PATH DEPENDENCY, NETWORKS AND INTERMODAL TRANSPORT (WORK-IN-PROGRESS)

Jesper Aastrup, assistant professor
Department of Marketing
Copenhagen Business School
Solbjerg Plads 3
DK-2000 Frederiksberg
Denmark
Phone: +45 38152931, +45 38152100
Fax: +45 38152101
e-mail: jesper.aastrup@cbs.dk

Abstract:

This work-in-progress paper presents some initial considerations for a study aiming at analysing path dependencies in the European intermodal rail-road industry. More specifically this paper reviews some of the literature relating to path-dependency in networks and relate it to a specific interpretation of the structure-agency duality, and the attempt is to move towards an initial explication of the authors view of the phenomenon.

Based on Håkansson & Lundgren (1995), Araujo & Harrison (2000) and own work (Aastrup, 2000) the paper proposes an explanatory structure with different layers of path-dependency ultimately to be understood as a duality of structure and agency. Secondly, the paper presents two versions of path-dependency and relate these to the proposed explanatory structure. These are economics of increasing returns (the AD story) and evolutionary economics (the NW story). Finally the paper discusses different contributions to an IMP based story – and outline what is regarded as the essence of such an IMP view (biased towards the authors view, obviously) as well as the possible role of some IMP models and concepts in relation to the proposed explanatory structure.

1. Introduction

> "Processes of change are always filled with episodes and events, with temporary successes and failures, and they are enclosed by futile attempts and unexplored routes and the outcomes will neither be optimal or conclusive. Change, thus, results from a series of connected activities and events, both advancements and set-backs, and the outcome of these activities and events is not necessarily moving towards a final optimal or balanced state……How can these processes of change be understood?" (Håkansson & Lundgren, 1997).

This work-in-progress paper presents some initial considerations on path-dependencies in networks ultimately aiming for an analysis of the development of (networks in) the European intermodal rail-road industry. In a sense it explores the question above of Håkansson & Lundgren by addressing the content and power of the path-dependency metaphor. Basically, this paper is an attempt to review some of the literature relating to path dependencies and to move towards an initial explication of my own view on path dependencies in networks[1].

In my view path-dependency must be viewed in relation to a duality of structure and action, which is the aim of next section primarily based on Håkansson & Lundgren (1997) and Araujo & Harrison (2000) in relation to own work (Aastrup, 2000). Section three and four shortly addresses three 'versions' of path-dependencies – ie economics of increasing returns (the AD story), evolutionary economics (the NW story) as well as contributions to an IMP story.

2. Path-dependency understood as a structure-agency duality

Ones view on path-dependency, as I see it, heavily relates to the view on structure and action[2], whether explicit or implicit. My position on the action-structure duality[3] is based on critical realist contributions. The most fundamental assumption in critical realism, whether studying social or natural phenomena, is the existence of generative mechanisms that create events (Bhaskar, 1975)[4].

[1] The steps following this paper will be to address some first hypotheses and methodological considerations for studying path-dependencies in intermodal transport.
[2] This is also the explicit starting point for Araujo & Harrison (2000), see below.
[3] See Aastrup (2000 or 2003) for my interpretation/position, Easton (1995 or 1998) for the introduction of critical realism to the IMP forum or Archer et al (1998), Bhaskar (1975; 1979), Lawson (1997), Sayer (1992) for some of the original sources.
[4] The critical realist approach distinguishes between three domains of reality (Bhaskar, 1975). The real domain contains the generative mechanisms existing independently from their activation and independently from the observer. These mechanisms in the real domain create events, thus constituting the actual domain. Events are *"phenomena that constitute the actual states and happenings of the world"* (ibid.). These events can be regular as well as non-regular, 'one-offs' as well as patterned (Easton, 1998). This domain likewise exists independently of the observer. The empirical

Seen in this perspective path-dependencies can be seen as sequences of events in some regular or patterned manner representing what we empirically may characterise as a 'path'. However, path-dependencies is more than a patterned sequence of events. Path-dependency is also about the mechanisms generating and linking together these events (Araujo & Harrison, 2000). This link to the 'real domain', ie addressing the causal forces that create those sequences of events that we categorise as path-dependent, is to be explored via the duality between structure and action.

Based on the critical realist view, I see structure and action as two distinct spheres of reality[5]. Structures are the actors' base for acting and must therefore pre-exist any action (and thus process). As such structure represents a static sphere enabling and constraining the abilities to act. Action and practice represents an active sphere changing and reproducing structures. *"Human practices or doings are the key to it all…….the social world depends upon human activities and practices. Human beings are the motivating forces in history, and it is through human doings that society and economy are reproduced"* (Lawson, 1997). Thus, structures are reproduced and transformed by prior actions/practice[6], and structures determine actors' abilities to act, however not the act itself. A distinctive feature of the critical realist approach is the emphasis on both material and non-material aspects of social structure (Sayer, 1992; Lawson, 1994)[7]. In this respect the critical realist agrees with the social constructivist point of view that how social phenomena is perceived and ascribed

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domain is created when events are experienced by the observer. Following this distinction in three domains, the critical realist argues that the understanding of 'reality' as constituted by actual events and the empirical experiences of these is not sufficient. The *raison d'être* of critical realism is to link the generative mechanisms and the actual events in causal analysis.

[5] The critical realist position on the issue states that structure and agency should be viewed as distinct strata of reality. The critical realist argument for upholding the distinction between structure and agency is that a given structure provides the agent certain powers to act, but these powers are not necessarily activated. Consequently, structures must be regarded as something distinct from human agency, as they must exist whether or not they manifest themselves in concrete actions. Social structures, according to the critical realist position, are a necessary condition for any intentional action and, consequently, social structures must necessarily pre-exist social action. Thus, in critical realism there is logically a temporal relation between given structures and given actions (Archer, 1998; Bhaskar, 1979).

[6] It should be noted that my position is relatively speaking individualistic in the sense that structures exist, but they do not develop through 'own dynamics' or 'own logics', only through the practice of human agents.

[7] Sayer (1992) offers the, in my view, crucial distinction between intrinsically meaningful (or concept-dependent) and intrinsically meaningless objects. The nature of intrinsically meaningless objects do not depend on their meaning in society, although their possible use and functioning in society is concept-dependent. Intrinsically meaningful objects on the other hand are intrinsically dependent of the meanings ascribed to them, in the sense that what these are depends on what they mean. Positions, power, identities, relationships, beliefs are examples of non-material dimensions of social structures. What these aspects are depend on what they mean in society (Sayer, 1992). Physical behaviour and material objects, on the other hand, exist in society independent of how they are perceived and interpreted. Their use and functioning in society, though, still depend on their ascribed meanings. Examples of these material dimensions are economies of scale in production, restricted warehouse capacity and distance to customer.

meaning is fundamental aspects to understand. However, social activity is embedded in material circumstances which affect the scope and direction of action.

