

## 16. Path-dependency, Externalities and Related Variety in Regional Innovation Systems

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*Evolutionary economics has become one of the most influential theories on the processes of technological change in the past few decades. Interested in the spatial aspects of said change, the newly forming approach of evolutionary economic geography explicitly relies on path-dependency. In this paper I focus on path-dependency and its key notions, such as positive feedback-loops and irreversible processes are at the heart of a dynamic economic structure and the evolutionary nature of technological change.*

*This paper<sup>1</sup> argues that the path-dependency of a regional economy is linked to the newer evolutionary approach of related variety. It attempts to connect the evolutionary process of generating variety with the existing technological regime of a regional economy. This approach may serve useful insights for policymakers, when facing the inertia of a locked-in regional economy, especially in the cases of post-socialist economies of Central and Eastern European countries.*

*We conclude that path-dependency is crucial for policymaking in a regional economy. Respecting the historic embeddedness of a local economy can help policy achieve its goal. Proximity, agglomeration economies and variety have path-dependent aspects. Related and unrelated variety affects the intensity of knowledge spillovers occurring in and between sectors, as well as the overall resilience of the regions' economy.*

*Keywords: path-dependency, externality, related variety, evolutionary economics*

### 1. Introduction

In the realm of physics, time is perceived as one of several dimensions of space-time. The laws of physics, like the equations of Newtonian mechanics, explain the interactions and movements in said space-time. One particularly interesting property of such laws, including those of classical mechanics, is that they are time-symmetric. There is no constraint in their theoretical construct, banning them from being applied “backwards” in time. The developments of thermodynamics in the 20<sup>th</sup> century, most notably the second law of thermodynamics, introduced such constraints. It states that the *entropy* of an isolated system can never decrease. In essence, this means that the “perceived order” of a system decreases

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over time, and this change cannot be reversed. The Second Law thus represent time-asymmetry and irreversibility in theoretical physics. In economics, the mainstream neoclassical theory has similar time-symmetric characteristics and a disregard for time as a “real” factor. Evolutionary economics on the other hand recognizes the importance of irreversibility, and has a time-asymmetric approach.

In recent years of economic theory, evolutionary economics has become one of the most influential concepts of innovation, following the work of Richard R. Nelson and Sydney G. Winter. *Evolutionary economic geography*, interested in the spatial aspects of technological change, explicitly builds on the idea of path-dependency, the main focus of present paper. In the theory of processes of innovation and regional economics, much like the Second Law in physics, path-dependency has an important role in understanding self-reinforcing processes and irreversibility. Through these, history and time become “real” and important factors of economic and technological change.

In this paper I am looking to answer the question *what are the implications of path-dependent technological change based on agglomeration economies and related variety to policymaking?* In the first part of my paper I highlight key aspects of the theory of path-dependency from the point of view of evolutionary economic geography. In the second part I link the notion of path-dependency to the somewhat new idea of related variety, within the theoretical context of externalities. Finally, I outline suggestions for policymakers, especially in Central and Eastern European countries, based on the relation between externalities and path-dependency.

## 2. Path-dependency

The newly forming theoretical approach of evolutionary economic geography (EEG) analyzes the spatial properties of innovation and technological change. It consists of three distinct, yet interlinked concepts. First, the theory of *complex adaptive systems* argues that economic systems are by their nature in a far-from-equilibrium state, and their emergent properties cannot be derived from the individual components of the system in question. Second, the concept of *generalized darwinism* focuses on organizational routines, somewhat stable behavioral patterns of firms. These routines are the basis of variety, selection, adaptation and the evolutionary analogy itself, as applied in evolutionary economics (Lengyel – Bajmócy 2013). In this section I focus on the third main interest of EEG, the notion of path-dependency.

According to evolutionary economics, a theory is considered evolutionary if it incorporates random elements (variation) and mechanisms ensuring systematic selection. In addition, such theories contain forces granting continuity to successful variations. Finally, the aim of an evolutionary theory is to explain the historically embedded change of a variable or variable group. A theory like this is not completely stochastic, yet not completely deterministic either (Bajmócy 2007, Hideg 2001). This last part is exceptionally important for us now for two reasons. First, it offers a different approach of innovation processes than mainstream neoclassical economics. One, that does not consider the future of an economic system fully explainable by the complete knowledge of all economic forces in effect – much like Newtonian mechanics does in physics. Second, it highlights the importance of history in understanding technological and economic change.

