Doctoral Thesis

A system dynamics analysis of socio-economic development in lagging Swiss regions

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Publication Date:
2005

Permanent Link:
https://doi.org/10.3929/ethz-a-004931324

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A system dynamics analysis of socio-economic development in lagging Swiss regions

A dissertation submitted to the
SWISS FEDERAL INSTITUTE OF TECHNOLOGY ZURICH
for the degree of
DOCTOR OF TECHNICAL SCIENCES

presented by

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Zurich 2005
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Summary

In many countries, lagging rural areas face the challenge of adaptation and structural adjustment to changing economic and social conditions. In lagging communities in Switzerland, population decline, demographic change and a narrowing economic base constrain future development perspectives and threaten the fulfillment of the national policy goal of a decentralized settlement. At the same time, Swiss regional policy is undergoing fundamental changes. This implies an increasing need for policy concepts and analyses based on an integrative view of the processes and actors affecting rural development.

This study focuses on the local dimension of employment and population dynamics in lagging areas in Switzerland and on an ex-ante analysis of development perspectives. To this end, it develops a system dynamics simulation model. The purpose of the model building effort is to identify generic processes and determinants of employment and population in lagging and particularly vulnerable communities in Switzerland. The model is built for the typical development of these communities and not for the exact development of specific case study communities.

An economic analysis of rural areas clarifies their problems and the processes affecting employment and population development. It is shown that communities in rural areas vary in terms of their locational characteristics, their economic and demographic structure. Depending on the combination of these features, different development trajectories can be observed. The geographical distribution of socioeconomic community types shows a much differentiated pattern and particularly vulnerable communities can be found in several community types.

The elements in the simulation model and the relationships between them are derived from theories in regional economics and rural studies. The debate on economic development in rural studies is concerned with the more organizational aspects of the rural economy. Regional economics, on the other hand, focuses on the interplay of the production factors of capital and labor, often affected by several other factors. In order to distill the feedback processes in these theories, related theories such as the theory of collective action and innovation theories are analyzed.

The quantification of the relationships in the model is based on the analyzed theories and on related analytical studies. Input-output analyses for lagging rural areas in Switzerland are important both to capture the relevant economic relationships and to estimate economic parameters. Employment and population related parameter values are based on statistical data. For sociopolitical aspects, data are taken either from the literature about case studies or from the literature about related studies such as innovation implementation efforts.

Model simulations and policy analysis highlight the economic development of rural micro-regions depending on external market forces and internal socioeconomic proc-
esses to counteract these forces. The application of a dynamic, feedback perspective leads to a series of important insights.

The reinforcing relationship between population, production and employment constitutes a dominant feedback loop. The basic problem that particularly vulnerable communities face is that the forces that are potentially capable of either shifting the direction of this loop or the dominance of this loop have to be very strong. The leading development principle for particularly vulnerable communities consists in stimulating growth in external demand through investment in export activities. From the feedback analysis, three sources for a failure of such a policy can be identified.

First, the investment strategy should consider that continuous growth in external demand is more effective to bring about sustained economic growth than a sizeable, one-time increase in external demand.

Second, a long term perspective for investment activities is crucial. Stable employment development in the short run does not necessarily mean that the forces leading to employment decline in the long run have lost their strength. Because of the delayed reactions in employment and population the effect of an export-oriented strategy only sets in after a few years. During this period, population continues to decline so that the necessary growth in external demand becomes even higher. It is therefore important not to stop investment in export activities too early.

Third, external demand can also result from endogenously generated economic activities. One reinforcing and one balancing feedback loop control the evolution of entrepreneurship and local initiatives as a development strategy. The defining feature for the success of such a strategy is that the reinforcing feedback loop shifts direction and works as a virtuous cycle that supports the development efforts. An important source of policy failure in this context is underinvestment in management skill and entrepreneurial capacity so that the shift in loop dominance cannot be brought about.

The findings from scenario and policy analysis imply that the effectiveness of the new regional policy paradigm for particularly vulnerable regions depends on two key aspects. First, decision makers have to make sure that the volume of the export oriented projects generated by the regions is high. Second, endogenously developed projects need external support over a sufficiently long period of time. The results, however, also imply that stabilizing employment and population in all particularly vulnerable communities through local economic activities is not possible without very high public support. Development strategies for lagging rural areas therefore have to be coupled to development strategies for regional centres. Only if the rural areas surrounding regional centres become an important asset for the development of these centres can rural areas be stabilized.
Zusammenfassung


Die vorliegende Arbeit bezieht sich auf die lokale Ebene der Beschäftigungs- und Bevölkerungsentwicklung in gefährdeten Gemeinden der Schweiz und auf eine ex-ante Analyse der Entwicklungsperspektiven dieser Gemeinden. Dazu wird ein dynamisches Simulationsmodell entwickelt. Das Ziel des Modellbildungsprozesses besteht darin, die grundlegenden Prozesse und Bestimmungsfaktoren der Beschäftigungs- und Bevölkerungsentwicklung in gefährdeten Gemeinden der Schweiz zu identifizieren.


Die Quantifizierung des Simulationsmodells beruht auf den analysierten Theorien und auf analytischen Arbeiten, die in engem Bezug zur vorliegenden Arbeit stehen. Input-Output Analysen für gefährdete Regionen in der Schweiz sind beispielsweise eine wichtige Grundlage für die Erfassung der ökonomischen Beziehungen und für die Schätzung der ökonomischen Parameter. Die weiteren Modellbereiche beruhen entweder auf statistischen Daten, auf der Literatur zu Fallstudien oder auf der Literatur zur Innovationsimplementierung.


1 Introduction

In many industrialized countries, lagging rural areas face the challenge of adaptation and structural adjustment to changing economic and social conditions. In particular, the socioeconomic viability of such areas is threatened because of their economically unfavorable location, structural deficits and lack of physical capital and productive knowledge. In remote micro-regions in Switzerland, for instance, population decline, demographic change and a narrowing economic base constrain future development perspectives and threaten the fulfillment of the national policy goal of a decentralized settlement. At the same time, Swiss regional policy is undergoing fundamental changes. Instead of distributive measures aimed at attenuating regional socioeconomic disparities, emphasis is given to the competitiveness of rural localities and to local initiatives (Evd 2004). This implies an increasing need for policy concepts and analyses based on an integrative view of the processes and actors affecting rural development.

The discussed shift in the regional policy paradigm is in line with the recent literature in regional economics. Contributions point out the importance of knowledge diffusion for the development of regions (Bretschger 1999) and the role of innovation and entrepreneurship in regional competitiveness (Nijkamp 2003; Cheshire and Maldecki 2004). At the same time, they identify the need for further analyses in the realm of variables essential to development including leadership, innovation, entrepreneurship, networking, social values and confidence (Bailly and Gibson 2004; Nijkamp and Poot 1998) and in the realm of policy making in an evolutionary world (Lamboo and Boschma 2001). They also claim that more attention be paid to the combination of local and non-local processes and decisions which impact together upon rural areas (Marsden 1998) and to the combination of exogenous and endogenous models of development as both agency and local structure are in a complex interplay (Lowe et al. 1995).

Existing work, however, focuses mainly on urban areas or spatial clusters of economic activities. It gives little insight into the question how lagging areas can meet the challenges of adaptation and structural adjustment. A series of studies on the local, regional and national level in Switzerland provide information about the structure and development perspectives of different economic sectors (Buser 2005, Flury 2002, Abegg and Thierstein 2004), evidence on the general potentials and limitations of regional policy measures (Stalder 2001) and knowledge about their effects in selected case study locations (Küpper 2000, Mühlinghaus and Wälti 2001, Schmid 2004). Insofar, no approach enabling an integrative and comparable view of socioeconomic development perspectives of policy measures and private initiatives has been elaborated for the local level, however. It is therefore necessary to integrate the existing knowledge into a synthesis allowing ex-ante evaluation of rural development initiatives and providing decision support for effective and efficient investment in economic as well as in social terms.
1.1 Main trends and issues in rural regions

Rural communities have small, specialized economies that produce only a fraction of the goods and services their residents want to consume. The small size implies that rural communities cannot produce everything and the requirements of the market to produce efficiently mean that rural areas tend to be specialized in the goods and services they are able to produce and sell. This makes rural economies vulnerable to trade shocks (Krugman 1991).

The economy of a rural community grows when local businesses sell goods and services of value to buyers elsewhere. Not every business produces for exportation, however. Local market businesses provide services inside the community. Their benefits to the community are that they employ people, attract tourists, pay taxes and provide many of the essential things that make life both possible and pleasant. Additionally, the co-existence of a variety of enterprises creates a beneficial agglomeration effect (Rizov 2004: 212).

Rural areas find themselves in a delicate balance between the necessity of specialization to be competitive and the resulting exposure to external threats from changing terms of trade. An optimal response is to both specialize at the firm level and diversify at the community level (Rizov 2004: 212). Rural development can therefore be enhanced by achieving optimal diversity of economic activities in rural communities.

The diversity at the level of a rural community, however, has the features of a privately provided, pure, nonexcludable public good. The community benefits from diversity are e.g. reduced vulnerability to adverse trade shocks, positive agglomeration effects and improved quality of life. This all adds up to higher incomes and welfare. The private costs of achieving diversity are search and other transaction costs for rural households to switch from one private income-generating activity to another, thus enhancing diversity at the community level (Rizov 2004: 213).

The fact that rural development has the features of a public good explains the potential need for public policy measures. Public policy influences economic structures and the development of regions. While in the last decade most regions in Switzerland showed economic growth, some lagged behind this national trend. Figure 1-1 compares total employment in Switzerland and in vulnerable regions. Vulnerable regions were identified in Rieder et al. (2004) and are regions that have either experienced population decline in the past or are threatened by it (see also chapter 3). The total number of employees measured in full-time equivalents increased between 1985 and 1990 in vulnerable regions and Switzerland alike. While absolute employment continued growing in the entire country, vulnerable regions experienced continuous decline since 1990. This decline was mainly caused by the ongoing structural change in agriculture and by stagnation in the building and construction industry. The relative analysis in the second half of the figure shows the change rates between 1985 and 1990, 1995 and 1990 and 2000 and 1995. The widening gap between the national development and the de-
development in vulnerable regions visualizes the political concerns about vulnerable regions.

**Figure 1-1: Employment development in Switzerland and in vulnerable regions**


As a consequence of the narrowing economic base, vulnerable regions have also experienced population decline. On the local level, this has led to a development where many communities have reached a critical minimum population level. When population falls below a minimal level, the maintenance of basic private and public services is threatened. This becomes visible for example when the primary school, the local shop or the restaurant is closed. Without the provision of basic private and public services, the attractiveness of a community for its own residents and for potential immigrants decreases considerably. A number of communities have been affected by these processes in the past or are threatened by them today. In some of them, settlement is slowly being completely abandoned. In others, however, a reverse of this process can be observed. Figure 1-2 shows the example of two communities that had very similar demographic structures in 1970. The number of the 20 to 39 years old population and the number of the 20 to 65 years old population was almost identical. The 20 to 65 years old population represents the economically active population group. The
group of 20 to 39 years old population reflects how the younger population assesses the attractiveness of a location. Many other examples could have been chosen. Apart from being similar in demographic terms, the two communities also had similar economic structures in the 1970s, both being agrarian communities at that time. The figure compares the development of different age groups between 1970 and 2000 (1970 as 100%). The first example (Safien in the canton of Grisons) shows the problematic behavior that this study is concerned with. Population declined continuously during the last 30 years and only the age group of the retired population increased. The second example (Isenthal in the canton of Uri) shows a different behavior with a constant increase in the economically active population. The decline of the 20 to 39 years old population shows that also in this case, all is not unproblematic. The increase in population since 1970 has many reasons. In the first place, Isenthal is not located as peripherally as Safien. In addition, Isenthal has a long experience of projects to maintain employment and population. These projects were the joint effort of the local population as well as regional and national authorities (see SCHÜLER 1999).

**Figure 1-2: Comparison of population development in Safien and Isenthal**

**Safien relative to 1970**

**Isenthal relative to 1970**


The comparison of the two examples raises the question under which conditions local actors take the initiative for some development effort and seek support from external
actors. It also raises the question what additional conditions have to be fulfilled so that these initiatives are successful.

1.2 Aim of the study

The main trends and issues outlined in the preceding section give rise to two broad questions. First, which factors can be considered to be the main driving forces behind employment and population development in lagging rural areas in Switzerland and second, how do effective policy measures have to be designed and implemented in order to stabilize employment and population? This study does not pretend to answer these questions fully, but it attempts to contribute:

- To the answer of the first question by synthesizing existing theories into an integrative framework about employment and population dynamics in lagging rural areas.
- To the answer of the second question by translating this framework into a simulation model that enables to identify high leverage points for policy measures.

In order to achieve this aim, the focus of the study will be on the following four objectives:

1. Analysis of employment and population development trends and issues in lagging rural regions.
2. Analysis of regional economic growth theories which can be used for the explanation of employment and population development in lagging rural regions.
3. Development of a simulation model to quantify the relationships stated in the theories.
4. Analysis of policy instruments and testing of effective development strategies. Model simulations and policy analysis should highlight the provision of goods and services in rural areas, how goods provision reacts to external market forces and when and how people take the initiative to counteract market forces.

While the problems of rural development and the possibilities of individual regional policy instruments are well known, the complexity of these two issues is not understood. Three features are common to the current discussions of fostering regional growth and competitiveness. First, there is broad consensus that successful development strategies in lagging rural regions have to combine traditional top-down measures with newer bottom-up strategies. Second, the discussions suggest that developing the knowledge and commitment to introduce and use initiatives in bottom-up strategies is a dynamic process created by the complex interaction of numerous forces within a region. Third, when viewed from a feedback perspective, which seems adequate for complex, dynamic problems, the different theoretical frameworks complement each other to a high degree.

With this in mind, this study offers two contributions. First, building on the existing literature, it synthesizes a framework describing the dynamics of population and em-
ployment development in lagging rural regions. The model captures the core structures common to the theories that bear on the issue and relates them to the small-scale level and to the specific case of lagging rural areas. Second, the integrative framework is translated into a simulation model. The formal model allows the detailed analysis of the dynamic behaviors created by the structures common to the relevant theory. Thus, the principle contributions of this study do not stem from proposing an entirely new framework or significant new extensions to an existing framework. Instead, the analysis highlights and clarifies the complex interactions between the elements common to the existing frameworks.

Increased human longevity and the growth of both private and state pension schemes mean that rural employment opportunities are no longer the necessary prerequisite for an area to remain populated (Errington 1997: 207). The retirement villages or even states in other industrialized countries but also in some parts of Switzerland are striking testimony to this fact. However, this study focuses on lagging rural areas that base their survival and future development on local economic processes.

1.3 Plan of the study

Chapter 2 describes the research approach of this study. It clarifies how economic theory is combined with simulation for policy analysis from a feedback perspective and introduces the data base used for the analysis. Chapter 3 analyzes trends and issues in lagging rural areas from an economic perspective. It contributes to the overall study by introducing and defining the object under investigation, employment and population development in lagging rural areas. Regional policy with its different approaches to development and its policy instruments is described in chapter 4. Chapter 5 presents regional economic theories concerned with employment and population development in lagging rural areas and elicits the feedback complexity inherent to these theories. It thus lays the base for the formulation of the quantitative simulation model in chapter 6. Chapter 7 tests and evaluates the model so that policies can be analyzed and compared for different scenarios in chapter 8. Insights from model simulations and conclusions about the policy implications are summarized in chapter 9.
2 Research methods

This study develops an integrative framework for the analysis of population and employment development in lagging rural areas. Chapter 1 showed that the research approach for achieving this goal has to take several important aspects into account:

- It has to be able to add variables essential to development like leadership, innovation, entrepreneurship etc. to the analysis.
- It has to be able to combine local and non-local processes and decisions which impact together on rural areas.
- It has to offer an integrative and comparable view of economic, social and ecological development perspectives of policy measures and private initiatives.
- It has to be able to integrate existing knowledge into a synthesis allowing ex-ante evaluation of rural development initiatives and providing decision support for effective and efficient investment in economic as well as in social terms.

This study adopts a system dynamics approach. System dynamics, according to Richardson (1991a: 144f) “is a computer aided approach to policy analysis and design. It applies to dynamic problems – problems that involve change over time – arising in complex social, managerial, economic or ecological systems – literally any dynamic systems characterized by interdependence, mutual interaction, information feedback and circular causality.”

Despite the similarities in the name, system dynamics emerges out of servomechanisms engineering, not general systems theory or cybernetics (Richardson 1991b). The field developed from the work of Jay W. Forrester (1961). It is now positioned in social theory in human agency/social structure integrative theories (Lane 2001) and in evolutionary approaches to economics (Radzicki 1990 and 2003). The system dynamics approach involves (Richardson 1991a: 145):

- Defining problems dynamically, in terms of graphs over time.
- Striving for an endogenous, behavioral view of the significant dynamics of the system.
- Thinking of all concepts in the real system as continuous quantities interconnected in loops of information feedback and circular causality.
- Identifying independent stocks or accumulations in the system and their inflows and outflows.
- Formulating a behavioral model capable of reproducing, by itself, the dynamic problem of concern. The model is usually a computer simulation model expressed in nonlinear equations.
- Deriving understandings and policy insights from the resulting model.
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- Implementing changes resulting from model-based understandings and insights.

The list shows that the approach involves the development of a simulation model. At the beginning of this chapter, simulation will briefly be compared to other model analysis techniques (section 2.1). Section 2.2 describes the system dynamics approach. Reflections on how to apply the approach to this study and how to combine it with other approaches will be reported in section 2.3. This section also describes the unit of analysis of this study and the data.