Hence, in this perspective path-dependency must be explained as processes in which material and non-material aspects of social structures enable and constrain actors abilities to act towards reinforcing practices (ie practices reinforcing existing structures or a change pattern empirically recognised as a 'path'). The position of Araujo & Harrison is, I take it, somewhat similar to this. *"Events are the products of mechanisms that derive from the properties of objects acting in specific spatio-temporal contexts…..current events bear the imprint of past events through the operation of social and material structures that act as the 'carriers of history' "* (Araujo & Harrison, 2000). Below two IMP contributions are addressed relating to these issues. Both address a problem of path-dependency as mainly emphasising constraining and self-reinforcing processes, and less so path-breaking and reactive processes. Because of this limitation Håkansson & Lundgren (1997) introduce a distinction between paths as structures and paths as processes, and Araujo & Harrison (2000) suggest a relational-temporal view of agency.

Paths as structures and paths as processes

Håkansson & Lundgren (1997) argue that emphasis in research on path-dependency has been the carriers of history, ie mechanisms that reinforce past achievements, preserve pre-existing structures and counteract novelties. To analyse also how to escape history, we need to address both the carriers of history as well the possibilities of path-breaking behaviour. These matters are explored based on two views of path-dependency – paths as structures and paths as processes.

Paths as structures emphasises elements existing in industrial structures – industrial structures affecting behaviour towards largely repetitive activity patterns. The carrier of history lies in pre-existing structures controlling and governing future actions. Using the prevailing IMP models of actors, resources and activities paths exist in network structures of organised activity patterns, webs of actors and resource constellations. The effect of these structures can be categorised into different degrees of stability (or degrees of path-dependency) depending on how 'locked-in' actions are, ie how constraining structures are. It is in 'crossings', ie where different overlapping structures meet, that opportunities of path-breaking behaviours exist. Actors (or companies) in this view is seen as a nexus of paths, and critical issues for actors is how to relate to and hold these traits together without

too many and too problematic conflicts and inconsistencies. Changing paths (or escaping history) originate from actors' initiatives from within existing structures, the effect of which (ie the emergence of new paths) is contingent on the mobilisation of support from other actors. *"The process must, however, be started, someone has to start to walk and others have to follow. The change must be set off and it must be reinforced and thus directed…a reasonable assumption must be that the start will be from one of the existing paths. In order for the process to end up somewhere it must also go in the direction of another path"* (ibid). The movement between paths is seen as structures with weaker path-dependencies. Thus, structural aspects largely determine the abilities of actors through initial actions and the required supporting/reinforcing reactions of others to move from one constellation of structural path-dependencies to new ones. This is, as I see it, highly consistent with the way I view the duality of structure and action.

This perspective is according to Håkansson & Lundgren (1997) quite important when addressing path-dependency. However, the perspective tend to emphasise inertia and structures as restrictions. *"New paths will very much be a product of the earlier structure of existing activities, existing resources and existing actors. The ties, links and bonds existing between these three categories give obvious 'path dependence' features carrying history, containing technological, economic, social and knowledge barriers to exploiting new avenues. Viewing paths as structures inevitably leaves us with history as a restriction. But we believe that there is more to path dependence than an inability to shake loose from the past"* (ibid). Therefore, paths as processes are explored. In this perspective unique processes of events (paths) are seen as possibilities to exploit, and the ability to take advantage of paths relate very much to actors reading/interpreting their past and present (thus incorporating an element of reflexivity in agency assumptions?). Paths are individual and are carried by actors. Paths consist of specific histories, experiences and attitudes of individual actors. In that sense paths lie in actors memory, perceptions and interpretations. The strength of a path lies in the ability and perceived meaning and importance of such things as relationships, investments etc. In that sense the past *"can mean everything or almost nothing!"* (ibid). Actors are seen each as a specific path, and crossings happen in exchange that per definition is the meeting of two paths. Such exchange situations can be insignificant for one part and alter the path of the other; they can be brief encounters given no significant meaning or they can significantly alter the actors perceived path. The paths followed by firms and the possibility to break paths lies in the ability to exploit own

and others' paths at 'crossings'. Actors can choose to follow the paths of others or they can pursue different directions and see if necessary others follow.

To sum up I see paths as structures as a model in which explanandum is the way (network)structures evolve, and explanans lies in the (network)structures mainly constraining actors abilities to break paths. It may be true that this line of thinking emphasises constraints and inertia, however, as I see it, it does not have to be limited to this. This line of thinking is necessary also when addressing the abilities of breaking paths – ie the conditions necessary for path breaking behaviour, the required initiatives as well as reactions of others, different actors different positions do this etc. Structures constrain actions, but they do not determine them. Paths as processes, on the other hand, I see as a model in which explanandum is the way individual firms evolve, and explanans relate to these firms abilities to interpret and take advantage of own as well as others' paths. The two approaches are by Håkansson & Lundgren seen as complementary – representing different levels of analysis. An assumption of larger reflexive capacity of actors, however, seem to be prevailing in paths as processes relative to paths as structures, but in my view paths as structures does not disqualify this larger reflexive capacity of actors.

A relational-temporal view of agency

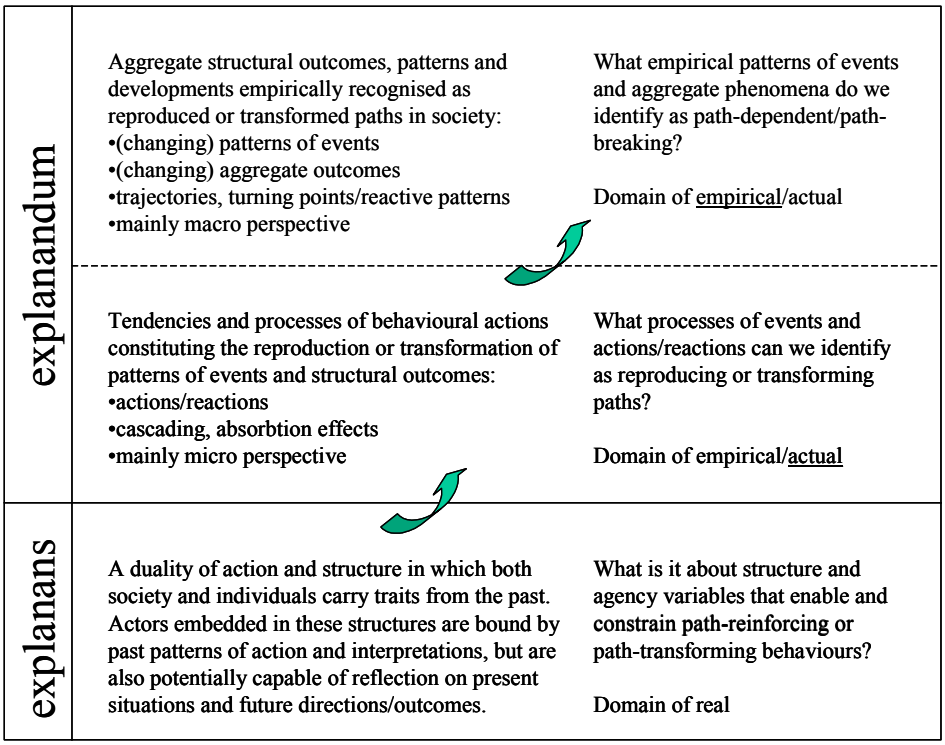
As in Håkansson & Lundgren (1997) the emphasis on self-reinforcing mechanisms in path-dependency contributions is also an issue in Araujo & Harrisson (2000). A distinction is made between self-reinforcing sequences and reactive sequences of events. Self-reinforcing sequences addresses the mechanisms that reproduce patterns of events – that keeps history on track. This is also described as trajectories of interlocked events forced into predetermined paths able to absorb only minor disruptions and variation. Reactive sequences on the other hand are processes of initial events and interlinked reactions having the potential to move the system into a new path. Temporal intersections of paths are seen as possible turning points, ie events having potential to redirect trajectories.

