of the Soviet Union collapse on Finnish cities, there are multiple instruments still available to policy-makers and to firms to respond to outer pressures. In evolutionary models, causal certainty (which has always had the hallmarks of modeling artificiality) has to be let go, but policies cannot always be reactive to external selection, they must anticipate some of these [see also 91].

Hyderabad became synonymous nationally and internationally in relevant development circles with a single political leader in the 1990s claiming vision of high-tech transformation. The election outcomes have shown that this vision was rejected by voters in the state of Andhra Pradesh, because “development” had predominantly targeted one city to the exclusion of the broader economy. Although some uses of technology had clear broader impact—such as the use of ICTs for “e-governance” (accountability in government, access to public records, better bill payment schemes and food distribution mechanisms) and the local launch of Hepatitis B through two competing Hyderabad-based firms, the high-technology vision of development appears to have had limited relevance in a state where farmers were committing suicide in large numbers due to repeated crop failures and people living in dire poverty continued to be ignored by policy. The impact of older technologies and policies (more pesticides, more fertilizers and ironically, greater crop vulnerability) appears to be a less glamorous discussion than the IT and biotech growth, but affect development more profoundly.

Building a narrative based on utopian relevance of the IT, pharmaceutical and biotech sectors is complicated and unconvincing when historically, co-evolution of technology with rural and urban economic development has been uneven. Policy co-evolves it seems, more

tightly with technology development (perhaps easier? more glamorous? More easily defined and executed?) than with economic development. Policy co-evolves far more with sectoral specifics, but such disaggregated conceptions of development negatively influence a possible collective local narrative for the future. The cities have fared better at retention and variation for innovation, if skill sets are any indication, it remains to be seen whether this type of retention of skills/people and variation in firm-types is useful for broader city-wide problem-solving leading to economic development.¹¹ The Indian education system exacerbates this by encouraging a relatively restricted range of skill types destined for certain (technical) career paths, instead of asking whether other skills might be important, or even whether these same skills could be utilized in other ways.

Ultimately, economic development is intertwined with all things political [8, 10, 91]. The ability to generate political coalitions such as occurred in Tampere, and which does occur successfully in parts of India, will continue to define how policy co-evolves with development. In the cases of both Indian cities profiled, there has been little in the way of shared experience, institution building or inward reflection on the city's future, as has occurred in (the admittedly much smaller) Finnish cities, although size alone cannot excuse a lack of debate [for some exceptions see 79 and the non-governmental literature].

5 The future of innovative economies – Co-evolutionary policy processes

We asked whether policy and economic development co-evolve, and if so, how? We cannot claim to have deeply penetrated the surface of so complex a topic. Nevertheless, we present two general overarching observations and four specific postulates for the design of more

¹¹ New policy initiatives such as the New Millennium Indian Technology Leadership Initiative (NMITLI), have tried to give shape to nationally relevant technologies in a more cohesive manner, rewarding public and private interactive research and deliberately nurturing certain technologies and skills. Much more is needed outside the purely formal R&D institutes.

rigorous empirical research of innovative economies and for the conceptualization of ‘coevolutionary policy processes’.

First, although some forms of development emerge and cannot be intentionally directed, public policies continue to have a vital role to play. The Gerschenkronian thesis [11], that the later the development, the greater the role of the State, suggests that where innovation is of low frequency or of low magnitude, governments see as integral their participation in ensuring a higher rate of innovative activity. To expect the Government, specifically the national government, to lead the cause for development in every case is unrealistic, except as a source of vision and commitment to resources and initiator of collective conversations (all undoubtedly very important). Universities, on the other hand, which are often given an important normative role, are not necessarily pliable instruments if disconnected from other actors.

It appears rare that purely local visions for policies are constructed; models are invariably sourced from elsewhere, and at best they are interpreted locally to serve local needs. In fact only a few models seem to exist in common circulation. Rarely is there an acknowledgement that policy and development co-evolve, that various involved organizations need time to experiment and learn, and that alternative yardsticks for development might be urgently needed. In short, we need alternative ways of seeing development and ways of promoting it. This is important, since both our and other studies [92] suggest that there is a gap between the images of futures (a mixture of hopes, positive expectations and fears) at grassroots levels (communities, firms, families, individuals etc.) and those circulating in the policy field. Further studies are needed but we suggest that policies are pulled by innovation and technology lead visions, whereas especially our Indian cases suggest that there is no clear pull of vision in as society as whole. Instead we can detect the push of the past. When aiming for more balanced co-evolution of development and policy this gap is one of the main issues. The

gap between “pull of the futures” and “push of the past” opens another interesting issue. As Bell [93] states, there is a possible source of conflict in orientation between policy scientist and futurists. According to Bell futurists aim to open up the future, to make a virtue out of uncertainty of the future for empowering people to achieve futures better than the past and present. Policy scientists, on the other hand, aim to “de-futurize” the future by increasing certainty (through technology, law, development programs, etc.) [93]. Our cases suggest that the secret of resilience, well balanced co-evolution of policy and development, may be found in the “gray zone” that lies between futures pull advocated by futurists and more controlled and directed policies advocated by some policy scientists.