2.1 Introduction to modeling

Models are central to the understanding of the world. Models are developed in order to better understand the impact of alternative decisions on a specific section of reality or a specific problem (RUTH AND HANNON 1997: 3). Models can be classified in many ways. According to Figure 2-1, formal mathematical models can be static or dynamic and stochastic or deterministic. Dynamic models are those that try to reflect changes in time and take into account that the model components are constantly evolving as a result of previous actions (RUTH AND HANNON 1997: 6). Deterministic models generate unambiguous results while stochastic models provide probability distributions. Deterministic models are adequate if the research purpose is to understand basic interconnections and dependencies in a system (BERG AND KULLMANN 1993: 28). System dynamics is a deterministic, dynamic approach to mathematical modeling.

Figure 2-1: Categories of models

![Diagram of model categories]

Source: KEUSCH 2000: 9

An important distinction from an economic point of view lies in the differentiation between positive and normative models:

- Positive models explain a given economic situation and its development (KOCH 2002: 47). Relationships between variables can be identified and quantified by
formulating and testing hypotheses. Positive models aim at improving the basis for predictions about system behavior (KEUSCH 2000: 9).

- Normative models make prescriptions about what a situation is supposed to be like. They identify the best ways to achieve a given goal (KEUSCH 2000: 9f).

Models that contribute to the understanding and management of socioeconomic systems can be broadly classified into four categories: system dynamics, econometrics, input-output and optimization. The models in these categories refer to different stages of social decision-making at which they are most applicable (MEADOWS AND ROBINSON 1985: 23ff):

- When a socioeconomic problem is first identified, there may be a need for general understanding.
- If there is some agreement about the cause of the problem or the nature of the system generating it, the policy design phase begins. Models in this stage provide suggestions about the general directions in which a cure might be found.
- When a basic policy direction has been formulated, a whole host of new questions arises concerning the detailed implementation required to carry out that policy.

System dynamics models are most effectively used for purposes of general understanding or broad policy-making and design for aggregate systems. Econometrics and input-output models provide decision support in the policy design phase. Optimization techniques are most often used to select the final best operating decision at the detailed implementation stage of decision making. System dynamics, econometrics and input-output are based on simulation models.

Simulation models

The purpose of a simulation model is to mimic the real system so that its behavior can be studied. While optimization models are prescriptive, simulation models are descriptive. A simulation model clarifies what would happen given a certain situation. The purpose of simulations can be foresight (predicting how systems might behave in the future under assumed conditions) or policy design (designing new decision-making strategies or organizational structures and evaluating their effect on the behavior of the system) (STERMAN 1988: 216).

Every simulation model has two main components. First, it includes a representation of the physical world relevant to the problem under study. How much detail a model requires about the physical structure depends on the specific problem being addressed. In addition to reflecting the physical structure of the system, a simulation model must portray the behavior of the actors in the system. Behavior means the way in which people respond to different situations, i.e. how they make decisions. The behavioral component is put into the model in the form of decision making rules. These rules are determined by direct observation of the actual decision-making procedures in the sys-
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tem (STERMAN 1988: 216). Simulation models are neither restricted to analytical methods nor to quantitative variables (KEUSCH 2000: 17). One of the main uses of simulation is to identify how feedback, nonlinearity and delays interact to produce troubling dynamics that persistently resist analytical solution. The limitations of simulation models lie in the accuracy of the decision rules, the quantification of soft variables and the choice of the model boundary (STERMAN 1988: 217).

Econometrics evolved out of economics and statistics, while most other modeling methods emerged from operations research or engineering. As a consequence, the purpose and practice of econometric models differ considerably from those of other models (STERMAN 1988: 13). Econometrics is the measurement of economic relations. Econometric modeling includes three stages: specification, estimation and forecasting. Specification means defining the structure of the system by a set of equations. Then, the values of the parameters are estimated on the basis of historical data. Finally, the resulting output is used to make forecasts about the future performance of the system (STERMAN 1988: 219).

Input-output analysis is a way of representing flows of money, resources or products among producers and consumers in an economy. Input-output analysis, like econometrics, uses directly observable economic data. The basis of input-output analysis is an input-output table which is a summary of the operation of an actual economy in a particular year. It is an array of the purchases made by each industry (its inputs) and the sales of each industry (its outputs) from and to each other industry in the total economy. The input-output table can be represented by a matrix. The inverse of this matrix is the primary analytical tool of input-output analysis and enables the identification of economic linkages and dependencies (see ISARD ET AL. 1998). The assumptions of linearity and constant returns to scale limit the use of input-output analysis to short-term forecasts and to the extrapolation of marginal changes from historical conditions. However, within these limitations an input-output model can provide a disaggregated, internally consistent representation of a complex, interdependent productive system (MEADOWS AND ROBINSON 1985: 64).

Optimization models

The output of an optimization model is a statement of the best way to accomplish a goal. An optimization model typically includes an objective function, decision variables and constraints. The objective function specifies the goal or objective. The decision variables are the choices to be made. The constraints restrict the choices of the decision variables to those that are acceptable and possible. An optimization model takes as inputs these three pieces of information. It yields as its output the optimal decisions given the assumptions of the model (see HAZELL AND NORTON 1986). Optimization models are the best technique to use if the problem to be solved is one of choosing the best from among a well-defined set of alternatives (STERMAN 1988: 215).
Simulation and optimization complement each other to a certain degree. Simulation models generate information about the potential development of a system and about system perspectives. This information forms the basis for the generation of new development objectives or for the discussion of existing objectives (KEUSCH 2000: 22). Generating information and providing decision-support corresponds closely to the research goal of this study.

2.2 System dynamics: simulation for policy analysis from a feedback perspective

System dynamics is in the first place a body of theory dealing with information feedback systems. The simulation technique becomes necessary to reveal the behavior of the system because often, analytical solutions are infeasible (VENNIX 1996: 43f). This section describes the main characteristics of the system dynamics approach. The conceptual tools of the field are explained in section 2.2.1. Section 2.2.2 presents the simulation method.

2.2.1 Conceptual tools

The basic elements of system dynamics are feedback thinking, stocks and flows, the concept of feedback loop dominance and an endogenous point of view. Unless otherwise indicated, the following descriptions are based on RICHARDSON (1991a).

Feedback thinking

The feedback concept is at the heart of the system dynamics approach. Diagrams of loops of information feedback and circular causality are tools for conceptualizing the structure of a complex system. A feedback loop exists when information resulting from some action travels through a system and eventually returns in some form to its point of origin. The dynamic behavior arises from the temporal sequence of information that produces actions which have consequences generating further information and actions.

Feedback is said to be negative when the modification in a component leads other components to respond by counteracting that change. For example, the need for food in the city caused by workers migrating to the city leads to a demand for more laborers in the farmlands. Negative feedback is often the engine that drives supply and demand cycles toward some equilibrium. The word ‘negative’ does not imply a value judgment. Instead, it indicates that feedback tends to negate initial changes (RUTH AND HANNON 1997: 8).

1 For problems in integrating simulation and optimization see ANDERSEN AND ROHRBAUGH (1992). For a comparison of policy implications between simulation and optimization see ANDERSEN (1980) and KOPAINSKY ET AL. (2003).
Feedback is said to be positive when the original modification leads to changes that reinforce the component that started the process. In the same example as above, the migration of farm workers to a city attracts more manufacturers to open plants in that city, which attracts even more workers (Ruth and Hannon 1997: 8).

Negative feedback processes tend to counteract a disturbance and lead systems back towards an equilibrium or steady state. One possible outcome of market mechanisms is that demand and supply balance each other or fluctuate around an equilibrium point, due to lagged adjustments in the productive or consumptive sector. In contrast, positive feedback processes tend to amplify any disturbance and to lead systems away from equilibrium (Ruth and Hannon 1997: 9).

Figure 2-2 shows an example of a positive and a negative feedback loop for the case of a simple population model. In the remainder of this study, the term ‘reinforcing feedback loop’ is preferred to ‘positive feedback loop’ and ‘balancing feedback loop’ is preferred to ‘negative feedback loop’.

**Figure 2-2: Positive and negative feedback loops in a simple population model**

Arrows indicate the direction of causality. Signs ('+' or '-') at arrow heads indicate the polarity of relationships: a '+' denotes that an increase in the independent variable causes the dependent variable to increase, ceteris paribus (and a decrease causes a decrease). That is, \( X \rightarrow Y \Leftrightarrow \frac{\Delta Y}{\Delta X} > 0 \). Similarly, '-' indicates that an increase in the independent variable causes the dependent variable to decrease; that is, \( X \rightarrow Y \Leftrightarrow \frac{\Delta Y}{\Delta X} < 0 \). The loop identifier (R) indicates a reinforcing feedback loop, (B) a balancing feedback loop.

**Stocks and flows**

Stocks (population in the example above) and the flows that affect them (birth and death rate) are essential components of system structure. A map of causal influences and feedback loops is not enough to determine the dynamic behavior of a system. Stock variables are accumulations and indicate the status of the system through time. They are the basis for the calculation of all the rest of the variables in the model (Ruth and Hannon 1997: 8). Flows increase or decrease a stock over some time interval (Vennix 1996: 70). A constant inflow, i.e. an inflow that is independent of the value of a stock, yields a linearly rising stock; a linearly rising inflow yields a stock rising along a parabolic path and so on. Flows represent the operating policies (decisions) of a system. They correct a discrepancy between a desired and an observed system state.

In Figure 2-3, the simple population model from above is translated into stock and flow format. The stock and flow format generally includes more detail. It contains all the necessary information to determine the dynamic behavior of a system. Thus, in the
population example, births and deaths are replaced by the more operational formulation of two flows (birth rate and death rate) that depend on the value of the stock (population) and a fractional change rate (fractional birth rate and fractional death rate).

Figure 2-3: Stock and flow representation of population development

Stocks are represented as rectangles, suggesting a container holding the contents of the stock. Inflows are represented by a pipe pointing into (adding to) the stock, outflows are represented by pipes pointing out of (subtracting from) the stock. Valves control the flows.

Feedback loop dominance and nonlinearity

Nonlinear relationships complicate the study of feedback processes. A nonlinear relationship occurs when a control variable does not increase in direct proportion to another variable but changes in a nonlinear way. Nonlinear processes can cause a system to exhibit complex behavior (RUTH AND HANNON 1997: 9). A crucial requirement for a powerful view of a dynamic system is the ability of a model to change the strengths of influences as conditions change, i.e. the ability to shift active or dominant structure.

In a system of equations this ability to shift loop dominance comes about endogenously from nonlinearities in the system. The S-shaped dynamic behavior of a logistic growth model \( \frac{dP}{dt}=aP-bP^2 \) can be seen as the consequence of a shift in loop dominance from a positive, reinforcing feedback loop \( (aP) \) producing exponential-like growth to a negative, balancing loop \( (-bP^2) \) that brings the system to its eventual goal. Only nonlinear models can endogenously alter their active or dominant structure and shift loop dominance. For a formal analysis of loop dominance see RICHARDSON (1995) and MOJTAHEDZADEH ET AL. (2004).

Population development as a consequence of births and deaths follows the same structure (Figure 2-4). No real quantity can grow forever. Every system initially exhibiting exponential growth will eventually approach the carrying capacity of its environment. The carrying capacity can range from food supply to the potential market for a new product. As the system approaches its limits to growth, it goes through a nonlinear transition from a regime where reinforcing feedback dominates to a regime where balancing feedback dominates. The result is often a smooth transition from exponential growth to equilibrium, i.e. S-shaped growth (right half in Figure 2-4).

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2 The behavior mode of the logistic growth model depends on the initial value of \( P \). S-shaped growth only occurs with very low \( P_0 \).
**Endogenous point of view**

The shift from reinforcing to balancing loop dominance in the simple population example above is not engineered from outside the system; it happens internally as the system develops over time. With an endogenous point of view, the causes of system behavior are contained within the structure of the system itself. Exogenous disturbances are seen as triggers of system behavior.

For the purpose of this study, adopting an endogenous point of view means looking for sources of employment and population development within the structure and the policies (decision rules) of rural areas themselves. The goal is to view problems as consequences of a complex system of interacting subsystems, not as the unavoidable result of exogenous disturbances.

### 2.2.2 Simulation method

Dynamic simulation models are sets of equations that describe the behavior of dynamic systems. The models study cause and effect. Given specified initial conditions and assumed behavioral parameters, the models trace the changes in key variables over time and allow seeing the dynamic implications of the assumptions (RUTH AND HANNON 1997: 7).

Mathematically, the basic structure of a formal dynamic simulation model consists of a system of coupled, nonlinear, first-order differential (or integral) equations,

$$\frac{d}{dt} x(t) = f(x, p),$$

where $x$ is a vector of levels (stocks or state variables), $p$ a set of parameters and $f$ is a nonlinear vector-valued function (RICHARDSON 1991A: 145).
Simulation of such systems is accomplished by partitioning simulated time into discrete time intervals of length $dt$ and stepping the system through time one $dt$ at a time. Each state variable is computed from its previous value and its net rate of change $x(t)$,

$$x(t) = x(t - dt) + dt \cdot x'(t - dt) \quad \text{(RICHARDSON 1996: 807)}.$$

By breaking the simulated time into discrete intervals $dt$ simulation makes possible the creation and use of models that cannot be solved in closed form. Simulation thus expands the range and complexity of problems that can be modeled (RICHARDSON 1991A: 159). Other authors assess this ability as one potential weakness of simulation models (see KEUSCH 2000: 18).

2.2.3 Modeling process

The modeling process consists in several stages. LUNA-REYES (2004: 44ff) compares the organization of the modeling process across the classic literature. While the literature distinguishes between three and seven different steps, the activities considered along the different stages remain approximately the same. VENNIX (1996) gives a concise overview over the modeling process, which STERMAN (2000) describes in detail. This overview distinguishes six phases originally proposed in RICHARDSON AND PUGH (1989)$^3$ and provides the basis for the following descriptions.

Problem definition

In order to build a model one needs a clear purpose and one needs to focus on a problem rather than a system. This means that a clear purpose is needed to focus the study and to decide what to include in the model and what to leave out.

The process of model building starts with the identification of some problematic behavior. This behavior can be sketched over time in one or more graphs and is called the ‘reference mode of behavior’. Confidence in the simulation model increases when the model is capable of replicating this reference mode of behavior.

In cases where data for a reference mode of behavior from the system might be lacking it is still useful to think of what kind of time series the model will have to generate and how this will be helpful in the study of the problem. A second important element in problem identification is the time horizon, i.e. the time over which the behavior of the system will be studied.

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$^3$ The seventh phase, model use or implementation, is omitted as this study is primarily concerned with understanding of the system.
System conceptualization

An important step in conceptualizing a system for modeling is to settle on the system boundary. The boundary determines what is considered to belong to the system and what is not. Given the purpose of the modeling effort, the question is whether some element needs to be included in the model or not.

The second step in conceptualizing a system is accomplished by identifying causal relationships between the elements of the system and by detecting feedback processes.

Model formulation

An important step in the model-building process is to specify mathematical equations for each of the relationships in the model and to quantify the model’s parameters.

An important check of the internal consistency of a model is the so-called ‘dimensional consistency check’. The check entails that for each equation in the model the dimensions on the left hand side and the right hand side need to match.

Before a model can be run on a computer, it has to be calibrated, i.e. the parameters in the model have to be provided with a numerical value. One set of parameters are the initial values for the stocks. Another set are the constants in the model.

There are several ways to determine parameter values in system dynamics models (see Richardson und Pugh 1989, Graham 1980, Peterson 1980 and Kleijnen 1995). Data can either be found in statistical yearbooks or derived from databases, or they have to be estimated. This also applies to qualitative variables. Qualitative variables represent the intangible influences on decisions. Omitting them because they are unmeasured or unmeasurable would be equivalent to saying they have zero effect, probably the only value that is known to be wrong (Forrester 1961: 57). One of the goals of testing the model by means of a number of sensitivity analyses is to find out which parameter changes have a significant effect on model behavior and thus need to be estimated as accurately as possible.

Analysis of model behavior

Sensitivity analyses serve two important purposes. First they are useful to better understand the model. Second, through sensitivity analysis sensitive parameters in the model can be located.

Tests with the simulation model are conducted by first establishing a base run. This is a run with the model in its standard form. The standard form can either be the situation where the system is in equilibrium or the run which replicates the reference mode of behavior. A standard run is needed as a base of comparison. Next runs are conducted by changing one parameter at a time and studying the result of changes in the structure on the behavior of the model by comparing the outcome with the base run. The most
important tests are those in which one or more feedback loops are deactivated. Comparison of the base run with this type of run shows the exact effect of a feedback loop on model behavior.

If a sensitive parameter is located, there are three possibilities:

1. One might decide to estimate the parameter as carefully as possible.
2. One might decide to refine the model in order to capture the aggregate process, of which the parameter was the expression, in some more detail.
3. If parameter sensitivity corresponds to sensitivity in the real system, one might have located a leverage point in the system, i.e. a point with which to drastically affect the behavior of the system.

Model validation

Model validation is the process of establishing confidence in the soundness and usefulness of a model (FORRESTER AND SENGE 1980: 210). The validation process of the system dynamics model includes testing model structure as well as model behavior (BARLAS 1996). Structure validation is concerned with warranting that the internal structure of the model is a sufficiently accurate description of the real system, with respect to the issue of interest. Behavior validation means that the output behavior of the model reproduces closely enough the dynamic behavior of the real system under study (BARLAS ET AL. 2000: 53). BARLAS (1996), FORRESTER AND SENGE (1980) and STERMAN (2000) provide a detailed overview of a large number of model tests.