The path-dependency metaphor has a tendency to structural determinism over agency. *"...once locked in a particular trajectory, actors have no choice but to be carried along the paths that self-reinforcing mechanisms have shaped for them"* (Sabel & Zeitlin, in Araujo & Harrison, 2000). Based on Emirbayer & Mische (1998) the suggestion of Araujo & Harrison is a temporally oriented

view on agency allowing for strategic reflexivity of actors. Emirbayer & Mische (1998) distinguish between three constitutive elements of human agency – iteration, projectivity, and practical evaluation corresponding to actions more oriented towards past, future and present, respectively. *Iteration* refers to reactivation of past patterns of actions, routines and interpretations. *Projective* elements in action refers to the imaginative generation of actions towards futures desired or hoped for. *Practical evaluation* entails the ability of actors to make practical and normative judgements among alternative actions as they appear in situations of emerging demands, dilemmas, ambiguities etc (ibid, p 971). Incorporating these different elements and degrees of reflexivity in agency allows for addressing both self-reinforcing as well as reactive sequences of events (Araujo & Harrison, 2000).

Path-dependency, explanatory structure and levels of analysis

For now some levels and overall content in the explanatory structure can be outlined[8]. I tend to believe that it builds on both the Araujo & Harrison contribution as well as the Håkansson & Lundgren contribution (mostly paths as structures), however a relatively speaking individualistic position might be apparent.



[8] This is to be seen as an attempt to explicate some categories of elements in my view on path-dependency.

3. Views on path dependencies

The discussions above are quite abstract but the attempt of the next sections is to give more concrete content based on different theoretical views. Inspired by the terminology of Dosi (1997), I present shortly below the AD (Arthur-David) story and the NW (Nelson-Winter). Some contributions to what may be labelled the IMP story is addressed in section four.

3.1 Historical events, lock-ins and QWERTYnomics - the AD story

The AD story[9] deals with question of how economic systems develop (technology adoption and locational patterns among other things) under increasing returns. Historical cases and models of dynamic processes demonstrates that increasing returns as a condition have the effects of unpredictable, inflexible, non-ergodic and not necessarily path-efficient development of economic systems. Or in short it demonstrates how few and small initial (perhaps random) events eventually will/may lock the development into path dependent sequences of events that do not necessarily result in the optimal or the most efficient development of the system (even under strong rationality assumptions on micro level).

David (1985) defines path-dependency in the following manner: *"A path-dependent sequence of economic changes is one of which important influences upon the eventual outcome can be exerted by temporally remote events, including happenings dominated by chance elements rather than systematic forces*". The line of thinking is very explicit on the emphasis on single events as the constituents of macro patterns. In this paper two complementary elements of path dependency from these contributions are addressed – ie how processes are locked into certain paths as well as why paths are maintained[10].

[9] For the moment based on David (1985), Arthur (1994a) and Arthur et al (1994) as well as Dosi (1997), Lundgren (1995) and Håkansson & Lundgren (1997) addressing the AD story.
[10] These two issues are presented as two forms of path dependence – lock in by small historical events and path dependent transitions – in Lundgren (1995) and Håkansson & Lundgren (1997).

Lock-in by small historical events

Davids (1985) famous discussion on the emergence of QWERTY as the dominating keyboard standard is a story of how an inferior standard gained dominance over more superior ones[11]. This happened due to certain more or less random and semi rational events happening during the birth of the typewriter[12] that eventually locked the keyboard design into the QWERTY standard which most of us take as a given today.

That systems are sensitive to early random fluctuations are shown in dynamic models by Arthur (1994a) and Arthur et al (1994). Discussing a general class of models of stochastic processes (non-linear Polya processes) characterised by random events and positive feedbacks[13] it is shown that that certain patterns or structures (unpredictable) emerge heavily depending on small early events. These historical small events are defined as those events outside the knowledge of the observer (Arthur, 1994a), ie random when modelled. Properties of potential non-superiority and structural rigidity (lock-in and non-ergodicity) are characteristics of these emergent structures. *"Under increasing returns……the process becomes path-dependent. It is nonergodic – many outcomes are possible, and heterogeneities, small indivisibilities, or chance meetings become magnified by positive feedbacks to 'tip' the system into the actual outcome 'selected'*" or in short *"…it (the process) remembers its small-event history"* (Arthur, 1994a).

Path-dependence through positive feedbacks

What is it that eventually makes the process path dependent? What is it that makes the process 'remember' its small event history. A path dependent process is a process in which the probability of some event at a certain time depends on earlier events – or in economical terms the adoption choices feedback upon the incentives of the next adopters (Dosi, 1997). In path dependent processes the history affect the sequence of events through positive feedbacks, that according to Lundgren

[11] Originally the QWERTY standard was actually constructed to reduce the speed of typing due to a technical problem of type bar clashes and non-visibility of the printing point in the very early days of the typewriter.
[12] The development of the QWERTY keyboard was as mentioned aiming towards reducing the speed of writing due to an upstroke typing mechanism with non-visible printing point and a problem with type bar clashes. However, these technical problems was solved before QWERTY gained dominance. One affecting aspect might have been that QWERTY was associated with the largest manufacturer at the time which might have added some positive expectations. But the interpretation places more emphasis on the relation between the 'hardware' and 'software'. The development of fast typing techniques required that the keyboard was memorised which created a relationship between keyboard and typist. The competition between different typing systems resulted in a certain eight finger system gaining dominance, and this happened to be developed and taught using QWERTY keyboards (David, 1985; Lundgren, 1995).
[13] These processes are by Arthur (1994a) and Arthur et al (1994) discussed especially in relation to competing technologies and standards and actors' adoption of these.

