REGIONAL POLICY AS CHANGE MANAGEMENT
- a theoretical discussion with empirical illustrations

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Abstract

The paper focuses on challenges and potentials for policy in the presence of fundamental change processes that influence the long-term evolution of regions. The perspective in the paper implies that policy can be viewed as ‘management of change’. We present a conceptual model for understanding the nature of fundamental change processes, which emphasizes slowly changing regional characteristics and invariant self-organized response mechanisms. It is supported by empirical examples of the invariant character of regional development and innovation phenomena, such as long-term population growth, export dynamics and persistence in new firm formation across regions in Sweden. The examples are put in perspective by studying the behavior of dynamic systems. A discussion of how policy may support new trajectories are provided.

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Keywords: business renewal, innovation, regional policy, persistence, change-processes, dynamic systems, path-dependence,

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1. INTRODUCTION

There are two generic features of the long-term evolution of regions. The first is persistence in structures, which is revealed by the stable pattern of city-size distributions and spatial hierarchies (see e.g. Beckmann 1958, Gabaix 1999, Gabaix and Ioannides 2004). The second is durability and persistence in change-processes, which manifest itself in that evolution and change tend to follow a predictable path governed by initial conditions (see e.g. Glaeser et al. 1995). We focus in this paper on what the latter type of change processes imply for regional policy. Our contribution addresses the general policy issue of the focus and potential for regional policy (cf. Johansson et al 2002). The paper is conceptual and our arguments are based on theoretical discussions substantiated with empirical examples and illustrations.

Specifically, we address challenges and potentials for regional policy for situations in which durable change processes are present. We refer to such processes as fundamental change processes.1 An important characteristic of fundamental change processes is their persistence, such that they repeat themselves over time. In this way, they influence the long-term evolution of regions and are often associated with structural change. Examples of fundamental change processes at the macro-level include the steady increase of the importance of knowledge-intensive services in advanced economies over the last decades (Schettkat and Yocarini 2006), as well as the increase in the share of population living in urbanized areas that has taken place since at least the 1920s (see e.g. UNFPA 2007). The important role of services of contemporary economies and the large fraction of peoples livening in urban regions are results of a persistent change-processes that have operated over long periods of time. At the regional level, fundamental change-processes pertain to phenomena like in- and out-migration, entry and exit of firms, changes in the types of products and services firms in the regions produce as well as changes in the type inputs they require, and inflow of labor with different education profiles, skills and competences.

We argue that a major task of regional policy is to identify and respond to fundamental change processes. In a given period of time, such processes are ‘gifts from the past’ which define the context for regional policy. For certain regions they constitute a positive evolution trajectory which policy may aim to stimulate. For other regions such trajectories imply a negative trend which policy often tries to counteract or transform to something more

1 Regional policy is here broadly defined and refers to policies aimed at stimulating regional growth.
desirable. Some regions may for instance experience a gradual net outflow of population over time, whereas others experience a net inflow. Irrespectively, fundamental change processes form an important context to which policy must respond. In this regard we may view policy as ‘management of change’.

The paper focuses on two basic questions. The first question is about understanding the processes which policy attempt to strengthen, counteract and transform, while the second is about the identification of policies that have a potential to influence change patterns in a warranted way.2

i. What are the characteristics and underlying forces of fundamental regional change processes?

ii. What is the scope for regional policy to alter and adjust to these change processes and which aspects of the processes should policy focus on?

A major argument of the paper is that fundamental change processes should be understood as development paths with persistent mechanisms of change, driven by slowly changing (regional) characteristics and self-organizing feedback adjustments. This associates to the notion of cumulative causation that is a prominent feature of the work by e.g. Myrdal (1957) and Kaldor (1970, 1981) as well as of modern models of agglomeration economies and the evolution of spatial structures (Krugman 1991, Fujita and Thisse 2002, Fujita et al. 1999). It also adheres to the recent literature on evolutionary economic geography which emphasize the role of cumulative processes in the patterns of regional change (Martin and Sunley 2006, Boschma and Frenken 2006, Frenken and Boschma 2007).

The discussion of the scope and focus of policy is based on a distinction between slow and fast processes, which adjust on different time scales. Policy, viewed as the management of change, must recognize and deal with both types of processes while giving priority to the slowly changing factors. Variables which change on a slow time scale can be characterized as parameters that govern the evolution of fast processes. We make a strong case for that parameters of a change-process represent those things on which policy decisions should

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2 The second question is related to a recent analysis by Dolfsma and Leydesdorff (2009) who analyze theoretically the conditions for breakout from technological trajectories.
concentrate. Consequently, regional policy should be directed towards altering parameters that govern slowly changing regional characteristics. By doing so, policy may influence the evolution trajectory of regions. We use the concept of infrastructure as a comprehensive term for regional characteristics that develop on a slow time scale (cf. Johansson and Wigren 1996, Johansson 1998). Infrastructure pertain to various sorts of endowments including the knowledge embodied in the labor force and firms and other organizations located in the region, including durable contact links with the rest of the world. For medium term policy decisions, tangible and intangible infrastructure are parameters governing the change-processes which we consider in this paper.