Tests that concern model structure include the dimensional consistency check discussed above. Another test is whether experts on the system agree that the structure of the model is an adequate representation of the system.

Tests that focus on the behavior of the model employ sensitivity analyses to find out whether the model is not too sensitive to small changes in parameters. A test which is closely related to sensitivity analyses is the extreme conditions test. In this case the model is subjected to extreme conditions to see whether it behaves in a reasonable way.

Finally, there is the test of replication of the reference mode of behavior. In this case, the time series for a particular variable which is produced by the model is compared to a time series perceived in the real system. The central question is whether the time series produced by the model matches the one from the real system. No model will exactly replicate the time series from the system. In this context it is important to emphasize that simulation models aim at identifying behavior patterns rather than attempt to make exact predictions. Typical patterns are sustained growth or decline and sudden changes from growth to decline or the other way round. Others include damped or expanding oscillation. The focus therefore must be on patterns of behavior and the model should be able to replicate these patterns.
Replication of the reference mode of behavior should not be over-estimated. SAEED (1992) observes that many models precisely track a particular history but they are so closely tied to the specific behavioral pattern they reproduce that they may not contain the policy space for designing any mechanisms of change. He therefore proposes slicing a complex problem into smaller subsystems and to develop a policy design based on the many models representing these subsystems. These models consequently reproduce only parts of the reference mode of behavior.

**Policy analysis**

Policy analyses focus on changes of decision points in the model and their effects on certain outcome variables. Changes in decision functions can involve parameter changes and structural changes.

A good policy needs to be relatively insensitive to changes in the model as no model is perfectly valid. The final objective of policy analysis is to find robust policies. The notion of robustness is a very important one as dynamic models are designed for the analysis of system stability (PFISTERER-POLLHAMMER and KNOFLACHER 1998: 41).

Insights from policy analysis can be system specific or more generic. RICHARDSON (1991a: 165) summarizes generic simulation-based policy insights from the system dynamics literature. Among these are:

- **Insensitivity:** Complex systems are remarkably insensitive to changes in many system parameters.
- **Compensating feedback:** Complex systems counteract and compensate for externally applied corrective efforts.
- **Policy resistance:** Complex systems resist most policy changes.
- **Leverage points:** Complex systems contain influential pressure points, often in unexpected places, from which forces will radiate to alter system balance.
- **Worse-before-better and better-before-worse behavior:** Complex systems often react to a policy change in the long run in a way opposite to how they react in the short run.
- **Drift to low performance:** Complex social systems tend toward a condition of poor performance.

Additional generic insights are investigated in the literature about system archetypes (SENGE 1990, WOLSTENHOLME 2003).

**2.3 Application and combination with other research methods**

Criticism about the system dynamics approach centers on the empirical underpinnings of the models and on the prominent failure of taking account of behavioral adjustments operating through the price mechanism (PERMAN ET AL. 1996: 14). STREIT (2004: 225)
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argues in the same direction by saying that systems approaches are analytically weak compared to competing paradigms in economics. This study therefore bases the system dynamics modeling approach on economic theory and integrates either the analytical logic or results from other modeling approaches as far as possible. This integration and combination has to be differentiated in terms of the phases in the model building process described above. Figure 2-5 provides an overview of the application of the system dynamics approach and the combination with other research methods.

- Problem definition: For the development of a clear focus of the modeling effort, several points are considered. An economic analysis of rural areas clarifies the problems of these areas and the processes affecting employment and population development. Statistical data about employment and population and results from related analytical studies such as input-output analyses explore development trends and the current situation in detail. An analysis of regional policy as public policy and the discussed reform in Swiss regional policy leads to the formulation of specific questions that the simulation model has to address.

- System conceptualization: The elements in the system and the relationships between them are derived from theories that bear on the issue of employment and population development in lagging rural areas. In order to distill the feedback processes in these theories, related theories are also analyzed.

- Model formulation: The quantification of the relationships is based both on the analyzed theories and on related analytical studies. Input-output analyses for lagging rural areas in Switzerland (summarized in BUSER 2005) are important both to capture the relevant economic relationships and to estimate economic parameters. Employment and population related parameter values are based on statistical data. For sociopolitical aspects, data are taken either from the literature about case studies or from the literature about related studies such as innovation implementation efforts.

- Analysis of model behavior and model evaluation: The analysis of model behavior includes sensitivity analyses of model parameters and the question whether model sectors reproduce the behavior predicted by theories and related studies.

The unit of analysis in the model-building process is the community. This study focuses on the local dimension of employment and population dynamics in rural Switzerland. From a social and political point of view the local community has been an important entity. It constitutes a basis for socialization, a source for social support, a channel of information and an important component of identity (REIMER 2002: 846f and quoted literature). The analysis of rural locales also makes sense from a policy development point of view. Implementation and impact of national policies are significantly altered depending on the characteristics of the communities (REIMER 2002: 847). While the value and definitions of community continue to be a controversial issue within the social sciences (for an overview see REIMER 2002: 847), the level of analysis for this study is the lowest administrative subdivision in the Swiss census.
This subdivision is a political and not a geographical one, i.e. it is possible that a community consists of several spatially separated parts. Often, the discussion about the maintenance of a decentralized settlement of the country concerns only these individual parts and not the entire community. However, with the focus of this study it is not possible to make this small-scale difference.

The purpose of the model building effort is to identify generic processes and determinants of employment and population development in lagging and particularly vulnerable communities in Switzerland. Chapter 3 will provide an in-depth analysis of these areas. The model will be built for the typical development of these communities and not for the exact development of specific case study communities. The general theory about population and employment development is embodied in the structure of the model. The special cases are embodied in the parameters. Case studies will therefore be used for validation purposes.

**Figure 2-5: Procedures and research methods applied in this study**

- **Problem statement**
  - Model purpose
  - Political debate
  - Economic analysis

- **Economic, social, and political environment**
  - Agricultural policy, economic situation, social norms, technology, tourism, export markets, regional policy

- **Variables for policy & sensitivity analysis**

- **Model structure**
  - Model quantification
  - Data and parameters

- **Model quantification**
  - Validation
  - Policy & sensitivity analysis

- **Data and parameters**

- **Validation**
  - Policy & sensitivity analysis

- **Policy & sensitivity analysis**

- **Need for actions**
  - Set of potential actions
  - Economic dependencies
  - System stability
  - Leverage points for policies

SSA: Shift Share Analysis; IOT: Input-Output Table; LP: Linear Programming
3 Economic analysis of regional rural development

This chapter aims at introducing the object of investigation. It starts with a brief discussion about the term ‘rural areas’ (section 3.1) and proceeds with identifying the main stakeholders and their claim to rural areas (section 3.2). From these claims, both the functions of rural areas can be derived and the defining features of successful function fulfillment (section 3.3). Section 3.4 analyzes how structural change affects rural development. Structural change has led to different development patterns in rural areas depending on their differing locational and socioeconomic characteristics. Section 3.5 describes these patterns in detail. In section 3.6 conclusions regarding the economic analysis of regional rural development are drawn and translated into research questions for the ensuing chapters.

3.1 Rural areas and rural development

Traditionally defined, rural areas are remote, sparsely populated and often dependent on natural-resource-based industry. Distance from the centre of markets makes rural areas less attractive to people and to industry that is not materials-oriented (Kilkenny 1998a: 293). These established characteristics are, however, not sufficient anymore to allow for much of the current reality in industrialized countries (Bathelt and Glückler 2002: 67).

The theoretical and practical significance of rural areas in industrialized countries is the centre of significant debate (see Reimer 2002: 846 and quoted literature). The traditional focus on rural areas from a sectoral, primarily agricultural point of view is giving way to new representations of territorial settlement. New technologies, markets, systems of governance and concerns have meant that the functions of rural areas have become more extensive and complex (see section 3.4). Broadly speaking, three approaches to more appropriate frameworks for these changes can be identified (Reimer 2002: 846):

1. First, there are those who argue that the urban-rural distinction is becoming less important or even irrelevant. The reduction in power of rural interests is considered as an expected outcome of the new economies centered in urban regions.

2. Second are those who examine rural places because they have special consequences in the face of external changes. Attention is given to rural areas because they face specific challenges related to these external forces, not because they drive the economy in a significant way.

3. The third approach is to treat rural areas as being proactive in the new economies and providing functions that are sustainable and non-substitutable in their own right.
This study does not take a strong position on one or another of these approaches. Instead, it adopts a more strategic approach by starting with the local unit of analysis and differentiating between socioeconomic types of lagging communities (section 3.4) without engaging in the debate whether these communities are rural or non-rural. It proceeds with identifying particularly vulnerable areas (section 3.5.2) which will be the unit of any further analyses.

Despite the ambiguity inherent in the term of rural areas, a series of characteristics distinguish rural economies from other economies (ERRINGTON 2000: 117f):

- The wider geographical dispersion of consumers and producers compared with urban areas. This generally gives rise to higher transaction costs and higher transport costs which are the key feature of markets in rural areas and a prime driving force behind historic trends towards increased urbanization.

- The prevalence of small firms. These firms experience numerous difficulties by virtue of their size, particularly in terms of their market power, their ability to acquire new skills and to develop and adopt new technologies and working practices.

- The presence of a wide variety of public goods to which many of the stakeholders listed in section 3.2 attach very high values, particularly in relatively densely populated countries.

Development is an equally vague term as rurality and can only be defined clearly when applying value judgments. In a narrow sense, development equals economic development or economic growth, respectively and can be measured as a rise in output (GDP), a rise in GDP per capita or a rise in output per worker (ARMSTRONG AND TAYLOR 2000: 66). While economic growth clearly is not equivalent to development it is nevertheless an important component of it.

In a broader sense, ecological, social, cultural and political dimensions are added to the economic dimension. These dimensions are, among others, discussed to detail in the sustainable development literature (e.g. DALY 1996). The sociocultural dimension, for example, reflects cultural needs and community identity and the political dimension refers to political decision-making and the involvement of groups of individuals in the policy process (MOULAERT AND SEKIA 1999: 10).

Rural development in an economic analysis does not simply mean the nominal operation of the rural economy in a narrow or broad sense, but its structural and behavioral change. Rural development policy is then the active promotion of such change (THOMSON 2001: 9; for rural development policy see chapter 4).

3.2 Stakeholders in rural areas

Rural development occurs as a consequence of premeditated changes in human activity which seek to use resources within the rural area in order to increase human well-being. It therefore has to be understood as deliberate change which seeks to make bet-
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ter use of all types of rural resources in order to increase the well-being of humanity (ERRINGTON 2000: 116). According to this definition, those changes in human activity which safeguard or enhance environmental quality and increase human well-being in that way are just as much part of rural development as those which provide jobs or increase incomes.

A variety of different groups of people are involved in these activities. According to ERRINGTON (2000: 116f) the following stakeholders can be identified. With respect to subsequent chapters, the main activities of these stakeholders are added:

- Those who own land in rural areas. These stakeholders demand and supply labor as well as supply and demand goods.
- Those who live in rural areas. These stakeholders demand goods, supply labor and engage in sociopolitical activities.
- Those who work or run businesses in rural areas. These stakeholders demand labor, supply goods and invest capital.
- Those who visit rural areas for recreation. These stakeholders have tourist demand for rural goods and services.
- Those who, without physically being in rural areas, derive feelings of well-being from the reassurance that the countryside will continue to exist in some particular form. The utility these stakeholders draw from rural areas is related to the economic concept of existence values (PERMAN ET AL. 1996: 253).
- Those not yet born who will at some stage in their lives fall into one of the above categories. These stakeholders' utility refers to the economic concept of option and bequest values (PERMAN ET AL. 1996: 253).

From the last two stakeholder groups, public demand for the provision of rural goods and services can be derived. Strictly speaking, public demand would have to reflect both the preferences and the willingness to pay of these stakeholders.

This long list encapsulates one of the problems of rural development in industrialized countries. Rural areas have become to play so many different roles for so many different groups that there is a substantial problem in achieving balance between the interests of these different stakeholders (ERRINGTON 2000: 117).

3.3 Functions of rural areas

Traditionally, rural areas served the purpose of providing cities with food. Agriculture is, however, losing its predominant position in rural employment and settlement. On the other hand there is a growing demand for non-commodity uses of rural lands such as recreation for an increasingly mobile and leisure-oriented urban population and ecological compensation as a reaction to growing environmental problems (MÜHLINGHAUS 2002: 15f). Beside these functions that mainly satisfy the needs of external ac-
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tors, rural areas serve the internal purpose of providing living space and space for economic activities and leisure for the rural population (HENKEL 1999: 35). Figure 3-1 summarizes these considerations.

**Figure 3-1: Functions of rural areas in industrialized countries**

At the centre of Figure 3-1 are rural areas with their primary purpose of providing space for living, economic and recreational activities for the rural population itself. Ecological compensation, production and recreation services are not dependent on permanent settlements of people in rural areas. If, however, settlement is a social and political goal, the figure also shows that some conditions have to be fulfilled. For the case of agrarian communities, these normative conditions are illustrated in Figure 3-2. Communities with other predominant economic sectors work in a comparable way. The analytical framework shows the minimum requirements for the population to continue living in the community. These requirements are divided into several categories (RIEDE ET AL. 1999: 133f).

The first level includes the individual farm. In agrarian communities agriculture is the predominant economic sector without which settlement of the entire community would be threatened. The second level, agricultural institutions, supports individual farms by self-help among farmers which is necessary for the survival of individual farms.

The third level contains the basic goods and services that are essential for daily life to function normally. These activities necessarily have to be available locally for the stakeholders to fulfill their daily physical and social needs. Due to cost reasons, a

Source: HENKEL 1999: 36

24
minimum number of people have to live in a community otherwise it will be difficult to maintain these activities.

The *fourth level* describes institutions that are ideally available in the surrounding region. Region in this case is understood as the space within the distance that people are willing to cover for the occasional consumption of services.

*Figure 3-2: Community framework for agrarian communities*

| 4 | Agricultural extension services, higher education, vocational schools, public transportation |
| 3 | Carpenter and joiner, garage, private transportation |
| 2 | Collective farming, farm cooperatives |
| 1 | Farm |

- Markets: buying and selling markets for daily requirements
- Fire brigade, temporary personnel for farmers, municipal administration, part-time employment for farmers
- Medical care, lawyers, hospital, waste management
- Markets: buying and selling markets for non-daily requirements

1 individual farm 3 community institutions
2 agricultural institutions 4 regional institutions

*Source: Rieder et al. 1999: 113*

The normative condition of this analytical framework is that the requirements on these four levels have to be fulfilled. As a consequence of meeting the private needs of the local population, services in the realm of ecological compensation, recreation and production are also available. These services partly or entirely satisfy public demand. It can also be assumed that the pull-forces for people to out-migrate from a community are relatively low if their requirements on the four levels are met.

The framework is especially important in the context of structural change in agriculture. In the last decade, employment in the agricultural sector has continued to decline at approximately 2.5% per year (BLw 2003). Maintaining a decentralized settlement of the country implies that a sufficient number of alternative employment opportunities have to be created in the other economic sectors. If such a strategy fails the remaining farmers will have no incentive to continue to live in the community in the long run because their requirements on the second, third and fourth level are not met.
Table 3-1 summarizes the discussion about stakeholders, functions and the normative conditions for fulfilling the functions. Based on the claims that stakeholders have towards rural areas, five main functions of rural areas are distinguished: housing and sociocultural activities; economic development; agricultural production; ecological compensation; recreation and leisure. The first three functions are internal functions whereas the last two are mainly external i.e. external stakeholders derive benefit from their fulfillment. Landscape, for example, is a by-product of agricultural production and mainly satisfies the claims of external actors. The last column in Table 3-1 contains a selection of the private and public goods resulting from stakeholders’ activities.

**Table 3-1: Stakeholders, functions, goods and services of rural areas**

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Functions for stakeholders</th>
<th>Goods and services resulting from stakeholders’ activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Those who cultivate land in rural areas</td>
<td>Agricultural production</td>
<td>Private goods: Food</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public goods: see recreation and leisure and ecological compensation.</td>
</tr>
<tr>
<td>Those who live in rural areas</td>
<td>Housing and sociocultural activities</td>
<td>Private goods: informal activities, membership in associations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public goods: cultural diversity, retention of community ties, communal self-help in the provision of both services and</td>
</tr>
<tr>
<td>Those who work or run a business in rural areas</td>
<td>Economic development</td>
<td>Private goods: production of goods and services.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public goods: contribution to balanced communities containing inhabitants varied in age, economic and social status.</td>
</tr>
<tr>
<td>Those who visit rural areas for recreation</td>
<td>Recreation and leisure</td>
<td>Private goods: recreation infrastructure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infrastructure related public goods: development.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Landscape related public goods: scenery and variety of landscapes, experience of biodiversity.</td>
</tr>
<tr>
<td>Those with utility drawn from the reassurance that the countryside will continue to exist and those not yet born who will fall into one of the above categories in the future</td>
<td>Ecological compensation</td>
<td>Public goods: ecosystem functions and biodiversity.</td>
</tr>
</tbody>
</table>


For the purpose of this study, the stakeholder group of those who own land is subsumed with the stakeholder group of those who work or run a business in rural areas. As a consequence, agricultural production is treated as part of economic development.
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The functions of rural areas are also affected by the supply side. The supply side encompasses economic and social activities of the stakeholders. If there are sufficient such activities, the demand can be met and the functions can be fulfilled.

If demand and supply are combined, two observations can be made:

1. The market for private goods shows low demand intensity due to low population levels. As a consequence, natural monopolies for the supply of private or public services can develop where only few or no more than one supplier have the possibility to survive.