(1995) function as the carriers of history. History in the AD story affect through some forces or positive feedbacks functioning in the present that does not affect the system (process) directly, but affect the choices and events that make up the development (Lundgren, 1995).

The positive feedback mechanism addressed explicitly in the work of Arthur (1994a) and Arthur et al (1994) is increasing returns to adoption in which *"returns rise only with the numbers who have chosen a technology"*[14]. Positive feedbacks however are presented in many classes and in many contributions. Arthur himself (1994b) identifies four sources of self-reinforcing mechanisms: large set-up or fixed costs, learning effects, coordination effects, and adaptive expectations. In his interpretation of QWERTY David (1985) presents the following ingredients of QWERTYnomics:

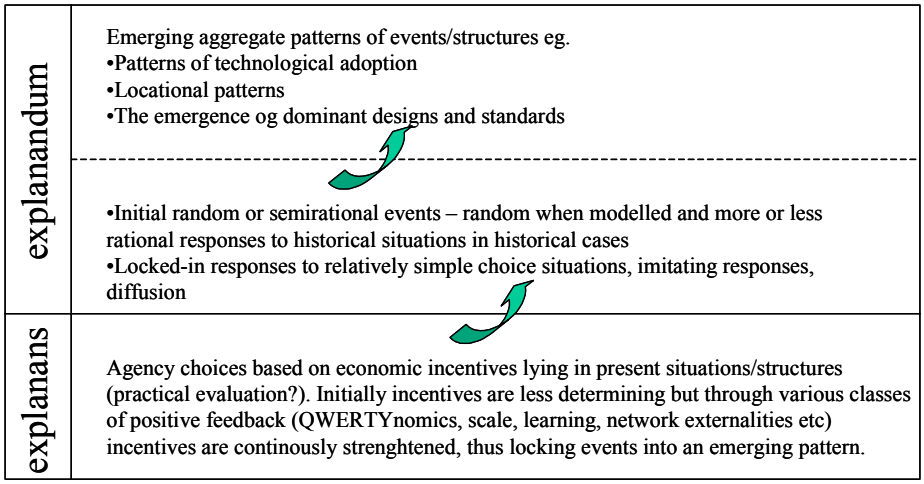
- Technical/technological interrelatedness: This covers the need for system compatibility. The value or functioning in one technical system is contingent on the value or functioning in parallel/larger systems – in the example of QWERTY the interrelatedness of 'hardware' and 'software'. This is about the contextuality of technology in the words of Lundgren (1995).
- System economies of scale: Here is mentioned increasing returns to adoption, size of compatible systems or networks, expectations as examples of system economies of scale (or more generally positive feedback mechanisms)
- Quasi-irreversibility: This relates to the (absolute) conversion costs due to learning, habits, fixed investments etc or to the relative conversion costs between interrelated systems – in the case of QWERTY the 'software' conversion costs were going up and the 'hardware' conversion costs were going down.

Complementary to (and overlapping with) these categories/classes of positive feedbacks are economies of scale in production, learning processes, network externalities, increasing returns to information and knowledge, the relation between the size of the market, division of labour and specialisation, cumulativeness of technological advances, imitation effects, routines and rules etc (Lundgren, 1995; Håkansson & Lundgren, 1997; Dosi, 1997)[15].

[14] Reference is made to Rosenbergs learning-by-using as an example on increasing returns to adoption.
[15] Positive feedback in institutional forms are also incorporated in contributions of North (1990) and David (1994) according to Araujo & Harrison (2000). Due to a limited time-scheme these are not included here – but they obviously needs to be dealt with in later versions. Positive feedbacks from industrial network as institutional forms (Lundgren, 1995) are seen as a contribution in the IMP story dealt with in later sections.

Summing up the AD story

The figure below shortly summarises the AD story.



3.2 Paradigms, search procedures, trajectories and selection - the NW story

The strength of the AD story is that it demonstrates the existence of path dependency and explains the persistency of paths in the case of positive feed backs (increasing returns to adoption, elements of QWERTYnomics). However, the limitation lies in the behavioural assumptions based on quite simple decision situations and decision rules (Dosi, 1997), and in that sense the NW story offers a richer behavioural platform. In this sense dynamics becomes not only path dependent, but also potentially behaviour dependent - also after 'lock-in'.

In the NW story[16] actors are carriers of certain technological paths, routines, behavioural rules etc, and the resulting behaviour are constantly being evaluated by some selection mechanism, typically in the form of a market. Compared to the AD story the NW story is first and foremost much richer on the micro foundation addressing how and why actors change in certain directions based on much lower commitments to rationality, while not being as adequate to address increasing-returns dynamics on more aggregate levels (Dosi, 1997).

[16] This section is mainly based on Dosi (1997), but also Dosi (1982 & 1984). This limited number of contributions in this version of the paper has resulted in this odd situation of presenting the Nelson and Winter story based solely on the work of Dosi. Dosi (1997), though, has character of being a review of evolutionary economics.

Dosi presents the main building blocks of the evolutionary theory (the NW story) as follows (ibid):

- Explanations need to address dynamics, ie how and why 'things' become or develop towards what they are. No purely functionalist explanations are accepted. Explanations further have to be explicitly microfounded in the sense that they must be consistent with actors' behaviour.
- The micro assumptions are based on bounded rationality and the actors imperfect understanding of their environments which also act as a precondition for persistent heterogeneity between actors. However actors always hold the ability to discover new techniques, new behavioural forms etc.
- These micro assumptions create variety between actors, and some collective institutional form (often a market) acts as selection mechanisms in relation to this variety based on some revealed performance.
- Resulting aggregate patterns and structures (regularities, 'trajectories', industry structures) are seen as emergent phenomena.

Technological paradigms and search heuristics – the microfoundation

The NW story abandons the idea of given and well defined innovation or adoption possibilities. Instead search, innovation and change largely follows 'technological paradigms' (Dosi, 1982 and 1984). Technological paradigms represent an outlook of the actors defining the relevant problems and patterns of search for improvements. *"We shall define a 'technological paradigm' as a 'model' and a 'pattern' of solution of selected technological problems, based on selected principles derived from natural sciences and on selected material technologies"* (Dosi, 1984). This outlook and knowledge base that the technological paradigm represent largely determines the search directions and efforts of the actors. But also the exogenous environment affect search behaviour and technological development. First of all exogenous changes in the environment can affect the search behaviour - either the direction of search (search heuristics) or the search priorities (the allocation between search heuristics). Secondly exogenous change affect technological development via the selection mechanism itself, irrespectively of its effect on micro level search behaviour (Dosi, 1997).