Our second general observation is that more metrics are required to be defined and tested, that allow us to track the co-evolution of policy with broader economic development, and also with innovation or technology development. Such metrics are relatively limited, save for the tired (and not always useful) ones of counting innovations, numbers of policy changes and types, patents (the truly limited metric) or economic growth measures. An honest appraisal must also recognize that it is extremely challenging to measure rigorously the different elements of variation, selection and retention. Furthermore, the policy and academic dialogue today does not explicitly recognize that an evolutionary process is underway, implicitly assuming that policy-making is a linear process, that all entering firms are homogenous, or that all institutions (such as universities) are the same. In terms of selection, therefore, we should hardly be surprised that some successes go through (the act of selection), and a lot fail (low variation and retention).

Next, we elaborate four specific postulates to shape future research on innovation and resilient economies. Each postulate has analytical, methodological and policy relevance and can serve as the basis of future research.

1) A measure of resilience is the extent to which the two separate forms of policy co-evolution come together. Truly resilient economies buffer themselves by strategic adaptive processes for future selection, variation and retention. More broadly, interpretative processes play a significant role in such strategic adaptation¹². Further, resilient economies show strategic adaptation, rather than pure (more passive) adaptation. Strategic adaptation refers to the sensitivity to recognize various changes and to adapt to them, but at the same time it stresses the abilities to create more or less collective perceptions of each phase of evolution, as well as its own “story of development” and its support. In addition, without interpretive processes institutions may have a freezing effect instead of a directing and guiding effect, and without reinterpretation of institutions too, economies or sub-economies may remain institutionally locked into the past development path.

This form of strategic adaptation can be seen as the policy equivalent of dynamic capabilities in evolutionary processes, originally suggest, as Teece et al. [94] for the firm. In connection with institutions and interpretative processes, the dynamic capabilities approach is promising both in terms of future research potential and as an aid to development when cities are endeavoring to gain competitive advantage in an increasingly demanding environment. Drawing on Teece et al. [94] we define capabilities as the organization’s (or policy-network’s) ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments. Dynamic capabilities in our context need to be approached from three points of view: from the point of view of firms, from the point of view of education and research institutes and from the policy-making point of view. In the best and most resilient case, the competences of these three spheres of life are in concert, support each other and together form regional dynamic capabilities.

¹² see [50] for significance of interpretative processes in firms. Our discussion here refers to broader social dialogues outside of firms and which can link wide perceptions of economic development with planning and policy. Our reference to dynamic capabilities is not to equate government with firms as institutions or to suggest that strategies are developed by regions in the same way they are developed in firms.

2) *Global selection forces a divergence between policy co-evolution with economic development and policy co-evolution with technological innovation.* Environmental selection clearly is a strong factor in the evolution of specific innovations and innovative areas. For example, in India innovative regions and attempts for technological innovation appear to be coevolving more with global economic development and less with local population needs. This is in contrast with Finland, where new economic development policies are responding to new global demands but where the Nordic welfare state systems provides the new policies with the platform that keeps them integrated to the local population. Thus, at least for now, the Finnish economic development and economic policies are not disconnected from local needs.

3) *Institutions provide the evolution of economies with a general framework, and hence institutions have a major directing effect on both innovation and policy processes¹³ and thus redesigning institutions for variety of futures is a powerful way of adapting strategically.* Institutions are major retaining forces and are important bases for new unexpected development variations to emerge. Institutions are important, because they frame the choices and actions of many agents, and therefore they play many roles in co-evolutionary processes. The policy rationale in the Finnish case cities has been to secure the institutional basis for selected clusters to have enough variation at least in some areas of economic activity, and to create networks to major knowledge pools in the world. This is needed, as we interpret the policies, to retain firms and individuals in the cities. In addition, founding new institutions proactively has actually provided later developments with soil to grow and thus it seems that planting the seeds for the future in the form of new organizational institutions and giving

¹³ see about the significance of institutions e.g. [95, 96, 97, 98]

them relatively free hands to operate¹⁴ has been one the most influential policies in our case city-regions.