The remainder of the paper is organized in the following fashion: In Section 2 we outline the ‘paradigm’ for analysis of fundamental change processes and demonstrate the durable and persistent character of regional development and innovation phenomena with a set of empirical examples over long-term population change, new firm formation and innovation activity across regions in Sweden. In Section 3 we analyze properties of the dynamic systems derived from the ‘paradigm’ and outlined in Section 2, and focus on how they can change and reach bifurcation points. Changes in the evolution path of the systems and bifurcation points are associated to policy decisions. Section 4 concludes.

2. FUNDAMENTAL REGIONAL CHANGE PROCESSES

2.1 A ‘paradigm model’ of fundamental change processes

How can we understand fundamental change processes? The basic argument here is that they depend on slowly changing characteristics and invariant response mechanisms. The latter implies that a process feeds itself in such a way that the state in current periods depends on the state in previous periods.

Figure 1 shows the paradigm model for fundamental change processes, with regional business renewal in the form of entry and exit processes as an example. It illustrates that the change processes at hand depend on two main factors. The first is the state of slowly changing regional characteristics conducive for entry and exit processes. Slowly changing characteristics of a region refer in particular to regional endowments in the form of climate, natural resources, infrastructure capital, skills of the labor force, social capital and many
similar things. It is a trivial conclusion that existing endowments provide regions with different opportunities for business renewal and development. At any moment in time, endowments are ‘gifts from the past’, which influence the development of each region’s economy. Glaeser and Gottlieb (2009) show for instance how the elasticity housing supply – an important factor for regions’ potential to adjust to population flows – depend on “fixed” attributes of the land in different regions. Moreover, Cheshire and Magrini (2006) illustrate how a previous dependence on coal fields and ports influences current development of regions.

The second factor is self-reinforcing adjustment mechanisms which imply that the phenomena in the current period is partly a response to the same phenomena in previous periods. An example is that entrepreneurial activity in a region in current periods can generate demonstration effects which stimulate entrepreneurial activity in the future (Andersson and Koster 2011). When such response (or feedback) mechanisms are invariant, they imply cumulative change processes, eventually combined with conservation principles. Conservation principles prevent explosive dynamics.4

Figure 1. Paradigm model for regional change processes (cf. Andersson and Koster 2011).

3 The role of initial conditions are also often discussed in the literature on regional clusters and innovation systems (see e.g. Afuah and Utterback 2000).
4 A general example of a conservation principle is congestion effects.
It is evident that a change process driven by slowly changing (regional) characteristics and invariant self-organized feedback mechanisms will remain persistent in its way to develop over quite some time. It is equally evident that such fundamental change processes imply evolution paths that may lead to new structures of economies over long time horizons. Examples of such paths of evolution include:

- The growth of the share of manufacturing products in Sweden’s export sales, where we can observe 10% 1920 and more than 50 percent 1990.

- The growth of the share of service sector production in the Swedish economy with around 20 percent 1920 and above 60 percent 1990.

- The increase in the share of population living in urbanized areas, from about 25 percent in the 1920s to around 85 percent 1990.

- The growth of knowledge-intensive producer services.

Having explained the ‘paradigm’ model for fundamental change processes we now turn to a set of examples of the general model in Figure 1 in a regional context. We describe two examples conceptually and provide empirical illustrations. The two conceptual examples focus on exemplifying the response mechanism emphasized in the paradigm model. We end the section with two further empirical illustrations of the relevance of response mechanism and slowly changing regional characteristics.

2.2 Example # 1 – long-term growth in regional size

An important aspect of the paradigm model in Figure 1 is invariant response mechanisms, and we shall here illustrate how cumulative processes pertaining to the long-term growth in size of a region can be based on such invariant feedback phenomena.

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5 Invariant response mechanisms and cumulative expansion/contraction are closely associated with the popular notion of path-dependence. As noted by Antonelli (1997, p.643-644), “path-dependence defines the set of dynamic processes where small events have long lasting consequences that economic action in each moment can modify only to a limited extent”. Path dependence imply that once a process for some reason is initiated, it tend to persist over time. Invariant response mechanisms may cause such persistence.

6 We discuss regions in terms of functional regions. A functional region can be delineated in such a way that firms and households have a common market within the boundaries of the region. Such a region will also be an arena for interaction between firms in exchange of products, information and knowledge. The most important
Consider firms that supply distance-sensitive products (goods and services). The exit, entry and expansion of such firms in a functional region can be described as a response to the demand for customers located in the same region. The self-reinforcing feedback is set into operation when the expansion of the pertinent activities attract new customers to the region or stimulates the output of customer firms to grow. Figure 2 illustrates such a generic change process.