2. In the realm of public goods the familiar problem arises that there is little or no incentive for actors to provide a sufficient amount of the goods concerned. Additionally, the value of public goods within the recreation and ecological compensation functions is expressed at the local level and at a non-local level at the same time. According to the principle of fiscal equivalence (Olson 1969, in Urfei 1999: 32) public goods with such features have to be regulated at different political levels in order to be provided to an optimal degree (Häfliger and Rieder 1996: 9).

From an economic point of view the viability of a community and the fulfillment of the different functions thus depend on two conditions. First, local demand and demand from external actors together have to be so high that suppliers are willing to continue producing. Sufficient local demand equates with a minimum population size and a sound population structure. Second, the supply of public goods has to be regulated on the optimal political level.

3.4 Structural change and regional rural development

Over the last two decades, there have been major changes in the economic structure of rural and non-rural areas alike. There have been shifts in the level and distribution of employment between sectors, changes in the nature of firms and in the relative importance of the private and public sectors. All have occurred within the context of increased global competition, new production organizations and technologies and industrial restructuring (Roberts and Thomson 2003: 61f). The drivers of structural change in peripheral rural areas can either stem from changes in final demand or changes in input-output relationships. Changes associated with input-output relationships in the economy can be brought about by two factors: changes in production technology and changes related to the origin of inputs (Figure 3-3).
The sources of structural change shown in Figure 3-3 are in a dynamic interplay with the market environment and political conditions. These conditions determine the success of a single firm and on an aggregate level the success of a regional economy. Success of a regional economy can be equated with regional economic growth. As the demand for locally produced goods is exogenous in the short run, the success of a regional economy depends on the competitiveness of its firms and thus on the supply side of production. Demand and supply conditions are influenced by public policies and nongovernmental conditions. These conditions are listed in detail in Table 3-2.

Source: ROBERTS AND THOMSON 2003: 64
**Economic analysis**

**Table 3-2: Market, governmental and nongovernmental conditions influencing regional economic growth**

<table>
<thead>
<tr>
<th>Market conditions</th>
<th>Governmental and nongovernmental conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demand conditions</strong></td>
<td><strong>Governmental influences on demand conditions</strong></td>
</tr>
<tr>
<td>- High quantitative demand</td>
<td>- Open domestic market</td>
</tr>
<tr>
<td>- High qualitative demand</td>
<td>- Open international markets</td>
</tr>
<tr>
<td>- High income elasticity of demand</td>
<td>- Expansion of markets through low transaction costs (infrastructure, legislation, administration, taxes)</td>
</tr>
<tr>
<td>- Big domestic market</td>
<td></td>
</tr>
<tr>
<td>- Easy access to international markets</td>
<td></td>
</tr>
<tr>
<td><strong>Supply conditions</strong></td>
<td><strong>Governmental influences on supply conditions</strong></td>
</tr>
<tr>
<td>High availability and low prices of:</td>
<td>- Open domestic market</td>
</tr>
<tr>
<td>- Production factors</td>
<td>- Open international markets</td>
</tr>
<tr>
<td>- Production inputs</td>
<td>- Optimal density of regulations</td>
</tr>
<tr>
<td>- Raw materials</td>
<td>- Monetary stability</td>
</tr>
<tr>
<td>High productivities and high growth rates of productivities through</td>
<td>- Favorable fiscal conditions</td>
</tr>
<tr>
<td>- Investment</td>
<td>- High availability of subsidiary public goods and facilities</td>
</tr>
<tr>
<td>- Innovation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Governmental influences on demand conditions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>High availability and low prices of:</td>
</tr>
<tr>
<td>- Production factors</td>
</tr>
<tr>
<td>- Production inputs</td>
</tr>
<tr>
<td>- Raw materials</td>
</tr>
<tr>
<td>High productivities and high growth rates of productivities through</td>
</tr>
<tr>
<td>- Investment</td>
</tr>
<tr>
<td>- Innovation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Nongovernmental influences on demand conditions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Market size (population number, level of wealth)</td>
</tr>
<tr>
<td>- Preferences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Nongovernmental influences on supply conditions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Economic mentality of the population (knowledge, skills, experience, efficiency)</td>
</tr>
<tr>
<td>- High availability of subsidiary private goods and facilities such as human capital</td>
</tr>
<tr>
<td>- Existence of good trade relations</td>
</tr>
<tr>
<td>- Existence of complementary sectoral structure</td>
</tr>
<tr>
<td>- Existence of economic synergies e.g. through networks</td>
</tr>
</tbody>
</table>

Source: adapted from KLEINEWEFERS 1997: 6

Table 3-2 shows that regional economic growth and development is determined by a variety of factors. These factors exercise push- and pull-forces on a region. Depending on the combination of these forces and on locational characteristics, the effects of these forces on regional rural development can differ widely.
3.4.1 Effect of push- and pull-forces on interregional flows of production factors

Regional flows of production factors lead to changes in final demand, in sources of input and in technology (see Figure 3-3 about sources of structural change). For the analysis of the structure and development of a region it is useful to distinguish four generic development types (Figure 3-4). The types are defined according to the two criteria of economic growth and wealth. Both criteria are closely related to regional income.

**Figure 3-4: Regional development types**

<table>
<thead>
<tr>
<th>Wealth</th>
<th>Low Growth</th>
<th>High Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td><em>Problem region</em></td>
<td><em>Development region</em></td>
</tr>
<tr>
<td>High</td>
<td><em>Potential problem region</em></td>
<td><em>Highly developed growth region</em></td>
</tr>
</tbody>
</table>

Source: adapted from Frey and Schaltegger 2000: 3-12

The mobility of goods and production factors heavily influences regional economic growth, spatial disparities and spatial structures. Figure 3-5 to Figure 3-7 describe in which direction the production factors labor, capital and know-how flow *ceteris paribus*, given rational behavior of stakeholders and decision makers.

According to the human capital model, the direction of labor flows is determined by the income difference between alternative locations. Other determinants of migration are e.g. costs of living, the quality of housing, environment and recreation, public services and taxes, families and friends. Based on these factors, a simple migration model for the four development types in Figure 3-4 can be constructed (Figure 3-5).

---

4 This section builds on Frey and Schaltegger (2000: 3-28 to 3-35).
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**Figure 3-5: Direction of labor flows**

<table>
<thead>
<tr>
<th>Wealth</th>
<th>Low</th>
<th>Growth</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Problem region</td>
<td>Development region</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Push: w low UE high</td>
<td>w low UE low</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Potential problem region</td>
<td>Highly developed growth region</td>
<td></td>
</tr>
<tr>
<td></td>
<td>w high UE high</td>
<td>Pull: w high UE low</td>
<td></td>
</tr>
</tbody>
</table>

\(w = \text{wages}, \ UE = \text{unemployment}\)

**Source:** FRY AND SCHALTEGGER 2000: 3-31

Capital is adjusted when differences in the rate of return or in the savings rate occur between regions. Development and growth regions achieve high rates of return. The savings rate, on the other hand, is high in potential problem regions and in growth regions. The resulting capital flows are shown in Figure 3-6.

**Figure 3-6: Direction of capital flows**

<table>
<thead>
<tr>
<th>Wealth</th>
<th>Low</th>
<th>Growth</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Problem region</td>
<td>Development region</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pull: r low s low</td>
<td>r high s low</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Potential problem region</td>
<td>Highly developed growth region</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Push: r low s high</td>
<td>Pull: r high s high</td>
<td></td>
</tr>
</tbody>
</table>

\(r = \text{rate of return}, \ s = \text{savings rate}\)

**Source:** FRY AND SCHALTEGGER 2000: 3-32

Know-how is a production factor that is of special importance for technical progress. In the broad sense of the term it comprises product and process innovation. Know-how flows are determined by research and development and the reception capacity for new knowledge and innovation. These flows are shown in Figure 3-7.
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Figure 3-7: Direction of know-how flows

<table>
<thead>
<tr>
<th>Wealth</th>
<th>Problem region</th>
<th>Development region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low Rlow</td>
<td>High Pull Rlow</td>
</tr>
<tr>
<td></td>
<td>Tlow Ilow</td>
<td>Tlow Ihigh</td>
</tr>
<tr>
<td>High</td>
<td>Potential problem region</td>
<td>Highly developed growth region</td>
</tr>
<tr>
<td></td>
<td>Push Rhigh</td>
<td>Pull Rhigh</td>
</tr>
<tr>
<td></td>
<td>Thigh Ilow</td>
<td>Thigh Ihigh</td>
</tr>
</tbody>
</table>

R = research, T = transformation capacity, I = innovation activity

Source: FREY AND SCHALTEGGER 2000: 3-34

Of specific interest for lagging rural areas is the fact that none of the flows in Figure 3-5 to Figure 3-7 points in the direction of problem regions. This would imply that the result of economic development is rather divergence than convergence.\(^5\) For Switzerland, however, no unambiguous, empirical trend can be identified (FREY UND SCHALTEGGER 2000: 3-39). The challenge for problem regions is therefore to initiate a transformation process towards any of the other three regional development types. The purpose of this study is to identify the preconditions and leverage points for such a transformation to occur.

3.4.2 Effect of push- and pull-forces on intraregional settlement and cultivation of landscape

The flow of production factors out of lagging rural areas affects the fulfillment of both internal and external functions. While the maintenance of a decentralized settlement belongs mostly to the internal functions, the maintenance and cultivation of the landscape through agriculture is above all an external function. The fulfillment of these two goals depends on the combination of economic push- and pull-forces. In this case, push- and pull-forces refer to agriculture. Push-forces result from the situation in the agricultural sector itself. Push-forces are high when structures are unsuitable for efficient production. In this case, incomes generated by agricultural production are low. Pull-forces affect agriculture from the side of the overall economy. Pull-forces are high when opportunity costs for agricultural employment are high, i.e. when the manufacturing and service sector offer alternative employment that is both better paid and compatible with farmers’ qualifications.

\(^5\) There is a vast body of literature concerned with the question of divergence versus convergence. For an overview see DE LA FUENTE (1997) or CHESIRE AND MALECKI (2004: 251-256) and the literature quoted there.
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Table 3-3 describes the effect of push- and pull-forces on agriculture. Different combinations of these forces lead to different problems in leading and lagging regions (see Rieder et al. 1999: 118-121).

**Table 3-3: Decentralized settlement and minimum cultivation of agricultural land reacting to push- and pull-forces affecting agriculture**

<table>
<thead>
<tr>
<th>Push-forces in agriculture low</th>
<th>Pull-forces from overall economy strong</th>
<th>Pull-forces from overall economy weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading region</td>
<td>Case 1: Natural structural change in agriculture (Sectoral out-migration mostly unsolicited)</td>
<td>Case 2: Structural change slowed down (Sectoral out-migration mostly unsolicited)</td>
</tr>
<tr>
<td>Lagging region</td>
<td>Leading region</td>
<td>Lagging region</td>
</tr>
<tr>
<td>Decentralized settlement</td>
<td>No problem</td>
<td>Critical</td>
</tr>
<tr>
<td>Minimum cultivation</td>
<td>No problem</td>
<td>Critical</td>
</tr>
<tr>
<td></td>
<td>Leading region</td>
<td>No problem</td>
</tr>
<tr>
<td></td>
<td>Lagging region</td>
<td>Critical</td>
</tr>
<tr>
<td></td>
<td>Leading region</td>
<td>No problem in the short run</td>
</tr>
<tr>
<td></td>
<td>Lagging region</td>
<td>No problem</td>
</tr>
<tr>
<td>Push-forces in agriculture high</td>
<td>Case 3: Accelerated structural change (Sectoral out-migration partly enforced)</td>
<td>Case 4: Structural change inhibited (Sectoral out-migration mostly enforced)</td>
</tr>
<tr>
<td>Leading region</td>
<td>Leading region</td>
<td>Leading region</td>
</tr>
<tr>
<td>Lagging region</td>
<td>Lagging region</td>
<td>Lagging region</td>
</tr>
<tr>
<td>Decentralized settlement</td>
<td>No problem</td>
<td>Critical</td>
</tr>
<tr>
<td>Minimum cultivation</td>
<td>Maybe critical</td>
<td>Partly critical</td>
</tr>
<tr>
<td></td>
<td>Leading region</td>
<td>Social problem in the short run</td>
</tr>
<tr>
<td></td>
<td>Lagging region</td>
<td>Social problem</td>
</tr>
<tr>
<td></td>
<td>Leading region</td>
<td>No problem</td>
</tr>
<tr>
<td></td>
<td>Lagging region</td>
<td>No problem in the short run</td>
</tr>
</tbody>
</table>

Source: Rieder et al. 1999: 119

In case 1 in Table 3-3, the push-forces in agriculture are low and sectoral out-migration from agriculture is easily possible. In leading regions, i.e. in growing regions, farmers find alternative employment in the overall economy and a decentralized settlement can be maintained. Alternative employment also allows for employment combinations between agriculture and the overall economy so that the cultivation of the landscape is not problematic either. The situation is different in lagging regions, i.e. in economically stagnating regions. Although push-forces are low, pull-forces from the overall economy are considerable. Especially young farmers follow this incentive for alternative employment.
and accept alternative employment in the overall economy. This, however, implies out-migration from the community because the community is located in a stagnating region. As a consequence of farmers leaving the community, both the maintenance of a decentralized settlement and of the cultivation of the landscape become critical.

Case 2 is an example of a situation where the overall economy grows but exerts only moderate pull-forces on farmers. This is the case when jobs in the overall economy are incompatible with farmers’ qualifications. Adaptation costs for farmers are too high so that they remain in agriculture. As a consequence, cultivation of the landscape is unproblematic. Slowed down structural change in agriculture, however, decreases competitiveness and enhances the pressure to adapt in the long run. This adaptation is problematic in lagging regions.

In case 3, push-forces in agriculture are high. At the same time, incomes in the overall economy are attractive. In leading regions, no problems concerning settlement arise because farmers easily find alternative employment. As the opportunity costs of farming are high, cultivation of the landscape becomes problematic. The situation is more critical in lagging regions. Sectoral out-migration from agriculture is not unsolicited anymore and there are no local or regional employment alternatives. In this situation, both settlement and the cultivation of the landscape are problematic.

Case 4 describes a situation where farmers face social and existential problems. Agricultural incomes are low and there are no employment alternatives. Because of this lack of alternatives, settlement and cultivation of the landscape will be maintained but especially in lagging regions, pressure to adapt in the long run will steadily increase.

3.5 Development patterns in rural areas

Depending on a region’s locational and socioeconomic characteristics, structural change as well as push- and pull-forces have different impacts on the development of rural areas. The following sections describe the current socioeconomic situation in rural areas in Switzerland and the developments that have lead to this situation. Together, these sections provide the basis for further analysis in the remaining chapters of the study.

3.5.1 Types of rural areas

The preceding sections have repeatedly shown that rural areas cannot be viewed as a homogenous entity. Instead, they have to be differentiated in several ways. Structural change, for example, leads to different socioeconomic structures and potentials. A recent study (BUCHLI ET AL. 2004) elaborated a typology of all the approximately 3’000 communities in Switzerland. On the basis of the statistical method of cluster analysis, 17 community types were identified. These types show similar combinations in the value of 21 socioeconomic indicators. The indicators belonged to five socioeconomic
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categories: demographic structures; employment structures; commuting and distance; financial power; infrastructure and quality of life.

The study provided the basis for a research project concerned with the contribution of agriculture to a decentralized settlement in Switzerland (see RIEDER ET AL. 2004). As the focus of this project is related to the focus of this study, the results of the cluster analysis can also be used for differentiating rural areas in the present study.

In a first step, BUCHLI ET AL. (2004) divided communities into the two categories of leading and lagging regions. In leading regions, the values of all the 21 indicators were above the Swiss average. The opposite was the case for lagging regions. Leading and lagging regions were subsequently divided into further socioeconomic development types. For the purpose of this study, only lagging regions are described. Figure 3-8 gives an overview over the eight types of lagging regions. On an aggregate level, it also shows the geographical distribution of leading regions and of statistical outliers.

Cluster analysis assigns a community to a specific community type. In individual cases, a community can differ from the characteristics of the type it belongs to. The differences, however, are still smaller than if the community was assigned to another type. The lagging community types have the following characteristics (BUCHLI ET AL. 2004: 27ff):

- Attractive residential communities with agriculture: This community type has a share of out-commuters on the total working population that is above average. The communities have experienced considerable population growth and the demographic structure is balanced. For those employed locally, agriculture plays an important role.

- Agrarian residential communities: Agrarian residential communities are smaller than attractive residential communities with agriculture. Population growth was less intensive and they are located in more peripheral areas.

- Agrarian communities: The share of out-commuters on the total working population is lower in agrarian communities than in agrarian residential communities. They are also located more peripherally. Population growth was low and the demographic structure is characterized by a high share of old people.

- Residential communities with manufacturing and industry: This community type is similar to the attractive residential communities with agriculture. Local employment, however, lies more in the manufacturing and industry sector instead of agriculture. Population growth rate is also lower.

- Rural communities with strong manufacturing and industry: These communities are, on average, slightly bigger but located more peripherally than residential communities with manufacturing and industry. Population growth is also lower and the demographic structure is characterized by a high share of old people.
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- Peripheral communities: The unifying characteristic of these communities is the distance variable (distance to expressway).

- Residential communities with services: These communities are characterized by a high share of commuters on the total working population. Local employment is mainly in the service sector, especially the hotel and restaurant industry. The demographic structure tends towards a high share of old people.