Emergent outcomes and selection mechanisms

The macro level in the NW story works as both explanans and explanandum. One aspect of the macro level is seen as aggregate outcome of micro behaviour and selection and another aspect is that macro phenomena act as the selection mechanism. Technological trajectories defined as *"the*

pattern of 'normal' problem solving activity …on the ground of a technological paradigm" (Dosi, 1982) can be seen as a way of describing the aggregate outcome of search and selection. Regularities and predictable patterns in industry structures and organisation can also be seen as an aggregate outcome (explanandum). However, the macro level also have an important function as explanans, as it also serves as the selection landscape which rewards or punishes revealed performance. According to Dosi (1997) the NW story view selection environments/mechanisms as exogenous or path independent, whereas the AD story tend to see the selection mechanisms as entirely endogenously, ie selection along the process based on more random performance criteria on another level. More random or unpredictable selection mechanisms work in interaction between 'hardware' and 'software' structures in the case of QWERTY - it is not, so the story goes, some collective exogenous force.

Path dependency – mechanism or outcome, micro or macro?

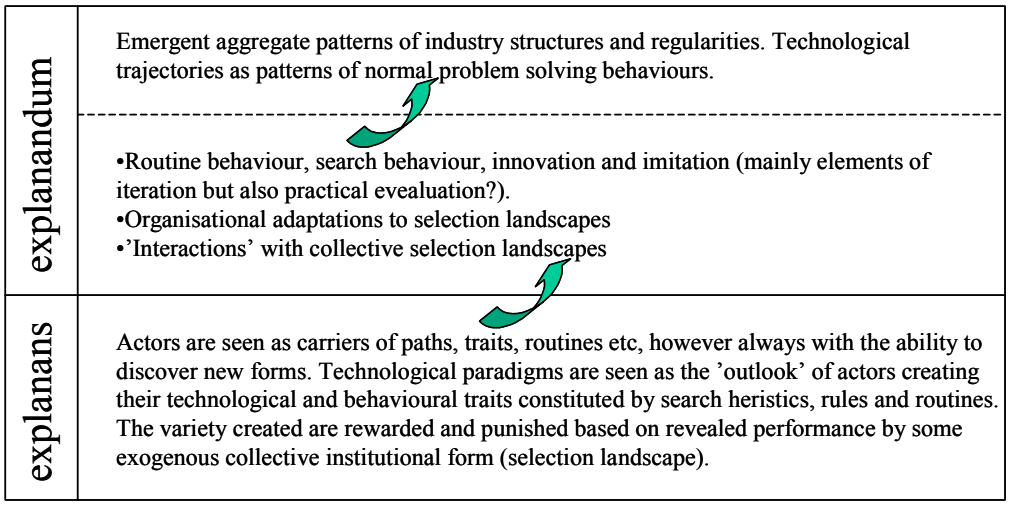
Path dependency, according to the NW story then, is the result of heterogeneous actors being carriers of different technological and behavioural traits (ie technological paradigms) interacting with some selection landscape that grant penalties or rewards. *"In the last resort, dynamics rests on some learning processes (search, innovation, imitation by individual agents), on the one hand, and some selection mechanism on the other"* (Dosi, 1997)[17]. Path dependency works on different levels in the NW story. Path dependency can be an aspect of technological learning or behavioural rules of the single actor, and it could represent a property of emergent aggregate outcomes/phenomena.

Summarising the NW story

A modest attempt to summarise the NW story is presented below[18].

[17] The main problem with the idea of selection landscapes, seen from the IMP perspective, is that it is often very difficult to separate and uphold a distinction between social entities and the environment constituting the selection mechanism (Lundgren, 1995, p 43).

[18] Please note that these few contributions that I use do not at all do justice to the richness and quantity of work in evolutionary economics. Hopefully, I have captured some of the essence of evolutionary economics and the view on path dependency.



4. Some contributions to (or from) an IMP story

This section addresses elements of or contributions to an IMP story. Many of the contributions do not explicitly address path-dependency, but more generally issues of change and stability in networks[19]. I believe though that the lines of thinking relate and contribute to path-dependency in networks. The contributions are related to my more individualistic worldview and the layers of the explanatory structure pursued. Since the importance, strength and form of path-dependencies is primarily an empirical question (Dosi, 1997), I see the different contributions from IMP as analytical tools for conceptualising different aspects of path-dependencies in empirical research.

Stability and change

A path-dependency related issue dealt with in IMP was the early recognition that change and stability co-exist or even presuppose each other. This co-existence and interdependency between change and stability occur in different dimensions of the network (Lundgren, 1992) - change in the activity structure might presuppose a stable actor structure or vice versa. Gadde, Håkansson & Öberg (1989) and Gadde & Håkansson (1992) explicitly addresses change and stability based on the activity, actor and resource model in a channel setting.

One important point made is that stability is something that has to be created. Stability does not exists as a normal condition[20]. In fact stability can be seen as a rather surprising condition (Gadde & Håkansson, 1992) when assuming that actors and social systems tend to adapt to their

[19] Parts of this section is heavily based on earlier work (Aastrup, 2000).
[20] This parallels the critical realist notion that there is no ontological asymmetry between relative continuity and relative change (Lawson, 1997).

environments. If environments are considered to be constantly in flux, why then should we view stability in networks and organisations as the normal condition? Hence, *"...mechanisms supporting stability are, therefore, as important to understand as are the mechanisms creating change"* (Gadde & Håkansson, 1992). Another explicit point is that actors in the network should be seen as important initiators of change, not as passive adapters to the environment. Basically, change or stability in networks must has to it some active participation from one or more actors. *"...no change is created without activities undertaken by an actor, regardless of the occurrence of new conditions in the environment"* (Gadde & Håkansson, 1992). In these contributions the actor dimensions (interest and power) seem to be the turning point when addressing change and stability. While the existing structure (both the actor, activity and resource dimensions) is important as precondition and direction of change, the actor initiative and the mobilisation of power is a prerequisite of change. *"All changes that are possible, which means all opportunities involving new combinations of actors, activities and resources, will be evaluated in relation to their perceived effects on the existing structure and furthermore developed in order to give rise to certain preferred outcomes…… Some actors will be easier to mobilise than others, in relation to a certain activity, due to their different perceptions of the outcome of the activity undertaken. Thus, one important attribute necessary to control change processes will be the ability to understand and handle the existing patterns of power"* (Gadde & Håkansson, 1992).

In relation to this paper stability and change as empirical categorisations can be seen as outcomes with different degrees and strengths of path-dependency. It is seen as important to detect both mechanisms supporting change and stability, and thus path-breaking and path-reinforcing behaviours, respectively. Change (minor or radical) comes about by actors taking initiatives from within existing structures (conceptualised as activities, actors and resources), however the interests in certain change directions as well as the ability to mobilise power in the network seem to be the central mechanisms to address.