The response process illustrated in Figure 2 consists of two coupled adjustments. Consider first a situation with regional growth. Then the first adjustment is based on a stimulus for new activities to establish themselves and expand generated by the size of regional demand at each moment in time. The second response is an increase of labor input which is stimulated by the growth of economic activities. The described growth trajectory obtains when the size of the regional market is sufficiently large, implying that the exit activities is smaller than the entry.

\[ \text{Size of the regional market demand (market potential), which is generated from firms and households located in the region} \]

\[ \text{Attracts households to stay and establish themselves in the region} \]

\[ \text{Attracts firms with scale economies and distance-sensitive transactions} \]

\[ \text{Location and expansion of firm activities which direct the supply to the local market of the region} \]

\[ \text{Figure 2. Cumulative change based on adjustment in the internal market of a region.} \]

A second trajectory obtains when the regional market potential is too small. Also in this case there will be entry and exit of firms as well as expansion and contraction of firms selling

Feature of the concept of functional regions is that they allow for frequent face-to-face contacts between individuals and firms.
distance sensitive output. However, in the second trajectory, exit and decline will dominate over entry and expansion.

To illustrate the above phenomenon, we can apply a simple differential equation showing the net change of distance-sensitive output per time unit, denoted by \( \dot{x} = dx/dt \). With the help of the following parameterized equation we can depict both expansion and contraction:

\[
\dot{x} = dx/dt = \alpha + \beta M \quad \text{for} \quad \alpha < 0
\]

where \( M \) reflects the size of the regional demand. The output from the pertinent activities will decline as \( M \) is small enough to satisfy \( \alpha + \beta M < 0 \).

2.3 Empirical illustration of example # 1 - population growth across Swedish regions

In the previous section we introduced a simple change equation to depict the cumulative growth in functional regions that follow from the so-called home-market effect, which obtains with strength in an economy with an increasing share of distance-sensitive transactions. This example was compatible with the paradigm model for fundamental change processes. What is then the empirical relevance of this example?

The example in Section 2.2 suggests that functional regions change in response to the size of the internal market, such that a large region attracts households to settle and remain in the region, whereas a smaller region is unable to attract and retain sufficiently many of their respective populations. Hence, the smaller regions have to experience a gradual decline in population. The empirical relevance of this statement is illustrated in Tables 1 and 2.
Table 1. Population change in municipalities belonging to three types of regions 1981-1995

<table>
<thead>
<tr>
<th>MUNICIPALITIES IN</th>
<th>Negative</th>
<th>0-5 percent</th>
<th>5-15 percent</th>
<th>Above 15 percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan regions</td>
<td>4</td>
<td>9</td>
<td>38</td>
<td>49</td>
<td>100</td>
</tr>
<tr>
<td>Medium-sized regions</td>
<td>30</td>
<td>28</td>
<td>30</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Small regions</td>
<td>63</td>
<td>21</td>
<td>16</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Statistics Sweden (SCB), own calculations.

Table 1 shows that a clear majority of all municipalities were declining already in the period 1981-1995, whereas less than 5 percent were declining in the metropolitan regions. For the medium-sized regions, we can observe that 70 percent of the associated municipalities were growing. Table 2 presents data over longer time horizon (1970-2005). The table illustrates that 47% of all municipalities had a declining population 1970-2005 whereas 53% had an increasing population. The latter 53% are typically municipalities that were large in 1970.

Table 2. Municipalities and population change 1970-2005

<table>
<thead>
<tr>
<th>Population growth</th>
<th>Number of municipalities</th>
<th>Share in percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than -20 %</td>
<td>42</td>
<td>15</td>
</tr>
<tr>
<td>-20 – -10</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>-10 – 0</td>
<td>53</td>
<td>19</td>
</tr>
<tr>
<td>0 – 10</td>
<td>52</td>
<td>18</td>
</tr>
<tr>
<td>10 – 20</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>More than 20 %</td>
<td>73</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>284</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Statistics Sweden (SCB), own calculations.

The results make it clear that it is not just the size of the municipalities that matters but more so the size of the region to which it belongs. The reason for this is that the functional region...
represents the local market for each of the municipalities in the functional region. This conclusion is strengthened by Figure 3, which illustrates the population development in three types of municipalities during the 1990s.

Type I municipalities are defined as the largest central municipality, in terms of population, in each functional region. Type II municipalities are defined as non-central municipalities in large functional regions, again in population terms. Large functional regions are defined as those with a population size of at least 100,000. Finally, Type III municipalities are defined as non-central municipalities in those functional regions not considered as large, i.e. with a population below 100,000.