- Tourist communities: These communities are defined by the hotel and restaurant industry as well as by tourism. They are located rather peripherally so that there are not many out-commuters.
Figure 3-8: Types of lagging regions in Switzerland

Community types:
- Agrarian communities
- Agrarian residential communities
- Attractive residential communities with agriculture
- Residential communities with manufacturing & industry
- Rural communities with strong manufacturing & industry
- Peripheral communities
- Residential communities with services
- Tourist communities
- Leading regions
- Statistical outliers

Source: adapted from BUCHLI ET AL. 2004: 29
3.5.2 Particularly vulnerable rural areas

Not all the communities that belong to the lagging category are particularly vulnerable in terms of employment and population development. A community is particularly vulnerable if its population base becomes so narrow that it is no longer able to sustain the basic goods and services that are essential for daily life to function normally (third level in Figure 3-2).

In the context of the research project described above (RIEDER ET AL. 2004), these particularly vulnerable communities in Switzerland were identified. The analysis was based on a series of indicators that describe the development of the economically active population (RIEDER ET AL. 2004: 31ff):

- Short term (1990 to 2000) development of the 20 to 65 years old population.
- Short term (1990 to 2000) development of the 20 to 39 years old population.

A community is particularly vulnerable if it corresponds to one of two criteria:

- The long term development of the 20 to 65 years old population shows a decline and the short term development of the average of the 20 to 65 years old population and the 20 to 39 years old population shows only very moderate growth.
- The long term development of the 20 to 65 years old population shows only very moderate growth but the short term development of the average of the 20 to 65 years old population and the 20 to 39 years old population shows a decline.

Depending on the choice of threshold values for the two criteria, between 231 and 343 of the 2’896 communities in Switzerland are particularly vulnerable. Their geographic distribution is shown in Figure 3-9. The figure also shows the socioeconomic development type of these communities.
Figure 3-9: Particularly vulnerable communities in Switzerland

Community types
- Not vulnerable
- Agrarian communities
- Agrarian residential communities
- Attractive residential communities with agriculture
- Residential communities with manufacturing and industry
- Rural communities with strong manufacturing and industry
- Peripheral communities
- Residential communities with services
- Tourist communities
- Statistical outliers

Source: adapted from RIEDER ET AL. 2004: 40
Particularly vulnerable communities not only lie in the more remote alpine valleys. Instead, they can also be found in parts of the Pre-Alps and the Jura in the northwestern part of Switzerland. Their distribution among the Swiss cantons is shown in Table 3-4. Most of the particularly vulnerable communities are agrarian communities, rural communities with strong manufacturing and industry and residential communities with services. In a relative comparison, i.e. when the total number of particularly vulnerable communities in a community type is compared with the total number of communities in this type, peripheral and tourist communities are also of special importance.

<table>
<thead>
<tr>
<th>Canton</th>
<th>Agrarian communities</th>
<th>Agrarian residential communities</th>
<th>Attractive residential communities with agriculture</th>
<th>Statutory outliers</th>
<th>Rural communities with strong manufacturing &amp; industry</th>
<th>Peripheral communities</th>
<th>Tourist communities</th>
<th>Residential communities with manufacturing &amp; industry</th>
<th>Residential communities with services</th>
<th>Total especially vulnerable communities per canton</th>
<th>Total communities per canton</th>
<th>Share of especially vulnerable communities per canton</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>246</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>126</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AG</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>233</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BE</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td></td>
<td>27</td>
<td>404</td>
<td>7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BL</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>86</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GL</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>30</td>
<td>27%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GR</td>
<td>26</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td></td>
<td>4</td>
<td>54</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JU</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>83</td>
<td>27%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>64</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SG</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>93</td>
<td>1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SZ</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>34</td>
<td>3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TI</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>11</td>
<td>6</td>
<td>12</td>
<td></td>
<td>46</td>
<td>251</td>
<td>18%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UR</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>21</td>
<td>24%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VD</td>
<td>1</td>
<td>17</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td>388</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23</td>
<td>162</td>
<td>14%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>39</td>
<td>12</td>
<td>52</td>
<td>7</td>
<td>12</td>
<td></td>
<td>26</td>
<td>231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>180</td>
<td>302</td>
<td>226</td>
<td>17</td>
<td>330</td>
<td>24</td>
<td></td>
<td>371</td>
<td>201</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>37%</td>
<td>13%</td>
<td>1%</td>
<td>71%</td>
<td>16%</td>
<td>29%</td>
<td></td>
<td>15%</td>
<td>3%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: KOPAINSKY AND RIEDER 2004: 3
3.5.3 Socioeconomic situation in particularly vulnerable communities

Development of socioeconomic core indicators between 1970 and 2000

A central indicator for issues related to a decentralized settlement of the country is a community’s population size. Population is varied by births and deaths and by in- and out-migration. Migration decisions are heavily influenced by a community’s employment situation. Additional factors impact on these decisions. They will be analyzed in detail in chapter 5.

Figure 3-10 and Figure 3-11 contrast population development in Switzerland and in particularly vulnerable communities. Figure 3-10 describes total population of Switzerland whereas Figure 3-11 contains the average population per community of all the particularly vulnerable communities identified in section 3.5.2. The comparison of the population development in Switzerland and in particularly vulnerable communities shows that the entire country experienced an increase in total population between 1970 and 2000. This increase is mainly due to the growing cohort of the 20 to 65 years old population. At the same time, the cohort of the 0 to 19 years old decreases. In particularly vulnerable communities, on the other hand, total population declines as well the two age groups comprising the 0 to 65 years old population. Only the category of the retired population increases slightly during this period. Thus, the base of the economically active and future economically active population is moderately eroded which puts these communities even more under pressure.

*Figure 3-10: Development of total population in Switzerland between 1970 and 2000*

![Graph showing population development](image)

Figure 3-11: Development of average population per community in particularly vulnerable communities


Figure 3-12 and Figure 3-13 compare the development of births and deaths between 1985 and 2002. Again, for Switzerland the total births and deaths are indicated and for particularly vulnerable communities the average number of births and deaths per community are shown. The development of births and deaths is noticeably different for Switzerland and for particularly vulnerable communities. Over the period shown in the figures, births always exceeded deaths in the entire country. In particularly vulnerable communities, on the other hand, the number of deaths started exceeding the number of births in the mid 1990s. The absolute value of births and deaths are relatively low and oscillate around three persons per year. However, as the average total population of these communities is only about 250 people, an average variation of one person already makes a noticeable difference.

Figure 3-12: Development of total births and deaths in Switzerland between 1985 and 2002

Data source: BFS (various years): Statistik des jährlichen Bevölkerungsstandes (ESPOP) 1985-2002
Figure 3-13: Development of average number of births and deaths per community in particularly vulnerable communities

Data source: BfS (varios years): Statistik des jährlichen Bevölkerungsstandes (ESPOP) 1985-2002

Figure 3-14 and Figure 3-15 illustrate the development of in- and out-migration for the period between 1985 and 2000. The number of total migrants in Switzerland is the sum of all the in-migrants and out-migrants per community. The number makes no difference between migration within Switzerland and migration to or from other countries. With the exception of the mid to late 1990s, in-migration always exceeded out-migration in the case of Switzerland. In particularly vulnerable communities, on the other hand, out-migration started exceeding in-migration in the early 1990s. This was reversed only in the very recent past and it is not visible from the data whether this is a development trend or only a short-term oscillation.

Figure 3-14: Development of total in-migrants and out-migrants in Switzerland between 1985 and 2002

Data source: BfS (varios years): Statistik des jährlichen Bevölkerungsstandes (ESPOP) 1985-2002
Figure 3-15: Development of average number of in-migrants and out-migrants per community in particularly vulnerable communities

Data source: BFS (varios years): Statistik des jährlichen Bevölkerungsstandes (ESPOP) 1985-2002

Figure 3-16 to Figure 3-18 show the development of employment in four economic sectors. Agriculture is the most immobile sector and produces both short-lived consumer goods and, as a by-product, public goods mainly for external stakeholders (see section 3.2). The manufacturing and industry sector produces consumer goods with an intermediate lifetime and for local and external demand. Private services are very important for the attractiveness of a community (see the community model in section 3.3) and show high income elasticity of demand. The provision of private services is determined to a considerable degree by tourist demand. Public services are equally important for the attractiveness of a community. They often have a stabilizing effect on population and employment.

The development of total employment in Switzerland shows the classical economic development pattern according to Fourastié (e.g. Peters 1996: 41). The decrease of employment in agriculture as well as in manufacturing and industry is compensated by an increase in the service sector. Particularly vulnerable communities also experienced a decrease in agricultural employment and in the manufacturing and industry sector. However, the development of the service sector could not compensate for the loss in employment so that the economic situation deteriorated continuously.
Economic analysis

Figure 3-16: Development of total employees in Switzerland between 1985 and 2000

![Graph showing the development of total employees in Switzerland between 1985 and 2000.]


Figure 3-17: Development of average number of employees per community in particularly vulnerable communities

![Graph showing the development of average number of employees per community.]


The development of total population, births and deaths, in- and out-migration exhibited almost no variation between community types. This is different for the case of sectoral employment. Figure 3-18 therefore shows the specific development in agrarian communities, tourist communities and residential communities with services. The figure highlights the predominance of the different economic sectors in agrarian and tourist communities. It also shows that an employment loss in the dominating sector could not be compensated by the development in the other sectors in either community type. Residential communities with services experienced a very distinct decline agricultural employment and also in the industries sector. Local employment decline in this community type could, to some extent, be compensated by an increase in commuter labor.
Economic analysis

Figure 3-18: Development of sectoral employment in vulnerable communities of different types

Agrarian communities: sectoral employment

Tourist communities: sectoral employment

Residential communities with services

Economic analysis

Economic linkages and dependencies of some regional economies today

A series of recent empirical studies analyzed the economic structures of several particularly vulnerable communities and regions in Switzerland. With detailed input-output analyses, economic linkages and dependencies in these economies were derived (see BUSER 2005). Data from a regional input-output table indicates the value and pattern of flows of goods and services within a region, including sales to other local sectors, to local final demand and for export. It also indicates the level and source of inputs and the reliance on imports and primary factors of production labor and capital (ROBERTS AND THOMSON 2003: 63). Input-output tables apply for a specific point in time with a limited possibility of ex-ante simulation.

For the purpose of this study, two kinds of results are of special interest. First, the contribution of agriculture to settlement can be estimated. Second, the variety of results enables an integrative characterization of regional economies. In chapter 6, the analytical logic of input-output analyses and some empirical findings will also be used for the specification of the simulation model.

Agriculture, as every economic sector, has direct, indirect and induced effects on regional output, employment and income. These effects can be calculated on the basis of input-output analyses. Table 3-5 shows this calculated relative effect of agriculture on settlement in the third column and for five case studies. The total effect of agriculture on settlement (fifth column) depends on the share of farmers on the total working population of a region (fourth column). If most people living in a region work in another region the total effect of agriculture on settlement may be low even though it is the most important regional employer.

Table 3-5: Effect of agriculture on settlement in different community types

<table>
<thead>
<tr>
<th>Community type</th>
<th>Region</th>
<th>Relative effect of agriculture on settlement</th>
<th>Ratio of local employees to total working population in the region</th>
<th>Derived total effect of agriculture on settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrarian community</td>
<td>Safien GR)</td>
<td>60%</td>
<td>90%</td>
<td>54%</td>
</tr>
<tr>
<td>Tourist community</td>
<td>Gadmen (BE)</td>
<td>42%</td>
<td>53%</td>
<td>23%</td>
</tr>
<tr>
<td>Tourist communities</td>
<td>Urserntal (UR)</td>
<td>3%</td>
<td>81%</td>
<td>2%</td>
</tr>
<tr>
<td>Residential community with services</td>
<td>Medel (Lügern) (GR)</td>
<td>27%</td>
<td>49%</td>
<td>13%</td>
</tr>
<tr>
<td>Peripheral communities</td>
<td>Val Müstair (GR)</td>
<td>11%</td>
<td>84%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Source: RIEDER ET AL. 2004: 55
Agriculture influences the overall economy, but it also depends on the other economic sectors and external demand. A regional economy can be characterized by a combined linkage analysis. Every economic sector is analyzed for its impact on regional economic growth and its dependence on the regional economy. The example shown in Figure 3-19 is taken from HÜRLIMANN ET AL. (2004: 11f).

Economic sectors belonging to the category of nodes (Q1) depend very much on the regional economy and influence the regional economy very much. They react directly to positive and negative developments in the regional economy.

Economic sectors belonging to the influencing category (Q2) are only weakly dependent on the regional economy but they have a big impact on the regional economy. They transfer growth impulses and sell their products on export markets and for final demand. Influencing sectors are only weakly affected by processes in the regional economy.

Economic sectors belonging to the following category (Q3) have little impact on the regional economy but they are very dependent on it. They are very dependent because they demand a lot of intermediate inputs by other regional sectors.

The autonomous sectors (Q4) have little influence and are little influenced. Their development usually follows the development on the export markets.

*Figure 3-19: Regional economic portfolio for the tourist region, Urserntal*(UR)

<table>
<thead>
<tr>
<th>Degree of dependence on regional economy</th>
<th>Nodes (Q1)</th>
<th>Influencing (Q2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (forward-linkage above average)</td>
<td>Energy</td>
<td>Army, federal employers</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public sector</td>
<td></td>
</tr>
<tr>
<td>Low (forward-linkage below average)</td>
<td>Following (Q3)</td>
<td>Autonomous (Q4)</td>
</tr>
<tr>
<td></td>
<td>Manufacturing, trade, reparation</td>
<td>Agriculture</td>
</tr>
<tr>
<td></td>
<td>Building industry</td>
<td>Retail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: HÜRLIMANN ET AL. 2004: 11

Figure 3-20 and Figure 3-21 show two more examples of regional economic portfolios. The degree of dependence and influence always refer to the relative dependence or influence regarding regional added value.
### Figure 3-20: Regional economic portfolio for the peripheral region 'Val Müstair' (GR)

<table>
<thead>
<tr>
<th>Degree of dependence on regional economy</th>
<th>Nodes (Q1)</th>
<th>Influencing (Q2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (forward-linkage above average)</td>
<td>Manufacturing, industry</td>
<td>Building industry</td>
</tr>
<tr>
<td>Low (forward-linkage below average)</td>
<td></td>
<td>Public sector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of influence on regional economy</th>
<th>Following (Q3)</th>
<th>Autonomous (Q4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (backward-linkage above average)</td>
<td>Agriculture</td>
<td>Trade</td>
</tr>
<tr>
<td></td>
<td>Retail</td>
<td>Tourism</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td></td>
</tr>
<tr>
<td>Low (backward-linkage below average)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Buchli 2002b: 64

### Figure 3-21: Regional economic portfolio for the tourist community ‘Gadmen’ (BE)

<table>
<thead>
<tr>
<th>Degree of dependence on regional economy</th>
<th>Nodes (Q1)</th>
<th>Influencing (Q2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (forward-linkage above average)</td>
<td></td>
<td>Agriculture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacturing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Services</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of influence on regional economy</th>
<th>Following (Q3)</th>
<th>Autonomous (Q4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (backward-linkage above average)</td>
<td>Retail</td>
<td>Trade</td>
</tr>
<tr>
<td></td>
<td>Public sector</td>
<td></td>
</tr>
<tr>
<td>Low (backward-linkage below average)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Dijkstra 2003: 37

Figure 3-19 to Figure 3-21 show that the economic sectors in the case study regions or communities differ in their influence or dependence on the regional economy. There are, however, also trends. Tourism, for example, is always autonomous. Agriculture never assumes the function of a node. Instead, it is mostly an economic sector with little influence on the regional economy. In the case of Gadmen, a single community, agriculture gains in influence on the regional economy.

### 3.6 Conclusions to the economic analysis of lagging rural regions

Rural areas show a series of characteristics that differentiate them from other economies. Higher transaction costs and transport costs, low demand intensities and the presence of a variety of public goods describe markets in rural areas. Rural development arises from structural changes in the rural economy as a result of the decisions made by internal and external actors. Rural communities become particularly vulner-
able when structural changes lead to a situation where population and market size are not sufficient for the maintenance of a minimum provision of the local population with goods and services.

Communities in rural areas vary in terms of their locational characteristics, their economic and demographic structure. Depending on the combination of these features different development patterns can be observed. Figure 3-8 and Figure 3-9 showed a much differentiated pattern of community types in Switzerland. The figures also showed that particularly vulnerable communities can be found in several community types. This has two important implications. First, this result supports the choice of the community level as unit of analysis. Aggregating communities into regions would blur important differences as community types vary on a small-scale level and as the vulnerability of communities is also a small-scale phenomenon. Second, development strategies aimed at inducing regional economic growth have to allow for this diversity. The community types have different socioeconomic structures and development patterns. As a consequence, no single one development strategy will prove to be effective in all types.

Based on these insights, the objectives of this study formulated in chapter 1 can be complemented by the following questions:

1. What are the generic processes underlying the observed development patterns?
2. Which combinations of locational and socioeconomic characteristics lead to the observed variety of development patterns?
3. Which policy strategies are effective in the different community types?

The units of analysis for answering these questions are particularly vulnerable communities of different types as identified in section 3.5.2.
4 Regional policy

Chapter 1 showed that the benefits of rural development have many public goods aspects. It is therefore not surprising that private incentives fail to deliver it effectively. To achieve socially desirable spatial allocation of population and industry, a nonmarket mechanism may be needed (Kilkenny 1998b: 276). This chapter explores regional policy as public policy. It describes the goals that regional policy tries to achieve and the instruments it uses in order to do so. In a last section it introduces regional policy in Switzerland and analyzes the currently discussed shift in development paradigm.

4.1 Regional policy as public policy

Regional policy is often equated with regional economic policy. It comprehends instruments applied by the government and by private actors. The instruments aim at influencing the spatial structure of a national economy and the development of regions (Frey 1985a: 167).