Structures of weak and strong history

Håkansson & Lundgren (1997), related to paths as structures, presents a classification of different structural situations determining the strength of structures as 'carrier of history'. This classification is based on a prevailing IMP model (Håkansson & Snehota, 1995) with Activities (structures, links and patterns), Actors (organisational structures, bonds and webs) and Resources (collections, ties

and constellations). Weak and strong structures relate to how well-established network structures are, and degree of overlap is to be understood as the extent to which the different structural elements (activities, actors and resources) match each other. Four classes of structural situations influencing the direction and strength of paths can be outlined (Håkansson & Lundgren, 1997):

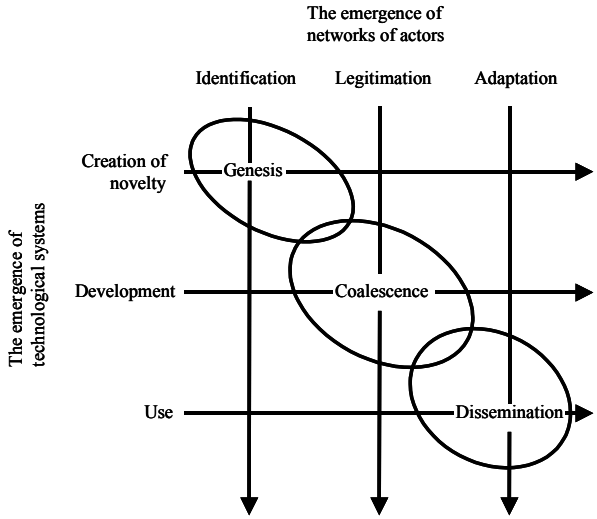
		Overlapping	
		Large	***Small***
Structure	***Weak***	*Medium history* Stable situation with a clear direction. Behaviour directed towards rationalization in the use of resources will be reinforced. Drift towards strengthening of structure	*Weak history* Unstable situation, many changes but no direction, low economic efficiency. Behaviour notreinforced. Exogenous shocks necessary to provide direction.
	Strong	*Strong history* Stable situation with efficient production and little room for endogenous change.	*Medium history* Stable situation but without any clear direction. The network could tip in several directions. Inventive behaviour will be reinforced.

The four classes of structural situations determine the 'strength of history'. Structures can be more or less strong or well-established in the sense that they can be transformed by different degrees of ease. Furthermore, the structural situation can be characterised by different degrees of overlap between actor, activity and resource structures. Large degrees of such result in few paths crossing each other, thus limiting the possibilities of combining paths. Hence, strong and weak structures is about the difficulties in breaking up existing structures, and degrees of overlap, on the other hand, relates to the possibilities of path-breaking initiatives (directions being questioned). Path-breaking processes can be understood as an initial strong structure/large overlap situation being broke up, thus creating situations of weaker history (no paths) at least locally, however with the establishment of or drift towards new paths or new situations with large overlaps and stronger structures.

In relation to explanatory structure these ideas represent a contribution to how structural situations affect the room for and possibilities of actions reinforcing and transforming structures/paths. Basically it is quite similar to the discussions on stability and change above. Different change patterns come about through initiatives, reactions and the mobilisation of support. However, the contribution is more explicit on the structural conditions for and possibilities of path-breaking behaviour – through the conceptualisation of strong and weak history situations.

Processes of genesis, coalescence and dissemination

The first two lines of thinking is quite similar in the sense that they emphasise the actor structure, the initiatives and the mobilisation of power or support as the way change come about. Lundgren (1995) shares this view. *"Changes emerge from pre-existing structures and, if viable, they will eventually be re-integrated with the structures from which they originated. To realize changes, the semi-autonomous actors of industrial networks are dependent upon the support of others. But others will also induce changes which require reactions"* (Lundgren, 1995). However, Lundgren (1995) broadens the perspective and distinguishes between two spheres of industrial networks – ie technological systems and networks of actors. The evolution of networks is to be found in this interplay between technological systems and the network of interrelated actors. This results in a descriptive model for understanding the emergence of industrial networks based on the processes of genesis, coalescence and dissemination.



The process of genesis is the creation of novelty in proportion to the technological system and the identification in the network of actors, ie actors start mobilising interest and problem ownership and searches for support and complementary resources in- and outside the existing network. The process of coalescence is the development of a new technological system and the legitimation of a new governance structure or network of actors. The process of dissemination consists of a further exploitation of use in the technological system, a further adaptation in the network of actors and perhaps an integration with the existing structures.

In relation to earlier mentioned contributions and the path-dependency issues it is about how paths are created. Lundgrens model is a descriptive tool[21] for capturing patterns of change, especially the creation of paths (in a sense how situations of weak history develop into stronger history situations). The generation of this evolution is captured in the processes of genesis (invention and mobilisation of interest), coalescence (development and mobilisation of support/legitimation) and dissemination (changes in use and adaptations in networks). The structural situations in which these processes take place, however, are not conceptualised.

Resource structures as facilitators of path breaking behaviour

Contributions from Håkansson & Waluszewski (2002a, 2002b) explicitly deals with path-dependency. The contributions build on 'path as structures' and is an attempt to give more concrete content to 'crossings' from Håkansson & Lundgren (1997) based on the resource dimensions of industrial networks. The discussion demonstrates how paths (or rather crossing of paths) can facilitate path-breaking developments. In particular this contribution is about 'crossings', ie opportunities of path-breaking behaviour – it relates to overlaps and the possibilities that emerge from such.

The argument is based on the parallel existence of 'heaviness' and 'variety' in structures of interlinked resources as well as a distinction between different forms/levels of resources, ie products, facilities, business units and relationships. Heaviness in structures consist of resources developed, invested in and combined in interaction. This creates a *"heritage from earlier interaction"* (ibid), ie a structure of resources interrelated in interaction that tends to be used in future interactions[22]. Heaviness creates visible paths, and pursuing these in interaction obviously results in path-dependent developments. On the other hand any structure of resource combinations is also characterised by variety. Variety exist in terms of existing methods as well as in terms of a tremendous number of development possibilities (different possible ways of combining resources).

[21] The model is a descriptive tool derived from Lundgrens empirical research and is as such not generalisable. *"Even if it is not meaningful to generalize the trajectory of an evolution, it is the role of scientific inquiry to search for the mechanisms generating the observed evolution. But the causes should not be assumed, they must be sought"* (Lundgren, 1995).

[22] Heaviness must relate very much to what Håkansson & Lundgren (1997) called the strength of history (see above), and can also bee seen as a resource-based or IMP-based view/conceptualisation of QWERTYnomics.