![Figure 3. Population development 1993-2001 in three types of municipalities in Sweden](based on Andersson and Klaesson 2004)*

*) Total population of Type I municipalities 1993 = 4,597,511

**) Total population of Type II municipalities 1993 = 3,288,816

***) Total population of Type III municipalities 1993 = 858,782

A similar message is conveyed by Figure 4, which shows the share of shrinking functional regions 1994-2006 in different size-classes. Of the functional regions with an initial population size less than 100,000, 93% were shrinking in terms of population between 1994 and 2006. The same figure for functional regions with a population between 100,000-500,000 amounts to 78%. In the group of functional regions with a population of more than
500,000, the share of shrinking municipalities was only 15%. Hence, the pattern is that small becomes smaller whereas large becomes larger.

![Graph showing share of shrinking municipalities for three size classes of regions.](image)

**Figure 4.** Share of shrinking municipalities 1994 - 2006 for three size-classes of regions.

### 2.4 Example #2 – the frequency of innovation activity in regions

Our second example pertains to how a regional ‘innovation milieu’ may develop in a cumulative process, where innovation activity by firms stimulate the development of a milieu which, in turn, stimulate further innovation activity.

Consider firms supplying to external markets. These firms are influenced by demand as it develops in other markets outside the own region. An important part of this external demand develops in export markets. Existing firms as well as potential startups have to transform information about the export markets into innovation ideas, comprising ‘know how’ about how to find customers in each such markets and knowledge about the preferences of the pertinent customers. Such information and knowledge is often generated in the regional milieu where a firm is located. A potential exporter’s conceptualization of such an opportunity is an ‘export innovation idea’ which according to empirical observations can be
described as a stochastic process, where innovation ideas arrive to exporters with different frequency parameters in different regions.

Figure 5 describes how characteristics of the regional milieu influence the arrival of ideas. In the figure the characteristics are divided into (i) knowledge sources in the region, (ii) communication opportunities in the region, and (iii) the absorption capacity in the region. When the frequency of new ideas is high, the milieu improves and the export-innovation intensity can increase. This further improves the milieu characteristics in self-reinforcing circle. Such a process is consistent with the response mechanisms discussed in the paradigm model.

In a recent study by Andersson and Johansson (2008), regional characteristics are reflected by the variables presented in Table 3. These variables are used as explanatory factors determining the basic parameter of a Poisson process, which depicts the arrival rate of innovation ideas.
Table 3. Regional characteristics influencing the arrival of export-innovation ideas

| Knowledge sources in the region | • The number of existing export varieties in a given industry of a region, reflecting the localized knowledge about the spectrum of export varieties
• The number of exporting firms in an industry of a region, reflecting the localized knowledge about neighboring export firms
• Number of destination markets in an industry of a region, reflecting knowledge about foreign markets |
| Communication Opportunities in the region | • Localization or cluster economies, measured as export specialization of an industry in a region
• Urbanization or diversity economies, measured by the size of the region
• Metropolitan contact opportunities, measured by the distance to the nearest metropolitan region |
| Absorption capacity | • Knowledge intensity, measured as the share of the employees with university education of an industry in a region |

2.5 Empirical illustration of example # 2 – export dynamics in regions

Above, we maintained that export firms, existing and potential, have to transform information about the export markets into innovation ideas, comprising “know how” about how to find customers in each such market and knowledge about the preferences of the pertinent customers. We also claimed that the regional milieu often is an important source for such information and knowledge.

Before entering into this discussion we first present a diagram illustrating the correspondence between the emergence of new export firms and the size of a region. A second diagram reveals the correspondence between the introduction of new export varieties and regional size. We also present results from a recent econometric analysis by Andersson and Johansson (2008) where the frequency of new export varieties and new export firms, respectively, is regressed on initial conditions of each region. The startup of new export firms, i.e. firms initiating exports, is depicted in Figure 6 as a function of the size of each region. The table figure illustrates that the number of new export firms is clearly higher in larger regions.
The information in the figure can be enriched with the help of econometric analyses that make use of the regional-milieu characteristics in described Table 3 in the previous section. Andersson and Johansson (2008) show in an econometric analysis, where a Negative Binomial Poisson model is used to estimate the likelihood of new exporting firms in a region, that the new export firms are positively influenced (in a statistically significant way) by the following factors:  

- The number of already established export firms in the sector  
- The number of destination markets in the sector  
- The export specialization of the sector, reflecting localization economies  
- The size of the region, reflecting urbanization economies in the sense of Jacobs  
- Distance to the closest metropolitan region  
- The knowledge intensity of the sector, reflecting knowledge absorption capacity.

Returning to the list of regional-milieu characteristics in Table 3, these characteristics are also candidates to be included in an analysis of the frequency of new export varieties in different regions. Again, we can plot the number of new varieties against the size of each region as

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It should be stressed that regional factors are measured for the year 1997, while the entrance of new export firms is recorded as firms exporting in 2003 but not exporting in 1997.
illustrated in Figure 7. In addition we can refer to the estimation results in Andersson and Johansson (2008), which show that the previous listed properties of the regional milieu also positively influence (in a significant way) the likelihood of new export varieties.