Acknowledging the importance of historic embeddedness is linked to a number of methodological and epistemological considerations. First, it accepts realism as a valuable trait of a theory (Orsenigo 2007). In essence, a “history-friendly” theory refers to the specific historical context, when applying general evolutionary concepts (Dopfer 2011). Second, it is a step towards methodological holism instead of reductionism. Third, it relies widely on inductive logic, in connection with the extensive use of case studies when formulating theories. Fourth, the processes that generate and reinforce change in some directions but not others become important topic of research.

Thorstein Veblen’s cumulative causality and Carl Menger’s thoughts on the formation of institutions can be considered conceptual predecessors of *path-dependency*. In recent economic theory, Paul David and Brian Arthur introduced the concept through analyzing the economic history of technological change and self-reinforcing processes. There is no consensus among economic geographers regarding the extent to which path-dependency can be utilized in economic reasoning. Some consider it one of many factors in generating the economic landscape, while others see it as a focal point in explaining differences of economic performance and spatial distribution (Martin – Sunley 2010, Lengyel – Bajmócy 2013).

According to Glasmeier (2000, p. 269–270.) “usually lying behind the notion of *path-dependence* is a series of factors that together add up to a directional bias”. He also claims that using the term without linking these factors to the specific historic background renders path-dependency “*uni-dimensional*” and empty. We argue that this approach is quite compatible with the epistemological standpoint of “history-friendly” evolutionary economics, and as such can be a useful working definition in this paper for path-dependence. In addition,

filling the general term with context-specific properties can be translated intuitively to policymaking.

Several theoretical notions have characteristics, that link them to path-dependency. Cumulative causation, self-reinforcing processes and positive feedback-loops are at the heart of strengthening the aforementioned “directional bias”. Recursive interactions of economic agents ensure this self-reinforcement. Numerous case studies track the diffusion of technologies, occasionally resulting in monopolies. In such cases, increasing returns appear for those using the dominant technology, contradicting the mainstream “law” of diminishing returns (Bajmócy 2007, Lagerholm – Malmberg 2009). And of course, externalities are intricately connected to the occurrence and prevail of path-dependency. The localized nature of knowledge and learning as well as the existence of knowledge-externalities generate regional lock-ins (Lengyel 2010). Facebook became the largest social networking site through “offering” the users network-externalities: the more were connected, the more valuable the social networks of those connected have become. In the next part of present paper, we will follow up on externalities, most notably related variety.

A relevant interpretation of path-dependency is that decisions in the past limit the range of options in the present. In a sense, history is embodied in the present (Allen 2004, Martin – Sunley 2010). Magnusson and Ottosson (2009) call this the “weak” interpretation of path-dependence. The “strong” interpretation takes it one step further, arguing that not exclusively the range of choices is limited by preceding events, but also the search processes of cognition and organizational routines. These restrictions in search patterns enhance the “directional bias” and are key aspects in lock-in situations.

The milestones of a path-dependent trajectory are generally the pre-formation phase, when several alternatives compete. It is followed by the path creation phase, when one of the alternatives emerges as dominant, gaining additional momentum. Next is path lock-in phase, in which the self-reinforcing processes significantly narrow down the range of possible choices. Finally, in the path-dissolution phase, the (economic or technological) system breaks out of lock-in (Martin – Sunley 2010). In light of economic and research practice, the most problematical part of this process is the last one. It is absolutely pivotal to understand, how can a regional economy break out of existing self-reinforcing patterns, most considerably for policymaking purposes.

The sequence of phases in this form may prove problematic for “history-friendly” application for a number of reasons. First, it is based on a clean slate. In reality, we seldom find a region or technological field, where several competitors appear “out of the blue”. In

addition, a regional lock-in might be an emergent consequence of different industries in different phases of path-dependence. Second, as Martin and Sunley (2010) pointed out, the original explanations of path-dependent trajectories, rely on some sort of equilibrium reasoning, whether it be one equilibrium or a series of “temporary equilibria”. However equilibrium reasoning is not compatible with evolutionary economics, where the economy is in a far-from-equilibrium state by its nature. Finally, the impulse breaking the lock-in was often considered an external shock, which is not necessarily the case in neo-schumpeterian reasoning.

The concept of path-dependency may prove useful in explaining current states of regional economies, spatial distribution of industries or the formation of local hubs in the global economy. Understanding the processes behind path-dependence can lead to a better grasp on the emergent phenomena of innovation and spin-offs. Its normative message is quite relevant for policymakers often trying to break out of regional lock-ins or national economic structure. In part two we will examine the new concept of related variety as a form of externality and a process of path-dependency. In the last part we will elaborate on said normative message, directing the main focus on the policymaker.