Further, a distinction is made between different resource forms/levels – ie products, facilities, business units and relationships. Non of these must be seen as given – but only as a result of their embeddedness and relation to other resources. The basic idea pursued is that path-dependence can exist in these different resource forms and possible 'new ways' origin in crossings of resource forms/paths. The point made theoretically and empirically[23] is that path-breaking developments happen *"...not despite of, but because of path-dependency"* (ibid).

In relation to the explanatory model of this paper Håkansson & Waluszewskis contribution represents a conceptualisation of structures – structures creating possibilities of breaking up existing paths. In relation to the contributions addressed above this model emphasises the resource structure, whereas the actor dimensions (mobilisation of power, support and legitimation) to me seemed to be the turning point in the previous contributions.

Patterns of network evolution and vectors of change

Many IMP contributions distinguish between different types of change, degrees of radicality and evolutionary patterns. These distinctions vary in content: Gradual and radical changes (Hertz, 1996); incremental and radical changes (Havila & Salmi, 1999); continuous and discontinuous changes (Lundgren, 1992); joining of nets, splitting up of nets, drifting closer and drifting away (Hertz, 1996) etc. The line of contributions dealt with here base their distinctions (gradual or evolutionary) on the idea that network change often follow a certain pattern, path or logic. This leads to the model of vectors of change (Håkansson, 1992; Håkansson & Snehota, 1995; Håkansson & Henders, 1995; Håkansson & Lundgren, 1995).

Three vectors of change are identified based on connections between activity links, actor bonds and resource ties. The first vector of change describes the way activity links and resource ties connect. *Structuring* is the refinement of existing ways to utilise and combine resources in activities. *Heterogenising*, on the other hand, is new ways of combining activities and resources. This structuring-heterogenising vector is about technology and economy. The second vector of change regards the connection between actor bonds and activity links. *Specialisation* is the tendency towards each actor performing a narrow range of activities, whereas *generalisation* describes the

[23] The empirical case of IKEAs demand for 'green' catalogue paper shows an example of paths already build into resources in the forms of facilities and business units combined with new relationships created the new product ' LWC paper based on chlorine-free pulp and secondary fiber.

tendency towards each actor performing a broader range of activities. The generalisation-specialisation vector is about the organisation of activities. The third vector connects actor bonds and resource ties in the hierarchisation and extrication tendencies. *Hierarchisation* is a change process towards the necessary resources controlled by fewer actors, whereas *extrication* is a change direction in which the resources used are controlled by a larger number of actors. This vector describes resource control or availability. These vectors of change are usable for identifying the general dimension in the development of a network structure[24].

In relation to the explanatory model pursued in this paper, the vectors of change can first of all be seen as conceptual tools for describing actual patterns of development, where structuring, specialisation and hierarchisation tends to strengthen history, whereas heterogenising, generalisation and extrication as patterns tend to weaken history. Thus, first of all the vectors of change can be seen as a framework for classifying empirically recognised patterns.

These vectors of change is seen, however, as more than a descriptive tool. They tend to be seen as representing dynamics inherent in the network (as a more holistic phenomenon). *"...single instances of change in a network can be attributed to the initiatives of individual actors, but the dynamics of a network cannot. Rather, network dynamics are more fundamentally a never-ending process that defines the core of the industrial game and that is an integrated aspect of the network itself"* (Håkansson & Henders, 1995). Also, vectors of change has been used as conceptualisation of a network logic or rationale (Håkansson & Henders, 1995; Håkansson & Snehota, 1995). However, in my individualistic view such an inherent dynamic or network logic must be understood as a structure-agency duality in which structures favour those actions tending to reinforce certain patterns or directions.

Alternatively, the vectors of change can be seen as the actors' individual rationales. The actors have some perceptions of the past and future development of the network as a whole upon which they act, and through this action they reproduce or transform the network structure and the network logic. Therefore, the concept of network logic could be viewed as a parallel to technological paradigms from the NW story – as the actors' outlook or mindset towards the network in which they are embedded, and the problems experienced and change directions pursued depend on this

[24] The vectors of change are combined with Lundgren's (1995) processes of coalescence and dissemination in Håkansson & Lundgren (1995).

individual outlook. Commonly agreed upon 'rationales' might be interpreted as a large degree of overlap thus reinforcing the paths that they represent, while different 'outlooks' represents low degrees of overlap and thus possible crossings from which new directions can possibly emerge.

Actions and reactions, the dyad as receiver and transmitter of change and domino effects

Even though these vectors of change and related contributions on overall change patterns seem to emphasise dynamics as inherent aspect of the network as an overall phenomenon, it is also recognised that change in networks basically must be understood as processes of actions/events that transform or reproduce network structures. For instance Håkansson & Henders (1995) state that *"...it is the change episodes initiated by individual companies in industrial systems that constitute the building blocks of network dynamics"*. A few contributions conceptualising network change as actions and reactions are addressed here (Smith & Laage-Hellman, 1992; Easton & Lundgren, 1992). Smith & Laage-Hellman (1992) discuss options for actors to transform or change the network structure (at the level of the triad). These 'patterns of transformation' is basically categories of actions possible for the single actor to initiate change. Easton & Lundgren (1992) similarly describe reactions to initiated change. *"A network actor has a number of options available when faced with a change initiated by another network actor"* (ibid). These categories of actions and reactions are presented below.

Initiating change (Smith & Laage-Hellman, 1992)	**Reactions to initiated change** (Easton & Lundgren, 1992)
• *By-pass* refers to the situation in which an actor wants to either avoid an intermediary actor (*avoidance*) by interacting directly with the third party or influence an intermediary actor through this third party (*flanking*). • *Combination* refers to the strategy in which the focal actor chooses to pool resources and co-ordinate activities with a second organisation in the context of their common relation to a third party. • *Bridging* refers to the strategy in which the focal actor uses an intermediary actor as facilitator or access to a third actor. • *Displacement* is basically a focal actor replacing a former partner with another. • *Separation* occurs when a focal actor establishes an indirect relation as a replacement of a direct one. Two degrees of separation can be distinguished – *elaboration* and *blocking*.	• *Reflection* is when the involved actors reject or nullify changes initiated by another actor in the network. • *Adaption* is when the change is managed by negotiations in the dyad, thus not influencing the rest of the network. • *Absorption* happens when the actor accepts the initiated changes and handles these within own firm boundaries. Ie, the change does not affect outside the receiving actors. • *Transmission* is the process in which the receiving actor transmits the effects of the initiated change further on to other members of the network. • *Transmutation* then is when absorption and transmission is combined. The actor receiving the changes adapts its own organisation but also transmits change requirements to the rest of the network. • *Amplitude modification* is a question of the receiving actor using the change initiative to either amplify or

	reduce the requirements to own organisation and/or the rest of the network. Thus, it is a question on the extent of the modifications required more than the nature of these. • *Dissemination* then is the question of whether the required changes involve many or few actors.