Figure 7. Relationship between the number of new export varieties between years 1997 and 2003 (vertical axis) and regional size in 1997 (horizontal axis) (Stockholm, Göteborg and Malmö excluded).

2.6 Empirical illustration # 3 – entry of new firms as a time invariant process

In Section 2.1, we stated that an example of self-reinforcing adjustment mechanisms is that entrepreneurial activity in a region in current periods can generate demonstration effects which stimulate entrepreneurial activity in the future (cf. Andersson and Koster 2011). When such effects operate, entrepreneurial activity in regions should be persistent over time. We will now illustrate the empirical relevance of this argument.

The entry of new firms varies strongly across sectors. Since the concentration of sectors in regions differs in a systematic way, we can conclude that one may expect the entry rate to differ between regions. The decision to start a new firm is frequently assumed to be determined by (i) profitability conditions of the firm’s sector, (ii) the market growth in the sector, (iii) tangible and intangible capital intensity, (iv) scale economies of the sector, (v) industry concentration (Nyström 2007).
For sectors with distance sensitive transactions and that mainly compete on regional markets, some of the described features will be region-specific. That applies to profitability, market growth, and sector concentration, which all can be expected to stimulate entrants in a positive way. To this we can add the demonstration and learning effect that stems from the frequency of entry events in the region’s recent history. Factors like profitability and market expansion can be referred to as pull factors. In contradistinction to these, one may also consider push factors that ‘force’ an individual to start a business as the only available means to earn an income. A typical push factor is the unemployment. Pull factors that can be assumed invariant regional-milieu characteristics include the concentration of sectors with low entry barriers and positive profit opportunities, and the demonstration and learning effects of a region’s experience of frequent entry events in the past.

At this stage we first consult Figures 8 and 9 from Andersson and Koster (2008) which shows that there is a clear pattern of persistence in new firm formation across regions, both in terms of business start-ups (Figure 8) and start-ups in the form of self-employment (Figure 9). The figures illustrate the relationship between the level current start-ups rates in Swedish municipalities and the level of start-up rates a decade earlier. The figures suggest that there are invariant regional characteristics that sustain the persistent pattern that we can observe. It is astonishing that vibrant processes of entry and exit can generate observed patterns that remain approximately unchanged or invariant over long periods of time.

As the paradigm model for fundamental regional change processes suggest, Andersson and Koster (2011) maintain that there are two basic sources for persistence in start-up rates: (i) slowly changing regional characteristics that are conducive for start-ups and (ii) high levels of start-up rates can generate demonstration effects and an ‘entrepreneurial’ climate, such that there is a self-reinforcing element in start-up rates across regions. Clearly, these two hypotheses are not mutually exclusive.

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8 Fritsch and Mueller (2007) find a similar pattern for regions in Germany.
Figure 8. Relationship between business start-ups rates in $t$ (2004) and $t-10$ (1994) across Swedish municipalities.

Controlling for regional characteristics assumed to influence start-ups, Andersson and Koster (2011) find that lagged start-up rates have a significant impact on current start-up rates. Moreover, quantile regressions and analyses of transition probabilities provide empirical support for that both factors (slowly changing regional characteristics and self-reinforcing mechanisms), i.e. the paradigm model of fundamental change processes, are important for explaining the level of start-up rates across regions in Sweden.

Figure 9. Relationship between self-employment start-ups rates $t$ (1994) and $t-10$ (2004) across Swedish municipalities.
2.7 Empirical illustration # 4 – slowly changing regional characteristics

In the previous sections we illustrated the empirical relevance of the paradigm model of fundamental change processes across regions with regard to (i) population growth, (ii) new export firms and export varieties and (iii) start-ups. The observed invariance and path-dependence in these dynamic phenomena can be explained by slowly changing regional characteristics in combination with self-reinforcing mechanisms.

Our final empirical illustration focuses on the invariance in regional characteristics assumed to influence the conditions for business renewal. In particular, we will illustrate invariance in structures among municipalities in Sweden with respect to the following set of regional properties:

- Education-level of the labor force
- Employment share
- Share of services in the regional economy

Figures 10-12 illustrate invariance in the structure of these characteristics across Swedish municipalities over a decade (1994-2004). In each figure, to horizontal axis measures the level of the variable in 1994 whereas the vertical axis measures the level of the variable in 2004 for each municipality.

![Figure 10. Relationship between education-level of the workforce 1994 and 2004 across municipalities.](image)
The education-level of the workforce is here measured as the share of the employees with a long university education (at least three years). It can be interpreted as the ability to absorb and assimilate new techniques, new knowledge, innovations and ideas (cf. Cohen and Levinthal 1994). As such, the education-level of the workforce in a region represent an important condition for business renewal processes. The employment share of a region can be interpreted as the inverse of a push factor, in the sense that low employment shares imply that a large fraction of the workforce is not employed. Suppose that this factor influences start-ups and is invariant in the sense that the relative size of unemployment rates remains unchanged across regions over time. Then this would make the start-up rate of regions persistent over time.