Scientific analysis of economic policy has to address development goals, policy measures, affected stakeholders and decision making processes. For the purpose of this study, scientific analysis helps clarifying the economic, social and political goals that are pursued by supporting a decentralized settlement of the country.

Goals describe the visions of a politically desired state or of a change in the state of a system (Peters 1996: 121). In the political debate that surrounds goal and policy formulation, different weights are implicitly ascribed to the interests of the different stakeholders identified in chapter 3.2. A scientific analysis of economic policy cannot formulate these goals. Instead, it has to interpret these goals and examine them about compatibility or trade-offs (Peters 1996: 121).

Maintaining a decentralized settlement of the country is one goal in regional policy. Regional policy itself is part of an overall societal policy. Societal policy goals are therefore on a higher hierarchical level than regional policy goals (see also Brugger and Frey 1985: 51). Societal policy goals are freedom, justice, security and wealth or progress. On a more operational level they can be defined in the following way (Brugger and Frey 1985: 51):

- **Freedom** can be rewritten as scope of decisions. On the level of regional policy, this goal is concretized by the two regional policy goals of 'sociocultural autonomy and diversity' and 'federalism'.

- **Justice** wants to achieve equal scope of decisions between persons, groups and regions. On the regional policy level, justice refers to the two goals of ‘federalism’ and ‘regional compensation’.
• *Security* calls for guaranteeing the scope of decisions. The regional policy goals of ‘economic stability’ and ‘landscape and environmental protection’ contribute to that societal policy goal.

• *Progress* occurs when the scope of decisions increases over time. The regional policy goals of ‘national economic growth’ and ‘landscape and environmental protection’ aim at achieving this societal policy goal.

Regional policy goals therefore comprise economic as well as non-economic goals that belong to other political areas (Frey 1985b: 11):

• Sociocultural goals: Maintaining and supporting sociocultural autonomy of regions and the sociocultural diversity of the country → sociocultural autonomy and diversity.

• Political goals: Maintaining the capability of acting of the cantons in the Swiss Federation → stability of federalism.

• Distributive goals: Decreasing regional disparities and maintaining (minimum) provision of merit goods → regional compensation.

• Stability goals: maintaining and creating employment in lagging regions, lessening (regional) structural change and decreasing monostructure of regions → economic stability.

• Ecological goals: maintaining and improving natural resource base and ecological stability in regions → landscape and environmental protection.

• Allocation and growth oriented goals: optimum provision of the population with private and public goods → national economic growth.

The order in which the goals were presented makes no statement about the importance of the individual goals. The importance of each goal varies over time. In general, a goal gains in importance if it is far from being reached (Brugger and Frey 1985: 56). The presentation of the goals also makes no statement about the relationships between the goals. Goals can either be complementary, conflicting or contradicting. For a detailed analysis of both the relationships between the individual goals and the development of the relative importance of each goal in the past see Brugger and Frey (1985: 56ff).

Figure 4-1 visualizes the hierarchy of economic policy goals, starting from a decentralized settlement of the country to public welfare. The figure differentiates between pure goals and goals that are at the same time means to achieve a superior goal. This is the case for the functions of rural areas that were described in chapter 3.3. Fulfilling the functions of rural areas is understood as being the precondition for fulfilling the regional policy goal of a decentralized settlement of the country.
Regional policy

Figure 4.1: Decentralized settlement and other regional policy goals

Source: based on a simplified version in Brugger and Frey 1985: 52

4.2 Regional policy as structural policy

Public policy takes its legitimization from the existence of public or merit goods. Public and merit goods on the regional level are important location factors and therefore preconditions for regional economic development and competitiveness. On the local level, a series of public goods belong to the government's responsibilities. Local and regional public goods are shown in Figure 4.2.

The provision of regional merit goods like infrastructure, schools and cultural facilities is summarized in the term 'public service'. The provision of these goods tends to be inefficient. As a consequence of this inefficiency and of increasing budget constraints, public service starts being privatized and deregulated (Flückiger 2000: 41). This liberalization necessarily induces structural change.
Chapter 3 showed that regional rural development is a result of structural change and that structural change is influenced, among others, by public policy. Structural policy has several options to affect structural change (PETERS 1996: 137ff):

- **Conserving economic structures.** Structural conservation measures are used if revenues from labor and capital in certain economic sectors are unsatisfactory and if this is an undesirable outcome from a social or regional policy point of view. Revenues are often unsatisfactory when markets are liberalized but economic structures can only be adapted in the long run. This is especially the case in the agricultural sector.

- **Adapting economic structures.** Structural adaptation measures facilitate the adaptation to structural changes. They do so by giving incentives and reducing impediments from regulations and interventions.

- **Creating economic structures.** Structural creation measures try to direct structural change towards a desired development and in a desired way.

The distinction between these three options of structural policy will be important for the analysis of regional policy instruments in section 4.3.

As structural change affects different stakeholders in different ways, structural policy always deals with interest groups. For the design of effective policy measures, the stakeholders' interests and their respective influence on decision-making has to be taken into account. This aspect will be treated in more detail in chapter 5.
4.3 Regional policy instruments

According to Nijkamp (2003: 396), public policy in a modern society is no longer a controlling strategy, but a facilitating strategy through which, by means of investments in research and development (R&D), education, training and knowledge centers etc., the seedbed conditions may be created for successful entrepreneurial performance. Regional policy is experiencing a shift in paradigm from social welfare measures towards innovation policy. It is therefore supposed to address causes (like low innovation potential) rather than fighting symptoms (like high unemployment; Morgan 1997: 492 and 496). This shift is also a shift from structural conservation policy towards structural adaptation and creation policy.

Regional policy makers have a wide range of policy options at their disposal. This section examines the economic case for using them without evaluating their effectiveness. The question of the effectiveness of different instruments in the context of regional rural development will be raised in the policy analysis chapter (chapter 7).

Regional policy instruments are designed either to influence the location decision of households and firms or to change the level of income and expenditure in specific regions. This suggests a distinction between micro-instruments and macro-instruments. Micro-policy instruments are concerned with influencing the allocation of labor and capital between industries and between regions. Macro-policy instruments, on the other hand, are designed to change aggregate regional income and expenditure (Armstrong and Taylor 2000: 232). Another potentially important set of regional policy options are those concerned with the co-ordination of government policy. Coordination is relevant both within jurisdictions and between jurisdictions (Armstrong and Taylor 2000: 234). These different regional policy options are summarized in Table 4-1.

**Table 4-1: Regional policy options**

<table>
<thead>
<tr>
<th>Micro-policy options</th>
<th>Policies to reallocate labor</th>
<th>Policies to reallocate capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reallocation of labor in situ: occupational retraining, education policies</td>
<td>Fiscal incentives: taxes and subsidies</td>
</tr>
<tr>
<td></td>
<td>Spatial reallocation of labor: migration/ mobility policies, improvement of labor market</td>
<td>On inputs: capital, land, buildings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On outputs: export rebates, price subsidized on technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policies to improve the efficiency of the capital markets: loan agreements, venture capital</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policies to improve the efficiency of operation of firms: advisory services for small firms, subsidies for management consultancy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Administrative controls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policies to develop social capital: capacity building schemes in community development</td>
</tr>
</tbody>
</table>

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Regional policy

<table>
<thead>
<tr>
<th>Co-ordination options</th>
<th>Co-ordination within jurisdictions</th>
<th>Co-ordination between different micro-policy instruments: e.g. training initiatives and investment initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Co-ordination between jurisdictions</td>
<td>Co-ordination between micro-and macro-policies: e.g. investment initiatives and fiscal expenditure on infrastructure projects</td>
</tr>
<tr>
<td>Macro-policy options</td>
<td>Devolution of trade policy, fiscal policy and monetary policy powers to regions</td>
<td>Regionally discriminating tax and expenditure policies: income tax, social security contributions</td>
</tr>
<tr>
<td></td>
<td>Central control of macro-policies</td>
<td>Regionally discriminating monetary policies: easier credit availability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regionally discriminating tariff and other trade controls</td>
</tr>
</tbody>
</table>

Source: adapted from ARMSTRONG AND TAYLOR 2000: 233

Policies to reallocate labor encompass all instruments designed to induce labor to move into those economic activities where its marginal product is highest (ARMSTRONG AND TAYLOR 2000: 236). These policies aim at improving the degree of matching between the demand and supply of labor by operating on the supply side of the labor market. The complementary policy is to improve the matching by diverting the demand for labor to areas of high unemployment. Capital reallocation policies, on the other hand, include policy instruments which induce the growth of investment in indigenous activities within regions (ARMSTRONG AND TAYLOR 2000: 238).

4.3.1 Labor and capital subsidies

Whether input subsidies on labor or on capital (investment subsidies) are more appropriate for regions suffering from poor employment opportunities depends on a variety of factors. This question will be addressed by a microeconomic analysis of factor subsidies which is based on ARMSTRONG AND TAYLOR (2000: 244ff) and summarized in Figure 4-3.

The figure shows a hypothetical firm producing at an optimum production level X as indicated by the isoquant I_{200}. The isoquant shows the various alternative combinations of labor and capital which yield together an output of 200 and X indicates the optimum combination of labor and capital, i.e. the point on the isoquant where production costs are minimized.

Figure 4-3 shows the effect of a labor subsidy which reduces the price of labor to the firm. The unit price of capital is unchanged. All isocost lines now swing outwards as a result of the subsidy (AB → AB'). The new least-cost technique now lies at point Z. This move from X to Z is the substitution effect of the labor subsidy. It occurs because
the price of labor falls relative to the price of capital, as reflected by the flatter isocost line. A capital subsidy, which reduced the price of capital while leaving the price for labor unchanged, would have the opposite effect, i.e. capital would be substituted for labor.

When faced with a fall in production costs, firms are unlikely to continue producing at the same level of output. Instead, they presumably increase output from 200 to 400 units as a result of the reduction in total production costs. It now moves to the higher isoquant $I_{400}$. Given the post-subsidy isocost lines, the firm minimizes its production costs at combination $Y$. The planned level of employment increases from $L_1$ to $L_3$ in total. $L_1L_2$ is the substitution effect and $L_2L_3$ is the output effect.

The demand for capital may also increase since a positive output effect may outweigh a negative substitution effect. The presence of output effects can also mean that a capital subsidy will result in additional employment.

*Figure 4-3: The output and substitution effects of a labor subsidy*

Source: ARMSTRONG AND TAYLOR 2000: 249

A variety of aspects have to be considered for an adequate interpretation of the analysis of substitution and output effect of factor subsidies.

The number of jobs created by a labor subsidy e.g. will depend on the supply elasticities of labor and capital, on the firm’s production function and on the size of the subsidy (ARMSTRONG AND TAYLOR 2000: 246).

The size of the output effect on the demand for labor e.g. will depend on the size of the reduction in production costs resulting from the subsidy, on the extent to which the reduction in production costs is passed on to customers in the form of lower product prices, on the responsiveness of the demand for the product to fall in its price and also on the production function of the firm (ARMSTRONG AND TAYLOR 2000: 248f).

The fact that regional subsidies reduce production costs is not itself sufficient to lead to an output effect. The stimulus to product demand and thus to output and employ-
ment depends on how the cost reduction is used in the firm and on how much of it is passed on to consumers (ARMSTRONG AND TAYLOR 2000: 249f).

Turning to long-term effects of factor subsidies, there is a strong case for preferring capital subsidies to labor subsidies (ARMSTRONG AND TAYLOR 2000: 251):

- Fast growing manufacturing industries tend to be capital intensive.
- Capital subsidies are investment subsidies and as a result they encourage not only the substitution of capital for labor but also the substitution of new, technologically advanced capital for older capital.
- Labor subsidies are continuous subsidies and this tends to ossify the existing technologies by keeping older, declining industries going longer than would otherwise have been the case. Investment subsidies, on the other hand, are once-for-all reward for modernizing the technological base of a region.

In summary, considerable caution needs to be exercised in deciding whether to favor capital or labor subsidies. The effects of subsidies on employment are much more complex than mere substitution effects.

4.3.2 Infrastructure policy

Infrastructure policy is one important realm of both, capital reallocation policy and structural policy. Infrastructure policy is often legitimized by the existence of natural monopolies (see chapter 3.3). Infrastructure comprises facilities that serve the benefit of several stakeholders and that cannot be regulated optimally by market mechanisms. Infrastructure goods are merit or public goods that enable stakeholders to develop and to increase wealth (LENDI AND ELSASSER 1991: 143). According to the stakeholders who derive benefit from infrastructure, two categories can be distinguished (LENDI AND ELSASSER 1991: 143): business oriented infrastructure (productive infrastructure) and household oriented infrastructure (consumptive infrastructure). Business oriented infrastructure facilitates the development of firms, especially of producing firms. Household oriented infrastructure is primarily used by consumers.

Infrastructure as an instrument of regional policy has the following implications on demographic and economic growth (FREY 1979):

- Infrastructure is necessary but not sufficient for growth. Infrastructure belongs to the minimum equipment in communities and regions (see community framework in chapter 3.3). If it is not available, development opportunities are clearly negatively influenced. If it is available, on the other hand, the effect on development opportunities is only very limited.
- Decisions about the choice of migrating to a certain location or of locating an industry in a certain location are affected by a combination of infrastructure services and not of single infrastructure facilities.
• Infrastructure policies are most effective when the population and the economy grow as shown in Table 4-2.

Table 4-2: Effectiveness of infrastructure in stimulating population and economic growth

<table>
<thead>
<tr>
<th>Economic growth</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population growth</td>
<td>Infrastructure policy mostly ineffective</td>
<td>Especially household oriented infrastructure important</td>
</tr>
<tr>
<td>High</td>
<td>Especially business oriented infrastructure important</td>
<td>Infrastructure policy relatively effective</td>
</tr>
</tbody>
</table>

Source: Frey 1979

4.3.3 Other regional policy instruments

Labor and capital subsidies and infrastructure policies are only two examples out of a variety of regional policy instruments. Instruments can be differentiated according to the nature and extent of exerting influence and according to the target group and the orientation (Table 4-3).

Table 4-3: Regional policy instruments

<table>
<thead>
<tr>
<th>Target group, starting point</th>
<th>Information and advisory service</th>
<th>Financial incentives</th>
<th>Infrastructure</th>
<th>Administrative measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>Information about locations, regional marketing</td>
<td>Support of new settlements</td>
<td></td>
<td>Location control</td>
</tr>
<tr>
<td>Investment</td>
<td></td>
<td>Investment incentives</td>
<td></td>
<td>Regulation of investment</td>
</tr>
<tr>
<td>New jobs</td>
<td></td>
<td>Premiums for new jobs</td>
<td>Expansion of business oriented infrastructure: Supply, disposal, transportation, communication, research</td>
<td></td>
</tr>
<tr>
<td>Technology, innovation</td>
<td>Consulting in the field of technology and innovation</td>
<td>Incentives for new technologies and innovation</td>
<td></td>
<td>Regulation of new technologies</td>
</tr>
<tr>
<td>Start up</td>
<td>Consulting in the field of start ups</td>
<td>Venture capital, incentives for start ups</td>
<td></td>
<td>Regulation of start ups</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Consulting in the field of cooperation</td>
<td>Incentives for cooperation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Population                  | Information about availability of education and training | Subsidies for training | Expansion of household oriented infrastructure: | |

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4.4 Regional policy in Switzerland

The goals of regional policy in Switzerland were described in section 4.1. This section presents the regional policy paradigm in Switzerland and its instruments. It builds the basis for further analyses as it describes policy options that will be tested with the simulation model in chapter 8. In Switzerland, a reform in regional policy is currently discussed. The suggested reform is basically a shift from conservation policy towards adaptation and creation policy.

4.4.1 Old regional policy paradigm

Explicit regional policy in Switzerland dates back to 1974 when the investment aid regulation was introduced. The investment aid regulation supported infrastructure investments in mountain areas. Regional policy at this time reacted to population out-migration and economic stagnation in mountain areas as a consequence of economic growth in more central locations. It also reacted to the fact that agricultural policy and financial compensation alone were not able to slow down or stop this process. The overall goal of regional policy was to decrease regional economic disparities. For this purpose, additional regulations were created that supported the hotel and restaurant industry, small and medium enterprises and monostructured regions.

The constitutional basis of regional policy is formulated in article 103 of the Swiss Constitution. This article allows explicit structural policy. It states that the Federation can support economic sectors and regions if their existence is threatened even with reasonable self-help measures.

In the mid 1990s, new instruments were introduced. These instruments were supposed to better allow for the increased complexity and velocity of economic development.

---

*The section about Swiss regional policy builds on EvD 2004.*
Regional policy

They were directed at a more efficient allocation of public resources and not primarily at reducing regional disparities. These instruments were aimed at supporting structural change in rural areas and supporting international cooperation in border regions.

The introduction of these new instruments, however, did not constitute a fundamental shift in paradigm. The perception was still that economic growth in centres and different measures for regional distribution were sufficient for correcting regional disparities.

4.4.2 New regional policy paradigm

Progressing globalization, reinforced European integration and increased competition between locations about mobile production factors in the 1990s pose new challenges for regional policy so that a complete reform of regional policy is currently discussed. In line with first reforms in the mid 1990s, new regional policy focuses on efficiency goals more than on distributive measures. This reform distinguishes two levels of aggregation: a large-scale dimension providing favorable conditions for increased international competitiveness of large regions; and a small-scale dimension strengthening intercommunal cooperation and local potentials.

Generally speaking, new regional policy aims at increasing regional competitiveness, thus maintaining and creating employment and contributing to an equitable development of regions. With the new regional policy, the productivity of firms and regions should be strengthened. Regional development potentials should be identified and translated into value generating activities. Entrepreneurship, capacity of innovation and creation of value are seen as means to achieve increased regional competitiveness. The logic of the new regional policy paradigm is visualized in Figure 4-4.