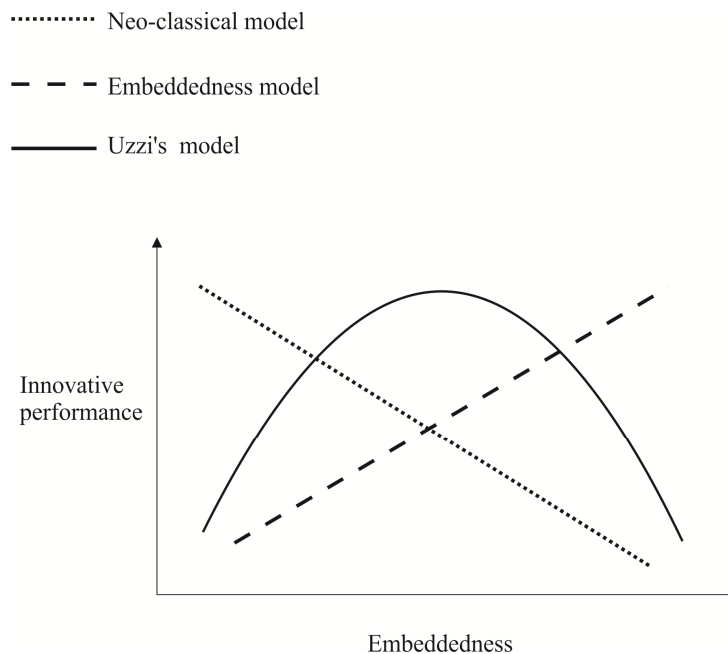
### **3. Related variety**

Variety is a central concept in evolutionary economics. The process of generating variety continuously reproduces economic structure, and is the main source a adaptability in a regional economy. In this part, we explore the relation of related and unrelated variety with the ideas of proximity and agglomeration economies, key aspects of regional economic activity and distribution. While doing this, we are looking for connections with the processes underlying path-dependency.

As mentioned above, externalities may be considered forces that – with others – add up to path-dependency. The effects of these externalities are oftentimes enhanced by geographical, cognitive or otherwise proximity, as Boschma (2005) argued. On the one hand, proximity and embeddedness facilitates knowledge transfer and the emergence of variation. On the other hand, a certain distance between firms can yield flexibility and creative solutions. In this sense, too much proximity results lock-ins, while too little generates coordination issues and isolation of a firms creative processes (Figure 1). We would like to accentuate that the self-reinforcing aspects of path-dependent processes can be applied for proximity. The more firms are in close proximity (cognitive or otherwise), the more a new

firm can benefit from moving closer. Regional concentrations of economic activities or technological regimes create this effect and are created by it.

*Figure 1* Relationship between the degree of embeddedness and the innovative performance of a firm



Source: Boschma (2005, p. 67.)

Externalities in the wake of concentration called agglomeration economies serve as an incentive for firms clustering in regions. *Localization economies* are available for firms within the same sector. In this case, sectoral knowledge spillovers occur and they are the basis for innovation processes. *Urbanization economies* arise from urban size and density, and affect all firms regardless of sector (Lengyel – Rechnitzer 2004, Heijman 2007). *Jacobs externalities* arise from the presence of a variety of sectors, and are available for the firms in the region. Jacobs externalities are considered one of the sources of regional knowledge spillovers (Frenken et al. 2007).

The connection of variety to agglomeration economies is twofold in the relevant literature. First, variety is a source of knowledge spillover in the region and is closely attached to Jacobs externalities within sectors. This can be considered *related variety* for these sectors. Second, variety can be seen as a portfolio of sectors, and in this manner it is a source of a regions stability in competitiveness (Frenken et al. 2007). Thus *unrelated variety* is linked to the adaptive capacity of the regional economy. This capability has been interpreted recently as

regional economic *resilience*, a form of “flexible stability” of the regions' economy (Tóth 2012).

From an evolutionary perspective it is important to ask the question: *variety of what?* With related variety, we focus on the variation of creative ideas, individual and organizational knowledge, and eventually innovation. This is compatible with the evolutionary economic approach of Nelson and Winter (1982), where the unit of variation – the *meme*, as called in general evolutionary theory – is the organizational routine. Unrelated variety is closer to a population level emergent property. A wide array of populational subgroups grants protective property against external shocks.