![Figure 11. Relationship between the employment share in 1994 and 2004 across Swedish municipalities.](image)

Moreover, considering that entry barriers in service sectors are relatively low and that private services is the fastest growing part of the Swedish economy during the past 10-12 years, the share of service activities in a region should influence the frequency of start-ups and business renewal in regions. The fastest growing segment of services is the group of knowledge-intensive producer services (Klaesson and Johansson 2008), which are often maintained to be vital in the upgrading of regional industry.
3. BEHAVIOR OF DYNAMIC SYSTEMS

The previous sections present the paradigm model for fundamental regional change processes and provided examples of the empirical relevance of invariant regional change processes in terms of population growth, export dynamics and start-up rates. Examples of slowly changing regional characteristics were also presented.

Given the observed persistence in the behavior of indicators of regional business renewal and innovation, we may ask: what is the scope for regional policy? Can policy alter the observed invariant change processes characterized by path-dependence? To provide a basis for a discussion of the above questions, we analyze the stability and evolution trajectories of simple non-linear dynamic systems that incorporate the essential characteristics of the paradigm model of change processes outlined in Section 2.

Consider a system for which we can identify invariance over time. As outlined in the paradigm model of fundamental change processes, such a lack of change can be associated with two alternative phenomena. The first case obtains when the seemingly invariant variable is just changing on a very slow time scale. The other phenomenon that can be associated with invariance is a system with feedback properties causing the system to behave in a stationary way. In this latter case the response mechanism functions like a homeostasis mechanism that brings the system back to its stationary equilibrium whenever it is disturbed. In this way we may think of the feedback as the major case for stationary processes.
When a cumulative development driven by an invariant feedback mechanism is present, this implies that a focused variable either increases or declines as time goes by. Such phenomena can be described by simple differential equations:

\[ \dot{x} = \alpha(N - x)x \]  

With this equation, \( x \) will expand as soon as \( x \) attains a value greater than 0 and it will continue to grow in response to the size of \( x \) itself as long as \( x < N \). The change-process has two equilibria. The first is \( x = 0 \) and the second is \( x = N \). It can describe an economic activity which is dependent on a resource, the size of which is signified by \( N \). As long as the resource-constraint is not binding, the process will develop along a sigmoid (S-shaped) curve (Figure 13).

![Figure 13](image_url)

**Figure 13.** The sigmoid shape of the development path of \( x \) in Equation (1), figure based on \( N=500 \) and \( \alpha=0.0001 \).

The curve in Figure 13 is a generic form of the evolution of shares, such as the share of a specific product in a product group or the share of a sector in an economy. The essential feature of this model is that the system is conservative and thus does not explode.

With a system with more than one change variable, one can sometimes order the variables with regard to their speed of adjustment. In a two-variable system, one variable can be classified as fast relative to the other. This is a basic element of Haken’s (1983) ‘slaving principle’ in which the fast-adjusting variable is slaved by the evolution of the slower one. In
accordance with the paradigm model outlined in Section 2, we may think of business renewal processes being slaved (or governed) by the education profile, competences and skills of the regional labor force which change slowly. This implies that the type of firms that can develop in a short time period adjusts quickly to a temporary equilibrium solution given the state of slow-adjusting regional attributes. As an example, consider the following coupled dynamics:

(3) \[ \dot{x} = \alpha x - xy + f(t) \]
(4) \[ \dot{y} = -\beta y + x^2 + g(t) \]

where \( x \) represents a slow variable and \( y \) a fast one, and where the functions \( f \) and \( g \) describe influences from a surrounding system, such that this influence evolves as time goes by. Suppose now that the external influences are absent so that \( f(t) = g(t) = 0 \). The change of \( x \) is described by \( \dot{x} = dx/dt \) and takes place on a slow time scale when \( \alpha \) is positive and small, while \( \beta \) is much larger than \( \alpha \). When this is the case we can introduce the approximation \( \dot{y} = dy/dt \approx 0 \), which yields \( y = x^2 / \beta \). This implies that \( y \) is slaved by \( x \), and we can insert this approximation into (3) and thereby reduce the coupled system into just one equation. Thus, as long as the approximation is valid and as long as \( f(t) \approx 0 \), we have:

(5) \[ \dot{x} = \alpha x - x^3 / \beta \]

When \( \alpha > 0 \) there are two stable equilibria at \( x = \pm \sqrt{\alpha \beta} \). However, when \( \alpha < 0 \), \( x = 0 \) is a stable equilibrium. If we make the \( y \)-variable a constant then Equation (3) simplifies into:

(6) \[ \dot{x} = \alpha + \beta x - xy \]

where \( \alpha \), \( \beta \) and \( y \) are positive fixed parameters and \( y > \beta \). This system comes to rest as a stationary equilibrium when \( x = \alpha / (\beta - y) \). In this case we obtain a system that will safeguard a stationary solution, i.e. it is stable with regard to disturbances.