4) *Technology or innovation policies or frameworks cannot be automatically equated with those for economic development.* Innovative economies require mechanism for reshaping science and engineering and reclaiming their outputs. Both relevance and prioritization [see 99] are important issues in development discourses about whether and how science and technology have a role to play to transform technologically innovative areas into economically prosperous ones. Economic development policy processes can and should be differentiated more carefully by impact on economic development and impact on technological innovations. In innovation, as in economic development, a general rubric of “technology policies” obscures, rather than reveals. Local actors often equate technology or innovation policy with local or national economic development, but in fact the link can be quite diffuse. Scientific or technological innovation itself may not be an explicit goal of technology policies, and economic development may be even more uncertainly linked. Yet, universities in particular, but various development organizations too, are being asked to take on economic development via technology and innovation policies (witness the proliferation of biotechnology policies in various Indian states, the Finnish attempts to trigger both innovation and development via technology projects and the common equation that Silicon Valley’s technological innovations explain all of its economic development).

What does all this mean for policy-making; is resilience based on the Hayekian [100, 101] notions on limited role of policy-making and on development arising from the interaction of free individuals and free markets. In this view the role of the policy-making is to promote the conditions in which spontaneous order can function to the advantage of all individuals. In a way, our analysis may appear to support this kind view by showing the potential of emergent

¹⁴ These are often managed by results and communication.

development. On the other hand, our cases show that what we need is directed emergence, and hence a new question can be posed: how to direct emergence. We have stressed the significance of collective sense-making, capability building and institutions in directing emergence, and hence our study suggests that in studying policy-making we should be more sensitive in recognizing the potential of emergent development and its possible routes to the future, and to find best possible policy-making approaches to each situation, location and time in question. Although the policy models are exhibiting a shift towards more network, partnership, and community structures, there are considerable differences in the way in which policy community interacts with development. Drawing on Richardson's [102] policy dimensions we are able to state the Finnish mode aims to anticipate development and by seeking to attain consensus influence the course of events. In India on the other hand policy is more fragmented and pluralistic aiming in selected fields to anticipate technological development and impose decisions to connect better to global technological trends. The co-evolutionary process forces us, however, to acknowledge that it may be impossible to completely shape and twist innovations and policies that do not cleanly match up with basic human needs. However, these 'unmatched' needs have to be acknowledged in society's debates. A decidedly non-dualistic and more careful approach to studying those who are *not* served by these policies, rather than those who are, may point us in the direction of wider future options. For industrializing countries, this may require more effort in understanding their inherent dilemma in shaping their future on Western readings of history, or even as a reaction against it [103, 104]. Clearly alternative visions are needed for technological change and economic development pathways.

6 Conclusions

The basic message here is that in the evolutionary approach the ‘touch’ in economic development policy-making is different from what we are used to in more direct and regulative forms of action as has pervaded most economic development discourse. As Cooke [105] points out, the theory of regulation is largely a theory of control suggesting a solution to a problem: ‘how can a competitive system of economic activity remain in place over long periods without collapsing under the strain of its internal, centrifugal forces.’ The answer today is: *it cannot* remain in place over long periods of time. We are continually forced to determine how to find our ways in the midst of the processes, and thus to determine not only what to do, but *how* and *with whom* to do it, and how to create such settings that innovation has room and proper soil to emerge.

The dilemma between emergence and strategic intents of the policy makers require capabilities to both adapt and to create futures, simultaneously, in the midst of the constantly emerging ”whole”. Therefore, from an evolutionary perspective, development policies play versatile roles. They may be ways to mould the institutional soil for futures, and legitimate forums for cooperation, and especially ways of making sense together, learning a common language and new concepts, creating shared lines of action and thought patterns, and they also are ways of reinterpreting the development and the role of various actors in it.

Overall, an underlying assumption of many discussions of development is that actors within the community who shape their broader selection environment, and in turn help to select certain elements of local innovation to improve their lot, have the ability to truly do so. This assumes a level of participation and freedom that we know not to be true even in the greatest of democracies. Our suggestion has been to track the ways in which policy co-evolves with technology advance or with broader development and to study when and how they might be related. This should contribute to a better understanding of 1) the divergences

and convergences of policy's infatuation with technology as a vehicle for all development, and 2) the conditions under which technological innovation can indeed lead to broader development. We are not suggesting that policies for technological innovation should always take on other elements of development, which would make the policies themselves perhaps too diffuse and unworkable, but rather that policies should themselves emerge from a dialogue about the local role of institutions engaged with technological innovations.

Whatever the policy approach, one of the key questions is whether it is possible to play a role in reducing the vulnerability of economies and societies to damaging external pressures, while promoting economic health and quality of life at the same time, i.e. how to create a local selection environment to buffer the effects of global developments on local agents. We have here raised an alternative view on which economic development policy-making could be based on. The relationship between policy and development is reciprocal even though it is often seen as, or hoped to be, a linear process proceeding from planning to decision to implementation to changes in development. In our view, it would be essential to see economies (nations, sub-national regions and cities) as giant feedback mechanisms, with policy-making as a means to transform information to new interpretations and action. The base of strategies is more solid when the feedback is not merely based on a few economic figures of global and national trends, but on wide conversations and a versatile range of information. To this end, our two observations and four postulates set the stage for future research on both innovation and economic development policies.

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