We can read the variety aspect together with proximity and agglomeration economies. If related variety is present in a region with agglomeration economies, with several firms in geographical and cognitive proximity that is, the knowledge spillovers of that region enhance innovation processes. If unrelated variety is present in the region, the cognitive proximity of firms in different sectors is less important for the systemic level resilience to arise (Asheim et al. 2011). Finally, we can link variety and cognitive proximity without the specific need for geographical proximity. In this case we find ways of understanding the unfolding technological trajectories of industries. In this sense, agglomeration economies have significance, when the cognitive space of generating related variety is overlapping the geographical space of the regional economy (Table 1).

Also the aforementioned relation between embeddedness and innovative performance may be present in the context of technology: related variety serves as a source of additional bifurcations on a trajectory, while the lack thereof yields a lock-in and need for path dissolution.

*Table 1* Agglomeration economies, proximity and variety

<b>Agglomeration economies</b>	<b>Proximity</b>	<b>Variety</b>	<b>Effect</b>	<b>Path-dependency</b>
localization economies (MAR externalities)	geographical proximity; relational proximity	relatedness without variety	knowledge spillovers within the sectors	reinforcing existing pathways
Jacobs externalities		related variety	knowledge spillovers between the sectors	widening existing pathways
urbanization economies	geographical proximity	unrelated variety	regional resilience	facilitating path-dissolution
	relational proximity	related variety	branching of technological trajectories	preventing technological lock-in

*Source:* author's own construction

What is the relation between path-dependency and related variety? From a regional economic point of view, the answer is twofold. First, the presence of related variety generates positive feedback loops through knowledge spillovers for the related and supporting industries, reinforcing the existing “directional bias”. Second, the presence of unrelated variety means a wide portfolio of unrelated industries for the region, thus generating the aforementioned “flexible stability” and a wider range of branching points for the economic and technological trajectories. However, this forecasts a possible relation between the “relatedness of variety” and the strength of path-dependency resulting in lock-in. The more related variety can be found in a region, the stronger the knowledge spillovers might be, leading to increased innovation potential and economic growth. On the other hand, this same region might become increasingly vulnerable to external shocks affecting its industries, and also this region is prone to be locked-in. Naturally, this *quasi-trade-off* requires further investigation.

In this part we explored the relationships between agglomeration economies, proximity and related variety. We found that the variety of firms and sectors in a region affects its innovativeness through knowledge spillovers, and also affects its resilience against external shocks. These spillovers occur in the form of agglomeration economies, and are closely linked to geographical and cognitive proximity. The latter has further connection with related variety in a sense that technological trajectories have additional branching points in the form of said variety. All together, these phenomena work as underlying processes of path-dependency. In the next part we explore possible applications of path-dependency and related variety for policymakers.

#### **4. Consequences for policymaking**

So far we briefly investigated path-dependency, a form of “directional bias” and a combination of underlying processes, self-reinforcing in nature. We have also seen the role of variety in generating knowledge spillovers in regional and technological context, working as one of said underlying processes. In the following paragraphs, we turn our attentions to the normative aspect of path-dependency, and articulate suggestions for policymakers on the basis of path-dependence and related variety.

In the literature of regional innovation systems it is widely accepted, that every region has unique aspects that rule out the use of uniform innovation policies (Tödtling – Trippel 2005, Vas – Bajmócy 2012). In the context of present paper it is important to reiterate this



principle, because it is based on “history-friendly” evolutionary economics. When making regional innovation policy, it is paramount to consider the institutional and economic history of the region, imprinted in the present. Adapting international best practices to local specifics and needs seems to be the way to go, “one size” most certainly does not “fit all”.

Another aspect of a policy embedded in the history of a locality is that it offers learning opportunities for the policymaker. Routines developed over time, cumulated in institutions may lead to more effective policies. Also the process of formulating policies benefits greatly from the involvement and participation of historically co-evolved institutions and entities of a local community (Bajmócy 2011). In this concept, policy is learning based, and trial-error is inherent part of the learning process. From this point of view the role of a policymaker is quite different from the usual. A “professional” policymakers distinctive ability is to coordinate between the participants, not “lead” them. Participation can help the legitimate formulation of policies, giving room for the learning of policymakers.

Irreversible processes in the wake of path-dependence increase the responsibility of a policy decision. An intervention in the present irrevocably changes the range of future options as well. This effect is most tangible in environmental and ecological issues, but it is also strongly linked to technological trajectories. Technology evaluations including potential stakeholders may alleviate some negative effects of technology spreading through self-reinforcing, path-dependent processes.