Consider again Equation (5) and assume that we add still another change process, this time describing the evolution of \( \alpha \). If this process starts for some negative value of \( \alpha \) and expands gradually over time, then a bifurcation point obtains when it reaches the critical value 0 (see
Figure 14. Bifurcation consequence of changing values of a slow response parameter ($\alpha$).

Our last example of dynamic systems is used to illustrate that a variable may be changing at a slow pace during certain phases of a development process and then suddenly adjust to much faster change (cf. Johansson 1993). To make this example concrete we may consider that an urban region consists of several different urban areas. Each such urban area will have its own local urban infrastructure and other support systems that generally develop on a slow time scale. The response to infrastructure development in terms of location of firms in the area may display a modest or even slow response. At a sudden point in time the infrastructure may reach such a quality and capacity that the attraction of new firms will give rise to a fast economic development that eventually settles at a new path of slow change, now with a declining direction. This is often observed in historical analyses of business location in sub-areas of an urban region.

This type dynamics is typically labeled ‘relaxation dynamics’ and is illustrate in the Figure 15. The horizontal axis measures the gradual increase of slowly-changing variables, i.e. with infrastructural properties and other similar milieu-factors. The vertical axis measures the intensity of the economic activity in question, for example the number of firms in an urban area. As can be seen there are four phases: (i) gradual increase in economic activity followed
by (ii) a fast expansion of activities and (iii) a gradual decline in activities an ending with (iv) a fast contraction. In our example the nature of the dynamics may be moderated by location and infrastructure policies.

Figure 15. Illustration of relaxation dynamics.

A classic example of relaxation dynamics as illustrated in Figure 15 is a newly opened restaurant where the quality of the meals served improves over time. At the first relaxation point there is a rapid increase in customers attracted by the qualities of the restaurant. As this happens crowding and congestion features sets into play due to the tensions of more customers than the capacity of the restaurant can handle. As a consequence the quality starts to worsen. At a new relaxation point customers are rapidly turning their back to the restaurant. For a district of an urban region one may think of cluster evolution as another example. At the first relaxation point, many firms are strongly attracted by the milieu created by the already clustered firms. Congestion and tensions, e.g. manifested in high land prices and competition for labor, or just capacity shortages, eventually imply that the cluster is not capable of renewing its business activities. Hence, firms find it less advantageous to stay in cluster or just loose their capacity to survive.

In summary, we have reviewed four basic models of aggregate change-processes comprising the essential features of the paradigm model of change processes outlined in Section 2. A common characteristic of the discussed prototype models is feedback phenomena. Once growth (decline) is initiated, continued growth (decline) is stimulated by the growth in
previous periods. A major reason for this is invariant response mechanisms phenomena. We also showed how slowly changing variables govern the evolution of variables that adjust on faster time scales.

Which are the policy lessons from the model exercise? The there two basic lessons. The first is that policy must be capable of recognizing the nature of the different parameters that govern slow and fast change processes. Equation (3)-(6) illustrate that there are parameters whose levels are critical for the direction of change. Importantly, changes in those parameters which make slow processes slow can imply that such processes increase their tempo of change. As this happens, the system reaches a bifurcation point which may impact the process to jump or shift to a new evolution path (Figure 14). We consider these types of factors as defining the basic area for regional policy. Policies that correspond to influencing the determinants of slow processes are a major field for regional development policy.

The second lesson points to the fact that regional policies must be persistent in the sense illustrated by the phenomenon in Figure 15. What this means in practice is that a policy altering the slow variables such that a new evolution path can be accessed or adopted, may have to build up resources for several decades to sustain the entrance into new evolution paths. This can for example pertain to shifts to new persistent tax policy, R&D and education policy and systems for facilitating entry and exit processes. Another lesson from Figure 15 is that if the relaxation dynamics in the figure represent one of several industries in a region, then every industry that has attained a large share of the regional activity eventually comes to a point where its importance is quickly degraded. As a consequence, a region that has managed to adjust to a new evolution path in which a sector gradually increase its share of the economy, a structural change process, will eventually as time passes enter a new situation in which the very same industry is phased out. Thus, the structural change process may be repeated for new industries.

4. SUMMARY AND CONCLUSIONS

We have discussed the challenges and potentials for regional policy in situations where durable and persistent change processes are present. These are labeled fundamental change processes and are claimed to form an important context to which policy must respond. Fundamental change processes exert a strong influence on the conditions for long-term
renewal and growth of regions and are often associated with evolution paths that imply structural change. We maintained that policy under these conditions may be described as ‘management of change’.

It is of course important that policy decisions are based on a solid understanding of the processes that govern the evolution of regions. We outlined a paradigm model of fundamental change processes, which suggests that they should be understood as development paths with persistent mechanisms of change, driven by slowly changing (regional) characteristics and self-organizing feedback adjustments. This model abstract from the specific circumstances that apply to each individual micro-case. It is designed to understand and predict the behavior of systems with many agents.