The contribution to path-dependency is a matter of what types of actions and reactions that reinforce paths as well as hold the potential to break up paths. How paths absorb minor disruptions, as well as how paths move towards new paths through the mobilisation of support can be seen as processes of specific classes of actions and reactions. How do these actions and reactions (practices) reproduce or transform paths in networks? Easton & Lundgren address this issue by the extent of modification and the number of actors involved. These aspects (together with the nature of the actions and reactions) affect the nature and amount of change in/to processes recognised as either path-reinforcing or path-breaking.

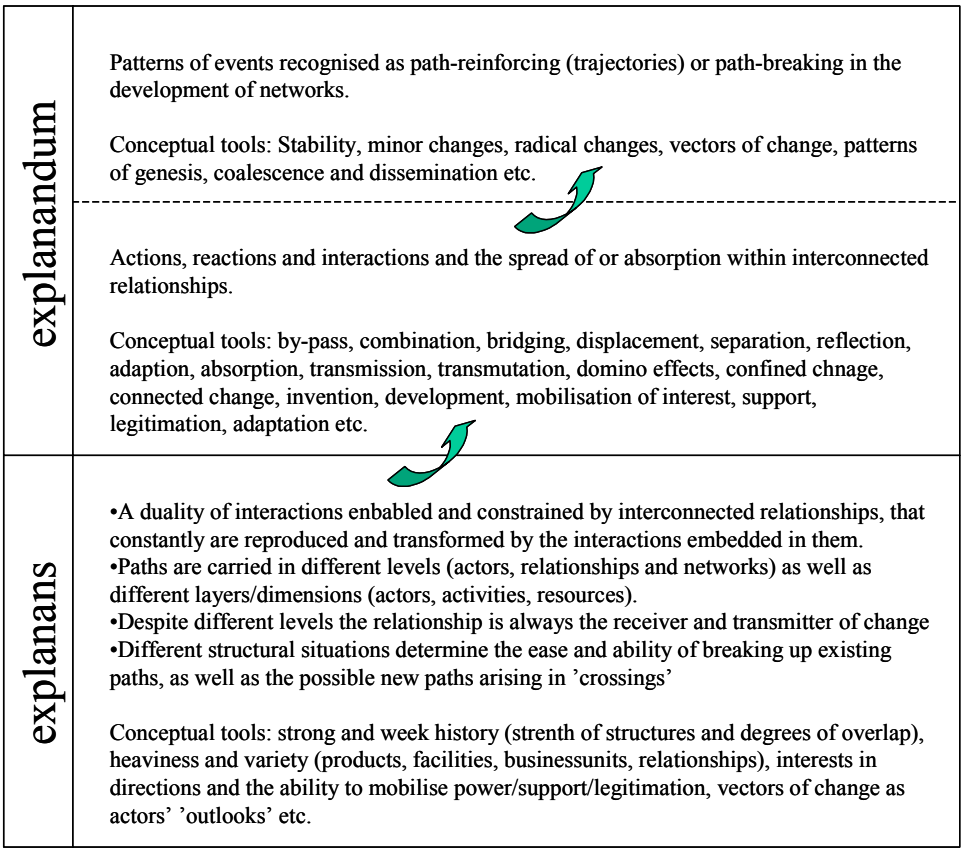
This relates to the idea of domino effects (Hertz, 1992 and 1998). The idea is that change is initiated in concrete relationships, but because of these relationships' interconnectedness to other relationships the initiated change has effects also on non-involved (but connected) actors. This leads to reactions by these actors, and consequently effects of the initial change on the relational level spread throughout the larger network. Thus, the argument is a way of anticipating change on network levels (whether path-reinforcing or path-breaking) as being actions and reactions following each other through interconnected relationships. *"…connectedness, speed and sequence of changes are seen as basic elements of domino effects. Sequences of changes are the process, connectedness is a prerequisite and speed a contributing factor to the development. These three are triggered by the initial change"* (Hertz, 1998). Similar thoughts are presented in Havila & Salmi (1999). The origin of change is situated in interaction based on the idea of the dyad as both the receiver and transmitter of change. Confined change is seen as change that remains within the dyad (eg based on the reactions of reflection, adaption or absorption), while connected change influence actors outside of (but connected to) the dyad through such reactions as transmission or transmutation[25]. Hence, if path-breaking initiatives are to result in the establishment of new paths on network levels certain processes of connected change or domino effects are required.

[25] This seems to be quite similar to Hertz' concept of domino effects

Summing up, the basic idea in these contributions is that change emerges from micro-level, ie from initial actions that, depending on the reactions, might have effects in the larger network recognised as path-dependent or path-changing[26].

4.1 Summing up the IMP story – essence and frameworks

What I regard as the essence of an IMP story is presented below along with some of the conceptual frameworks that relate to some of the different layers in the explanatory structure pursued. The 'frameworks' are seen as conceptual handles for analysing path-dependencies in empirical research – ie tools for developing hypotheses, for interpreting the content of and forces creating path-dependencies and conditions for path-breaking developments in empirical cases. Importance, strength and form of path dependency is basically an empirical question (Dosi, 1997), and the different 'tools' address different aspects of the path-dependency metaphor and will be differently suited for capturing elements regarding path-dependency in different contexts/cases.



[26] The historical events that lead to the emergence of QWERTY as the dominant standard can easily be seen as processes of actions, reactions and connected change.

What I in the figure have interpreted as the essence of an IMP story should rightfully be labelled as my relatively speaking individualist view. Many (probably most) IMP contributors will represent a less individualistic view, however I believe that much content (evolving around interactions, relationships and networks) is shared with IMP contributors – and also where the IMP story differs from the AD and NW stories. I believe that the IMP story is most in line with the AD story in its basic structure. In a sense it can be seen as a specific (or perhaps more nuanced) view on elements of QWERTYnomics in which different elements of industrial networks provide positive feedbacks. In relation to the NW story the major inconsistency lies in the view on selection. The idea of selection is not necessarily inconsistent with the IMP story. However, whereas the NW story is based on some learning process taking place at micro level and some (exogenous) selection mechanism working on macro level, the IMP based version would state that both learning and selection take place in interaction.

4.2 A few words on the research 'path'

The individual research 'path', that this first effort is a part of, ultimately aims for a study of the European intermodal rail-based transport sector and the particular networks producing these transport services. The ambition is that this review of path-dependency literature (in future versions) are to be used to develop and explore possible hypotheses of path-dependencies in this industry – through process based case studies of developments both along and breaking with paths recognised in the patterns of the industry (from secondary readings, statistics, interviews etc).

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