With a region on a path-dependent economic or technological trajectory, the range of options is limited by previous choices. Path-dependency is only considered an issue, when negative effects of these self-reinforcing processes outweigh the positive ones (intensive innovation, knowledge spillover, etc.). If the policy focus is inside the trajectory, it faces less uncertainty in exchange for a decreased mobility – the aforementioned range of options. If the focus is outside the trajectory, a wider range of possible policies exist, however the uncertainty surrounding these policies is much greater (Bajmócy 2007). The notion of the window of locational opportunity points out, that with radical innovations, there is no previous history narrowing down the range of locational options. However, as spatial positive feedback loops arise, this window of potential locations closes (Bajmócy 2013).

In any case, the policymaker may not only face the “weak” interpretation of path-dependency, but also the “strong” one. In this manner, policy have “directional bias” from the existing structure and trajectory of the regional economy, as well as from historically developed search routines, that narrow down the conceivable range of perception and solution of development issues.

This leads us to the next consequence. The policymaker is oftentimes part of the very socio-economic system it attempts to change. The self-reinforcing processes and feedbacks affect the policymaker and the policy alike. Through these feedbacks, the initial policy might have a delayed or altered effect. In the theoretical background of path-dependency we saw that the focal point of a path-dissolution phase is an external shock. The systemic approach of a regional innovation policy advocates considering the systemic innovation performance of a region (Edquist 2002). In such a complex system, policy can be seen as some sort of internal shock – or small historic event in evolutionary terms. In practice it is often the aim and desire of policymaking to become the origin of path-dissolution. However if a regional economy can be resilient towards an external shock, it may also be resilient towards an internal one, precisely because of the processes underlying path-dependency.

Regional policymaking strategies involving variety may focus on reinforcing related variety through attracting additional firms into the existing sectors of regional industries. It may also focus on attracting related and supporting industries to generate further opportunities for knowledge spillover. These goals may be achieved through facilitating the interactions between firms and sectors by increasing cognitive proximity when possible. On the other hand, focusing on unrelated variety may contribute to the resilience of a regional economy and the flexibility its industrial portfolio (Table 2). In any case, the economic structure and new variety generated by those within the structure mutually affect one another (Lambooy – Boschma 2001).

*Table 2* Summary of aspects and policy implications of path-dependency and variety

<b>Aspect</b>	<b>Policy implication</b>
Historical embeddedness.	“History friendly” and differentiated regional policy.
Learning manifested in routines and institutions.	Learning policymaking and trial-error.
Irreversible processes.	Technology evaluation.
Range of possibilities and uncertainty.	May increase or decrease simultaneously.
Directional bias in search routines.	Bounded rationality in problem identification and solution.
Part of the complex system.	Altered effects of policy and resilience against intervention.
Related variety.	Reinforcement of knowledge spillovers and innovative potential.
Unrelated variety.	Diversification of industrial portfolio and regional resilience.

*Source:* author’s own construction

Policymaking in path-dependent regional economies has special significance in Central and Eastern European countries like Hungary. The centralized creation of policies had catastrophic results in transition economies. In Hungary, the specialized industrial regions suffered from the dissolution of CMEA, followed by the decline of rural regions, previously specialized in agriculture. The local institutions and firms were limited in their adaptive capabilities by centralized policymaking, and several regions proved to be inadequately resilient to the external shock of entering the global market (Lengyel – Bajmócy 2013, Rechitzer 1997).

In this section we explored possible interpretations of path-dependency and related variety for regional policymaking. We found that path-dependent processes are intimately connected to the possible range of choices at the disposal of a policymaker. Different regional histories, intra-sectoral knowledge externalities and sectoral portfolios are all part of the systemic performance and possible future trajectories of a regional economy. Respecting the historic embeddedness of a local economy can help policy achieve its goal. Ignoring it may lead to unsuccessful policies, as seen in the case of Hungary and other Central and Eastern European countries.

## 5. Conclusion

We conclude by reiterating that path-dependency serves as theoretical bases for evolutionary economic geography. In this way it is connected to other aspects of the theory. Paying attention to the “real” history of a regional economy yields irreplaceable insights of the processes underlying path-dependency. Proximity, agglomeration economies and variety have path-dependent aspects. The concepts of related and unrelated variety have exciting possible applications in understanding the composition of a regional economy. They are also relevant in understanding why certain economies are more resilient than others against external shocks. This has increased significance when regions compete globally. The connections between these processes have relevant messages for policymakers intending to intervene to a regional economic system. With path-dependent processes at work, policy has extra responsibilities when making choices that affect the range of options in the future.

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