Figure 4-4: Vision of the new regional policy (NRP)

Source: EVD 2004: 34
Entrepreneurs are understood as actors who want to invest in economic, social or ecological projects, have the capacity to do so and the willingness to undertake the necessary risk. It is, however important, that there are not only individual entrepreneurs but also entrepreneurial institutions. Entrepreneurship is a precondition for innovation capacity. Innovation capacity is increased by the generation, transfer and use of new knowledge. Entrepreneurial activities and innovative projects result in additional employment and income. Implementing these projects depends on favorable conditions which are best met in functional or spatial economic clusters.

The strategy to implement the vision in Figure 4-4 also differentiates between entrepreneurship, innovation capacity and value creation. For lagging rural regions, strategies in the realm of value creation systems are of limited importance.

- **Entrepreneurship**: Support of small and medium enterprises (SMEs), especially because the success of SMEs slowly generates an entrepreneurial climate in a region. In addition, the self-help capacity of stakeholders has to be encouraged.

- **Innovation capacity**: Facilitation of access to and exchange of know-how.

A strategy purely based on entrepreneurship and innovation might not be applicable in particularly vulnerable communities. For these areas, a combination of an innovation-based strategy with traditional instruments is discussed. Cantons and the Federation together first have to identify these regions. Cantons then have to formulate development goals and strategies and negotiate the implementation of these strategies with the Federation.

New regional policy thus follows a fundamentally different approach than the existing one. The differences between the two paradigms are summarized in Table 4-4.

**Table 4-4: Comparison of the old and the new regional policy paradigm**

<table>
<thead>
<tr>
<th>Main goal</th>
<th>Present regional policy</th>
<th>New regional policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction of impact</td>
<td>Infrastructure support</td>
<td>Support of innovation processes</td>
</tr>
<tr>
<td></td>
<td>Support of individual firms</td>
<td>Intensified support of networks</td>
</tr>
<tr>
<td></td>
<td>Support of networks</td>
<td>Coordination with sectoral policies</td>
</tr>
<tr>
<td></td>
<td>→ Distribution</td>
<td>Know-how network regional development</td>
</tr>
<tr>
<td>Perimeter</td>
<td>Mountain areas</td>
<td>Country-wide</td>
</tr>
<tr>
<td></td>
<td>Regions with economic problems</td>
<td>Entire country and border regions as reference for program and project development</td>
</tr>
<tr>
<td>Level of aggregation</td>
<td>Small scale</td>
<td>Large scale</td>
</tr>
<tr>
<td></td>
<td>Fixed geometry</td>
<td>Variable geometry</td>
</tr>
<tr>
<td>Starting point</td>
<td>Improvement of infrastructure</td>
<td>Value added and innovation</td>
</tr>
<tr>
<td></td>
<td>Diversification of employment</td>
<td>Sustainable development</td>
</tr>
</tbody>
</table>
The shift from distribution to allocation goals implies a shift in the type of actors who decide on development measures. While especially the original regional policy focused on public actors, the discussed new regional policy concentrates on private actors. This development is summarized in Figure 4-5. The grey arrow indicates the direction of the development of regional policy over time. The decision about investment aids is made by public actors and they are also public actors who receive investment aids. Decisions about the support of SMEs, the hotel and restaurant industry and monostructured regions are also made by public actors but those who benefit are private actors. Finally, the suggested foundation for mountain areas would be run by private actors and the beneficiaries would also be private actors.

**Figure 4-5: Development in the focus of regional policy in Switzerland**

<table>
<thead>
<tr>
<th>Development impulses</th>
<th>Top down and bottom up</th>
<th>Bottom up (entrepreneurs, innovators)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal responsibili-ties</strong></td>
<td>Support and partial financing of regional development projects Approval and partial financing of individual projects</td>
<td>Support of clusters and networks Support of pilot projects Support of self-help Development of rules Monitoring and evaluation</td>
</tr>
<tr>
<td><strong>Financial instruments</strong></td>
<td>Investment aid regulation Annual budget for specific support programs</td>
<td>Global budgets for innovative projects in large regions Innovation fund and foundation for mountain areas</td>
</tr>
</tbody>
</table>

Source: EXPERTENKOMMISSION ÜBERPRÜFUNG UND NEUKONZEPTION DER REGIONALPOLITIK 2003: 12

Source: own illustration
4.5 Conclusions to regional policy

According to Armstrong and Taylor (2000: 262), three more recent developments have posed great challenges for regional economic analyses. The first has been the emergence of more complex multiple objectives for regional policy, including social, political and environmental goals. This has made the disentangling of the economic effects of regional policy a more difficult task. The second has been the switch from the use of simple, single policy instruments such as an investment grant or a location control to the delivery of complex packages of different types of help. Finally, the presence of many different organizations involved in the delivery of regional policy instruments also poses challenges for the analysis as it is much harder to disentangle the impact of the role played by any one organization.

At the same time, a new regional policy paradigm is discussed in Switzerland. One of the important questions that the new paradigm raises is how to deal with lagging regions and above all with particularly vulnerable areas. For these areas, an adequate combination of old and new development strategies has to be elaborated.

For these reasons, this study develops a quantitative simulation model with which the effects of different policy approaches can be analyzed. Regional development strategies are combinations of instruments. They are targeted towards specific development goals and are based on a theoretical understanding of regional development (Maier and Tödtling 1996: 179). The next chapter (chapter 5) therefore describes the most important theories that are relevant for the question of population and employment development in lagging rural regions. Chapter 6 quantifies the simulation model so that in chapter 8 development strategies can be tested.
5 Analysis of feedback complexity: theories on employment and population development

The purpose of this chapter is to develop a theory-based framework on population and employment dynamics in rural areas of industrialized countries. The framework will be translated into a dynamic simulation model in chapter 6 and used for policy analysis in chapter 8. To this end, section 5.1 gives an introduction to theories on employment and population development in rural areas of industrialized countries. Section 5.2 describes those theories in more detail that were found to be able to explain development trajectories in a wide variety of regions in previous studies. Section 5.3 subsequently analyzes the feedback complexity explicit and implicit to these theories. In order to capture the dynamic complexity stated in the relevant literature, generic structures from related disciplines will be added to the analysis.

5.1 Regional economics and rural studies

Theories that conceptualize the driving forces behind economic development in rural regions of industrialized countries can be found in various disciplines. Regional economics and rural studies offer promising prospects as the former focuses on regional economic development and the latter concerns rural development (TERLUIN 2003). In the course of this chapter, these theories will be applied to lagging rural communities in Switzerland.

5.1.1 Regional economics

According to FREY AND SCHALTEGGER (2000: 1-3ff) regional economics is the branch of economics that is concerned with regions within a national economy and with their relations with one another. It focuses on measuring, explaining and influencing the spatial structure and the development of regions. For this purpose it applies a variety of methods that are shown in Table 5-1. Apart from economics, economic geography also contributes to the debate in regional economics.

Table 5-1: Problems scrutinized by regional economics and methods of analysis

<table>
<thead>
<tr>
<th>Focus</th>
<th>Method of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring spatial structure and regional development</td>
<td>Shift-share analysis</td>
</tr>
<tr>
<td></td>
<td>Regional and interregional input-output analysis</td>
</tr>
<tr>
<td></td>
<td>Social accounting matrices and social accounting analysis</td>
</tr>
<tr>
<td></td>
<td>Regional incidence analysis</td>
</tr>
<tr>
<td></td>
<td>Analysis of quality of life</td>
</tr>
<tr>
<td></td>
<td>Regional benchmarking</td>
</tr>
</tbody>
</table>

For an encompassing overview of methods of interregional and regional analysis see e.g. ISARD ET AL. 1998
Analysis of feedback complexity

<table>
<thead>
<tr>
<th>Explaining spatial structure and regional development</th>
<th>Regional macroeconomic theories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regional microeconomic theories</td>
</tr>
<tr>
<td></td>
<td>Innovation theories</td>
</tr>
<tr>
<td>Methods of interregional and regional analysis:</td>
<td>- Location analysis for industry and service trades</td>
</tr>
<tr>
<td></td>
<td>- Regional and spatial econometric analysis</td>
</tr>
<tr>
<td></td>
<td>- Interregional programming</td>
</tr>
<tr>
<td></td>
<td>- Gravity and spatial interaction models</td>
</tr>
<tr>
<td></td>
<td>- Applied general interregional equilibrium models</td>
</tr>
<tr>
<td></td>
<td>- Interregional and spatial micro simulation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Influencing spatial structure and regional development</th>
<th>Regional policy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spatial planning</td>
</tr>
</tbody>
</table>

**Source: adapted from Frey and Schaltegger 2000: 1-4**

Chapter 3.5.3 presented results for rural regions in Switzerland from methods for measuring regional development (input-output analysis). Many of the methods in the measuring category in Table 5-1 are a prerequisite for the application of methods in the explaining category (e.g. input-output analysis and social accounting analysis for computable general equilibrium models). This chapter, however, focuses on theories to explain regional development. Regional macroeconomics analyzes regional growth and stability and the question of regional disparities. Regional microeconomics examines spatial structures by integrating distance and transportation costs into general price theory (Frey and Schaltegger 2000). The analysis of the spatial structure of an economy has re-gained in importance with the developments in the field of new economic geography (Krugman 1995, Fujita et al. 1999). At the same time, innovation theories are becoming more and more important (Frey and Schaltegger 2000). As Table 5-1 shows, innovation theories cannot be clearly assigned either to macro- or microeconomic theories.

Macro- and microeconomic theories put forward in the regional economics literature all focus on explaining growth of a region’s output (Terlun 2001: 57). As rural development policy is not only concerned with output growth but with providing employment opportunities as well, Figure 5-1 introduces a diagram of the interaction between a regions’ product market and its labor market.
The figure shows that employment growth depends on the growth of a region’s output, which is itself determined by the competitiveness of its firms, i.e. the ability of these firms to produce a certain share to meet the region’s own demand and the demand of other regions. Regional economic growth theories conceptualize the competitiveness of a region’s industries in different ways. In neoclassical theories, the competitiveness of firms is derived from the availability of labor and capital and the prices of the firms’ products. Other theories add factors like economies of scale, transaction costs and network relations and therefore expand the model shown in Figure 5-1. When the relation between the competitiveness of firms and output is expressed in terms of a production function as \( Y = f(A, B, C) \), regional economic growth theories can be divided into four main groups, depending on the factors in the production function (TERLUIN 2001: 59):

1. Traditional models,
2. Pure agglomeration models,
3. Local milieu models,
4. Territorial innovation models.

The sequence of the models is such that the production factors in the production function increase in complexity. The models also reflect a certain degree of chronological sequence: The traditional models were prevalent in the 1950s, the pure agglomeration...
models in the 1960s, the local milieu models in the 1970s and the territorial innovation models have dominated since the 1980s (TERLUIN 2001: 59).

In the traditional models output is assumed to be a function of the input of labor and capital (TERLUIN 2001: 59). Traditional models follow a comparative-static approach. They differ in their economic orientation where the neoclassical growth theory is supply-oriented and the Keynesian approaches are demand-oriented. The second group, the pure agglomeration models, links output to the availability of labor and capital and to external effects or scale economies. External effects and economies of scale may arise due to a concentration of labor and capital in a specific region (TERLUIN 2001: 60). Pure agglomeration models describe cumulative causation processes. In the theories governing local milieu models, the third category, various factors in the local milieu, such as skills of the labor force, technical and organizational know-how and social and institutional structures, affect the revenues from the input of capital and labor (TERLUIN 2001: 61). The last category, territorial innovation models, adds the diffusion of innovations as an important engine behind growth. Innovation has to be understood in a broad sense and includes product, process and organizational innovation in the firm as well as social and institutional innovation at the level of an industry, region or nation (TERLUIN 2001: 62).

5.1.2 Rural studies

The debate on economic development in rural studies is on the one hand concerned with theories on economic growth in rural regions and on the other hand with the question how rural development policy can stimulate economic growth in rural regions. It seeks to understand the interaction between spatial structures and sociospatial processes in rural areas and addresses a wide range of issues in rural areas such as people, settlements, landscape, environment, agriculture, economy, policy, minorities, gender and cultural issues (TERLUIN 2001: 17). The field of rural studies is grounded in a variety of disciplines such as rural geography, rural sociology, agricultural economics, demography, ecology, rural planning and administrative sciences (e.g. CLOKE 1997). Three main approaches can be distinguished (TERLUIN 2001: 66):

1. The exogenous development approach,
2. The endogenous development approach,
3. The mixed exogenous/ endogenous development approach.

These approaches reflect more or less a chronological sequence in the conceptualization of rural development. Until the 1970s the exogenous development approach tended to be the dominant model for explaining rural development. In European countries, this approach was largely reflected in a rural development policy directed towards modernization of the agricultural sector (TERLUIN 2001: 67). The exogenous development approach shows strong similarities with pure agglomeration models in regional economics.
In the late 1970s, the focus shifted to the endogenous development approach which is closely related to local milieu models. Where rural development policies were concerned, emphasis was given to rural diversification, bottom-up approaches, support of local business, encouragement of local initiatives and local enterprises and the provision of suitable training (LOWE ET AL. 1995: 91).

The mixed exogenous/ endogenous development approach focuses on the interplay of local and external forces in the control of rural development processes (LOWE ET AL. 1995: 87). This approach relates rural development to the process of increasing globalization. In this changing global context, actors in rural regions are involved in local and external networks through which resources are mobilized. This approach can be seen as a specific application of the territorial innovation models (TERLUIN 2001: 90).

5.1.3 Conclusions from theories in regional economics and rural studies

Synthesizing theories in regional economics and rural studies, it can be said that the debate on economic development in rural studies is especially concerned with the organizational aspects of the rural economy. Regional economics, on the other hand, focuses more on the interplay of the production factors of capital and labor, often affected by several other factors (TERLUIN 2003: 33). However, when the availability of capital and labor is assumed in the debate on economic development in rural studies, it was shown that there is a considerable amount of overlap between both debates.

Table 5-2 summarizes the most common theories in regional economics and rural studies. The theories are grouped according to the factors in the production function (first column; see section 5.1.1). The third column describes the determinants of regional development according to the theories and the fourth column indicates seminal contributions in the context of the theories. In line with EGGER (1998: 33-35), the table also distinguishes between the main focus of the theories, i.e. whether they are more factor-oriented or more actor-oriented.
Table 5-2: Classification of theories on regional economic development

<table>
<thead>
<tr>
<th>Category</th>
<th>Theories</th>
<th>Determinants of regional development</th>
<th>Founder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early micro-economic theories</td>
<td>Location theories</td>
<td>Location factors, especially costs</td>
<td>WEBER, VON THÜNNEN, CHRISTALLER, LOSCH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mobility of labor, capital, know-how</td>
<td></td>
</tr>
<tr>
<td>Traditional models</td>
<td>Neoclassical growth theory</td>
<td>Labor</td>
<td>SOLOW</td>
</tr>
<tr>
<td>Y = f (L, K)</td>
<td></td>
<td>Capital</td>
<td></td>
</tr>
<tr>
<td>Keynesian approach: export base</td>
<td></td>
<td>Export of goods and services</td>
<td>KEYNES, SOMBART</td>
</tr>
<tr>
<td>theory</td>
<td></td>
<td>Investment</td>
<td></td>
</tr>
<tr>
<td>Pure agglomeration models</td>
<td>Theories of growth poles</td>
<td>Availability of labor and capital</td>
<td>PERROUX</td>
</tr>
<tr>
<td>Y = f (AE, L, K)</td>
<td></td>
<td>Existence of a leading firm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiplier effects</td>
<td></td>
</tr>
<tr>
<td>Core-periphery theories</td>
<td></td>
<td>Availability of labor and capital</td>
<td>FRIEDMANN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Existence of a leading city</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiplier effects</td>
<td></td>
</tr>
<tr>
<td>Cumulative causation theories</td>
<td></td>
<td>Availability of labor and capital</td>
<td>MYRDAL, HIRSCHMAN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agglomeration of economic activities and people</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Increasing returns to scale</td>
<td></td>
</tr>
<tr>
<td>New growth theories</td>
<td>Endogenous technological progress</td>
<td></td>
<td>ROMER</td>
</tr>
<tr>
<td></td>
<td>Monopolistic competition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Economic Geography</td>
<td>Increasing returns to scale</td>
<td></td>
<td>KRUGMAN, FUJITA ET AL.</td>
</tr>
<tr>
<td></td>
<td>Monopolistic competition</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transportation costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actor-oriented theories</td>
<td>Endogenous growth models</td>
<td>Rate of technological progress endogenous and dependent on</td>
<td>CAMAGNI, MAILLAT ET AL.</td>
</tr>
<tr>
<td>Y = f (LM, L, K)</td>
<td></td>
<td>- human capital</td>
<td></td>
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<td></td>
<td></td>
<td>- knowledge from R&amp;D</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>- public infrastructure</td>
<td></td>
</tr>
<tr>
<td>Territorial innovation models</td>
<td>Theory of the innovative milieu</td>
<td>Relationships between firms and their environment</td>
<td>GREMI⁸</td>
</tr>
<tr>
<td>Y = f (I, LM, L, K)</td>
<td></td>
<td>Innovative capacity</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Capacity of learning</td>
<td></td>
</tr>
<tr>
<td>New industrial spaces</td>
<td>Agglomerated production system</td>
<td></td>
<td></td>
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<tr>
<td>Clusters of innovation</td>
<td>Social regulation system</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Market and competition</td>
<td></td>
<td>PORTER</td>
</tr>
<tr>
<td></td>
<td>Networking and social interaction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⁸ GREMI: Groupe de recherche européen sur les milieux innovateurs
Analysis of feedback complexity

<table>
<thead>
<tr>
<th>Regional innovation systems</th>
<th>Collective learning</th>
<th>Theory of the learning region</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cooperative relationships between members of the system</td>
<td>Knowledge (resource)</td>
</tr>
<tr>
<td></td>
<td>Innovation as a creative process:</td>
<td>Learning (process)</td>
</tr>
<tr>
<td></td>
<td>- Interaction between agents</td>
<td>Innovation</td>
</tr>
<tr>
<td></td>
<td>- Increasing returns</td>
<td>- Interactive</td>
</tr>
<tr>
<td></td>
<td>- Problem-solving orientation</td>
<td>- Shaped by institutional routines and social conventions</td>
</tr>
</tbody>
</table>

Y: income or output; L: labor; K: capital; AE: agglomeration effects due to external effects or scale economies; LM: local milieu, which includes factors like space, human capital, technology, networks, trust, culture and policies; I: innovation.