To illustrate the empirical relevance of the paradigm model, we investigated and identified regimes of change-processes in the system of Swedish regions. We showed that change-processes in the form of population growth, export dynamics and new firm formation feature a high degree of invariance over time. As such, they are characterized by path-dependence and sensitivity to initial conditions.

By analyzing the behavior of dynamic systems in concordance with the paradigm model, we also illustrated how they can be subject to self-generated sudden change and shifts in change-processes, either stimulated endogenously or by exogenous phenomena. The latter implies a potential role for policy.

Our main conclusions for policy are as follows:

1. Fundamental change processes constitute a major challenge for policy. A prerequisite for policy is to identify and understand the nature of any pertinent change processes.

2. Parameters that alter these change-process represent those things on which policy decisions should concentrate, and there are parameters whose levels are critical for the direction of change. Policy has thus a potential to influence the evolution of a fundamental change process by primarily influencing the parameters of slow processes. This, of course, requires a capability to recognize the nature of the different parameters that govern slow and fast change processes.
3. For medium term decisions, infrastructure – tangible and intangible – may often be thought of as a parameter governing slow processes.

4. Policy may need to build up resources for several decades to sustain the entrance into a new evolution path. Such a strategy can for instance pertain to a shift to new persistent R&D and education policies and systems for facilitating entry and exit processes.

The first conclusion is based on the argument that fundamental change processes influence the long-term evolution of regions and are often associated with structural change. Many regions in Sweden, for instance, experience a net outflow of individuals each year, i.e. they are depopulated. This depopulation may be understood as a fundamental change process of these regions, which clearly exert a major influence on their growth potential. At the same time, certain regions manage to attract firms and individuals, and maintain innovation activity over long periods of time. The typical example is vibrant cluster environments like the Silicon Valley in California and large city regions. In this case, fundamental change processes may operate in the same direction as the objectives of policy. Nonetheless, in both cases fundamental change processes set the context for policy; they are ‘gifts from the past’. To be able to manage this context, irrespective of whether policy wishes to counteract or reinforce the change processes, policy makers must identify and understand the nature of the pertinent change processes.

The second and third conclusion emphasize that policy indeed has a potential to influence change processes, and that this can be done by influencing the parameters of slow processes. Infrastructure is a typical parameter of slow processes. Infrastructure can be tangible (e.g. roads and buildings) and intangible (e.g. knowledge and competences of regional workforce, public and private R&D). Investments in such slowly changing features of a region is a way in which change-processes may be altered, because these slowly changing characteristics are parameters of the change-processes.

The fourth conclusion states that substantial resources and complementary investments may be necessary to sustain a shift in a region’s evolution path. As an example, a well-known regional policy (motivated by the arguments presented here) is to establish regional universities in order to boost the regional innovation potential and the education level of the
regional workforce (eg. Florax 1992). Such a strategy often needs to be complemented with investments designed to making the region attractive as place of residence and work for educated people. Otherwise, there is a risk that the region becomes an “exporter” of knowledge labor.

We end our contribution with a set of examples that provides a more concrete understanding of the conceptual conclusions above and illustrate that policy may matter. Let us start with an example of the Strömstad and Åre municipalities, which during the past 15 years or so have transformed from stagnating peripheral locations to areas with a sharply increasing share of tourist exports and other service sectors. In both cases, the local policy has adjusted in response to exogenous changes in conditions. Partly in line with the general transformation of the Swedish economy towards increasing importance of service activities, these conditions have increased the demand for tourism, retail and other services. Policy makers in Åre and Strömstad municipalities managed to support a new evolution path initiated by exogenous phenomena. The enhanced attractiveness of both regions is revealed by the expanding prices of property in the regions. Our next example illustrates the importance of policy makers capacity to hold on to long-term efforts in transforming a region into something new. In the middle of the 1970s, the shipyards on the west-coast in Sweden were closed down in sequence. In Gothenburg, three different shipbuilders discontinued their production. They were all located in an area of the city that made contact with central business district and had waterfront opportunities. Some 25 years later, most of these areas were completely rebuilt and designed form vibrating knowledge and producer service activities, culture and exclusive housing. A structure that accompanied the transformation of the Gothenburg region from a previously industrial economy towards as a knowledge economy. Even if this is part of a general trend in reshaping city regions, the change in Gothenburg required a great deal of persistence and patience in the regional policy making. Of course, the policy making was based on an understanding of the overall fundamental change processes at hand. Our final, and perhaps most eminent, example is the remarkable growth of the Umeå region during the past 40 years in which an initially very small town develops to an international research center and producer of university educated individuals for export to other parts of Sweden. In this case, national resources were part of the enduring efforts of change. However, the example illustrate that that policy decisions, in this case the establishment of a university, can push a region onto new trajectories.
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