Table 5-2 shows that there is a large number of theories that can be used to explain economic development in rural regions. These theories have served as a basis of comparative analyses of socioeconomic performance among rural regions in industrialized countries. Building on in-depth case studies of nine pairs of leading and lagging rural regions in nine EU member states, Terluin (2001) identified those theories that were able to predict the development trajectories in the case studies. These theories relate economic development to a high capacity of local actors and strong internal and external networks (Terluin 2003: 327). The next section describes these theories in more detail.

5.2 Theories supported by empirical evidence

The theories that were found to be widely supported by empirical evidence belong to the category of the mixed exogenous/ endogenous approach or the territorial innovation models, respectively. In those theories, a high capacity of local actors and strong internal and external networks – often indicated as self-help capacity – are supposed to be main factors behind employment growth (Terluin 2003: 341).

These theories identify the most important determinants of regional rural development but they make no statement about the processes leading to a change in these determinants. Therefore, other theories will be discussed so that the gap in the literature can be closed for the case of population and employment dynamics in rural regions.

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9 Such comparative studies have been carried out, for example, in the EU in the RUREMPLO project (Terluin and Post 2000) and the Dynamics of Rural Areas project (Bryden and Hart 2001) and in Canada through the New Rural Economy project (e.g. Redmer 2002).
5.2.1 Product market, factor market and population

Terluin (2001, 2003) repeatedly argues that the availability of labor and capital is a prerequisite for the validity of the more elaborate theories that were found to be supported by empirical evidence. As a basis for further analysis this section therefore develops the basic scheme of a regional economy shown in Figure 5-1 further and incorporates first interactions between the regional economy and the region’s population.

At the heart of all regional economic models is the notion of internal feedback through input-output linkages between economic agents such as firms and households. Firms are linked to other firms through the goods and services they buy from each other. Households sell their labor to firms and buy goods from them. These linkages occur both within regions and between regions (Armstrong and Taylor 2000: 7). Any change in the demand for goods and services produced by a region will have further effects on the local economy over time through indirect effects on other industries and induced effects through the household sector. Investment projects that lead to new economic activities raise the aggregate income and employment levels in a region.

However, there are also feedback effects emanating in the region’s labor market. An increase in employment, for example, will raise the regional wage. This induces an increase in net inward migration and an increase in the region’s participation rate, both of which will raise the supply of labor and dampen the upward pressure on wages. As wages rise, the region will lose some of its competitiveness, which in turn will lead to a decline in the demand for the region’s output (as prices rise relative to the price of competing products). The combined effect of an increase in employment and wages will stimulate the local demand for the region’s output (Armstrong and Taylor 2000: 29). This holds true also for small regions. Regional wage levels may be strongly influenced by national wage setting arrangements but they are unlikely to be entirely exogenous (Armstrong and Taylor 2000: 29). The same applies for product prices.

As a consequence of increased labor demand net outward migration will fall as more jobs become available and the participation rate will rise as more non-workers are induced into the job market (Armstrong and Taylor 2000: 29). Product and factor markets are therefore linked to a region’s population by the effect of labor demand and labor supply on net migration.

Labor migration in the economic literature is a case of seeking the highest return to one’s human capital, with the decision possibly modified by non-pecuniary aspects.

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10 See Buser 2005 for extensive empirical work on direct, indirect and induced effects of production activities in lagging regions in Switzerland.

11 An example for an increase in the participation rate is employment combination by farmers who, under favorable economic conditions, start work in the overall economy in addition to their work in the agricultural sector.
and the likelihood of unemployment.\textsuperscript{12} Non-pecuniary aspects include personal characteristics such as age, education, family structure, employment status, migration history, life-cycle changes and locational characteristics. Locational characteristics refer to differences in quality of life between regions which are a consequence of natural utility-yielding amenities and manmade amenities such as infrastructure, health care and public safety (CUSHING AND POOT 2004: 320f). Empirical results for rural areas in industrialized countries suggest that the rural population grows faster when residents can access a wide range of jobs. Investment in human capital has conflicting impacts. On the one hand, an increase in human capital induced by improving education and training lowers the working age population because it raises the income an individual can earn in an urban market. On the other hand, human capital also raises rural income which can reduce out-migration (HUANG ET AL. 2002). Quality of life factors including taxes and services and amenities such as developed recreational infrastructure also proved to be important in the context of rural economic performance (DELLER ET AL. 2001). Many of these manmade amenities are public goods. The extent and composition of the provision of public goods and the financing of public expenditures through taxes, charges and borrowing are important migration determinants. TIEBOUT (1956 in CUSHING AND POOT 2004: 321) summarized this fact in the notion that people 'vote with their feet'.

The simplest regional economic models to quantify the relations shown in Figure 5-1 on page 67 are based on the neoclassical growth model where one aggregated good (the region's output) is produced by the two factors labor and capital and according to specific overall factor productivity. Labor and capital are assumed to be perfect substitutes and output growth is induced by an exogenous increase in factor productivity through technological change (ROSSI 1995: 105).

Although the traditional neoclassical model still dominates, at least two significant theoretical innovations have occurred for understanding regional growth: technical progress has been made endogenous in new growth theories,\textsuperscript{13} and the new economic geography has integrated spillovers and increasing returns within a formal model based on explicit microeconomic foundations (CHESIRE AND MALECKI 2004: 262). This model is described in FUJITA ET AL. (1999). It uses the Dixit-Stiglitz model of monopolistic competition where externalities emerge as a consequence of market interactions involving economies of scale at the level of the individual firm. KILKENNY (1998b) shows that the assumptions used by new economic geography models render the models incapable of simulating rural development. She shows that rural development in the context of agglomeration economies depends on raising real rural wages

\textsuperscript{12} For a survey about migration research see CUSHING AND POOT (2004) and the quoted literature. EHRLICH AND LUI (1997) give an overview of the literature about population and economic growth.

\textsuperscript{13} For an overview of spatial perspectives on new theories of economic growth see NIJKAMP AND POOT 1998, for a comparison between the implications of exogenous and endogenous spatial growth models see BAL AND NIJKAMP 1998
and that one way to raise real rural wages without repelling firms or raising urban land rents is to improve the quality of rural life. Increasing the array of amenities enjoyed by rural people may, according to this analysis, be a more effective strategy than attempting to alter private incentives facing businesses (KILKENNY 1998B: 277).

There are different possibilities to induce regional economic growth through technological change (ARMSTRONG AND TAYLOR 2000: 86f):

- Technology embodied in capital goods is exogenous in the sense that regions buying these capital goods will automatically acquire the embodied technology. A region’s technology is therefore determined by the vintage of its capital stock. This can for example be observed in the agricultural sector where push-factors on agricultural employment depend, among others, on the age of the barns in the region.

- Disembodied technical progress is independent of the capital stock with which it is combined in order to produce output. It is more likely produced in knowledge-rich and creative environments, i.e. in regions with large quantities of human capital and with a favorable institutional setting. The creation of technical progress is determined by a collective learning process within which many individuals interact and exchange ideas and information, thereby providing a knowledge-rich environment. If such an environment exists, knowledge passes quickly from one economic agent to another, giving rise to the rapid creation of a wide variety of new ideas. These ideas are then transformed into new products and processes, thereby raising labor productivity. Technical progress, therefore, is not simply an automatic outcome of investment in research and development, but requires an institutional environment which is conducive to the adoption and assimilation of new ideas into the production system. This aspect is further described in the next section.

5.2.2 Regional innovation and local institutional dynamics

Theories governing territorial innovation models assume that, apart from labor and capital, local milieu factors and the diffusion of innovations are also important engines behind growth. The emphasis on innovation implies that technological ability to adapt to innovations is considered to be crucial for new types of production and entry into new markets. The development of the local economy thus depends on its capacity to transfer its resources from old activities to new ones, especially by mastering new product technologies (TERLUIN 2003: 331). The availability of innovation and the capacity to use it are therefore essential for economic growth.

‘Territorial innovation models’ is a generic name for models of regional innovation in which local institutional dynamics play a significant role (MOULAERT AND SEKIA 2004: 291). Between these models, there is a broad field of tensions. The apparent semantic uniformity and the shared theoretical sources hide a pluralism of interpretations of innovation dynamics and an ambiguity of the various dimensions of market-led innovation at the local and regional level (MOULAERT AND SEKIA 2003: 299).
TERLUIN (2001) formulated a series of hypotheses in the realm of territorial innovation models. Those that are community-oriented (instead of firm-oriented) and that were found to be supported by empirical evidence were the following:

- An active role of local actors in internal and external networks stimulates employment growth.
- The self-help capacity of communities is assumed to consist of three items: capacity of local actors, organizational expertise as reflected in partnerships and appropriate institutional structures.

In order to operationalize ‘an active role of local actors in internal and external networks’ and ‘a well-developed self-help capacity of communities’, the following definitions were applied (TERLUIN 2001: 102-108):

- Internal networks: networks of local actors.
- External networks: networks of local actors and actors from outside the region.
- Active role: Local actors are supposed to play an active role when they have the capacity to identify strengths, weaknesses, opportunities and threats and to cooperate with each other in order to address these issues. Capacity usually refers to the three aspects of knowledge, skills and attitude.
- Policy makers’ capacity: the ability to act effectively in formulating and delivering policies, in supporting local initiatives and projects and in attracting public funds and investments.
- Entrepreneurs’ capacity: the ability to perceive market changes and to respond to them.
- Partnerships: external assistance from regional and national authorities, universities and development agencies.
- Appropriate institutional structures: When local policy makers have good contacts with upper-level policy makers and when they are able to attract public funds for local projects from upper-level policy makers, institutional structures are positively assessed.

The two hypotheses raise the questions under which circumstances actors become active and which factors determine whether these activities are successful and stimulate economic growth and employment. These questions are closely related to the public choice literature and to the literature about innovation generation, diffusion and implementation.
Analysis of feedback complexity

Theory of collective action

As the context of innovations in this study is in the public realm, the specific characteristics of sociopolitical decision-making processes have to be considered. The answer to the question under which conditions actors become active in a sociopolitical context depends on several factors. Contributing to regional rural development by increasing economic diversity has the characteristics of a public good (see chapter 1). Voluntary contribution will therefore be low because of the possibility of free-riding. Other actors can profit from the benefits of the development effort without contributing to the costs of its provision (Henrichsmeyer and Witzke 1994: 494f). Generally, the larger a group of actors is the less they will promote their common interests (Olson 1985; see Figure 5-2).

The left hand side in the figure depicts the situation of a small group. Individual C is willing to provide quantity R of a collective good. A and B could consume quantity R without paying for it. If A, B and C join forces they improve their respective situations by providing quantity S. At this point, total demand equals marginal costs of providing the good.

The right hand side of Figure 5-2 shows the situation of a large group. A member of a large group cannot contribute significantly to the provision of the collective good. It therefore has no immediate incentive to do so. Only the sum of the contribution of many members would cover the marginal costs of providing the good.

In large groups, selective incentives are necessary to mobilize group members. Selective incentives can be positive or negative. Positive incentives are rewards in the form of additional private goods so that group members act according to group interest. Negative incentives would be measures that force members to contribute to the provision of the good. The costs of mobilizing group members rise with the size of the group. The costs also depend on the degree to which interests of the individual group members are homogenous. The more heterogenous they are the higher the costs. In the context of this study, one important determinant of the homogeneity of actors’ interests is the direct pressure they experience. A community’s population is more willing to contribute to local development initiatives if the stakes are very high, e.g. if the local school or grocery store are threatened.

The analysis of collective action has important implications. It shows that in the context of community development, the different stakeholders in a community need to have homogenous interests as a precondition for collective action and contribution to a public good, in this case rural development understood as increasing economic diversity. Interests are only homogenous under two conditions: Either when pressure is so high that a contribution to increasing diversity benefits the individual actor directly (small group case) or when incentives reduce transaction costs and facilitate the coordination of differing interests (large group case).
Collective action and innovation

Increasing economic diversity of a community depends on the generation and implementation of innovation. Since the works of Schumpeter (1934), innovation – the introduction of new combinations of methods for supplying commodities in the economy – has been considered as one of the most important drivers behind economic growth. In the broad sense of the term, innovation includes product, process and organizational innovation in the firm as well as social and institutional innovation at the level of an industry, region and nation (Morgan 1997: 492). Relative differences in innovation capacity are seen as the main reason for unequal regional economic development as the capacity to innovate in the realms of products, processes and organization crucially affects the competitiveness of a firm. The same applies to a region as a set of firms (Maier and Tödtling 1996: 119).

Current literature about innovation in the context of regional development conceives innovation as an interactive process that is shaped by a variety of institutional routines and social conventions (Morgan 1997: 493). The significance of routines and conventions for innovation and economic development is generally summarized in the concept of social capital. The aspect of innovation as an interactive process is an impor-

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14 The literature sometimes uses different terms for the different stages in the innovation process: invention, innovation, imitation or diffusion (Schumpeter 1961 in Maier 1998: 285). In this study, the term innovation is used for the entire process and not for a specific stage.
Analysis of feedback complexity

tant field of research in evolutionary economics. One important statement is that in-
ovovation is a path-dependent and therefore cumulative process as actors or entrepre-
eurs, respectively, draw on their experience with past innovations (TIDELSKI 2002: 661).

As this study is concerned with sociopolitical processes that contribute to employment
and population growth, the term 'local initiatives' will be used instead of innovation. Following MÜHLINGHAUS AND WÄLTY (2001: 237), local initiatives are defined as
innovative and collaborative activities that take place under local control and for the
benefit of the local population.

Innovation leads to economic growth and innovation is produced by the entrepreneur
(NUKAMP 2003: 396). The entrepreneur is defined as a person who creates new busi-
ness, brings new products to the market or develops new processes of production
(STIGLITZ AND DRIFFILL 2000 in NUKAMP 2003: 396). The general role of the entre-
preneur is concerned with a proper treatment of uncertainty and with the need to ex-
plor new endeavors, to initiate creative and innovative strategies and to collect and
deploy new knowledge (NUKAMP 2003: 399). The literature does not offer an unambi-
guous explanation for the determinants of entrepreneurship. Instead, it suggests three
complementary factors which may be used in an explanatory framework (NUKAMP
2003: 399 and quoted literature):

1. Personal motivation: psychological factors such as need for achievement, locus of
control and risk taking.

2. Social environment: displacement, disposition to act, credibility and availability of
resources.

3. External business culture: Structural changes in industrial composition and organi-
ization, shifts in the labor market, changes in institutional and governmental struc-
tures or sociodemographic changes may encourage entrepreneurship. On the other
hand, a low societal appreciation for entrepreneurship may lead to a low entry rate
into the business sector.

Adding a spatial dimension, the local environment, including its culture, knowledge
base and business attitude, appears to often act as a critical success factor for new
forms of entrepreneurship (NUKAMP 2003: 401). Empirical studies on the role of so-
cial capital – social capital viewed as networks of social relationships – in rural areas
reveal supportive evidence for this proposition. TIEPOH AND REIMER (2004) found that
the use of social capital in the form of market relations, associative relations and
communal relations and household income influence each other positively. However,
the analysis also reveals an important gap between the availability of social capital and
its use. This cautions those policies that focus on increasing the availability of social
capital alone, e.g. by increasing the availability of information about markets and

15 For a discussion about links between evolutionary economics and regional policy see LAMBOOY AND
prices, training of negotiation skills, enhancing the level of mobility or supporting informal and formal social groups.

The question whether innovation produced by the entrepreneur spreads to other local actors and whether the innovation is successful and thus stimulates employment and output growth is related to the literature on innovation diffusion and implementation. In the context of innovation research, adoption is the application or use of an innovation by an individual or a group of individuals. Diffusion, on the other hand, is the planned or spontaneous process by which an innovation is communicated through certain channels and over time among members of a social system (GERBER 2004: 55f).

The basic innovation diffusion model consists of a single differential equation that represents the rate of adoption as a fraction of the non-adopters (ABRAHAMSON AND ROSENKOPF 1997: 294f; LUNA-REYES 2004: 161; see Equation 1). Micro-economic analyses tend to view the process of innovation diffusion as the cumulative result of a series of rational individual calculations that weigh the incremental benefits of adopting a new technology against the costs of change, often in an environment characterized by uncertainty and by limited information. The resulting diffusion rate is determined by summing over these individual decisions (HALL 2004: 6).

Equation 1: \[ x_t = a(N - X_t) + bX_t(N - X_t) \]

- \( x_t \) rate of diffusion at time \( t \)
- \( a \) parameter associated with the influence of external forces initiating diffusion
- \( b \) parameter associated with the internal process of diffusion
- \( X_t \) number of adopters at time \( t \)
- \( N \) total number of potential adopters

Integrating Equation 1 produces a logistic S-curve similar to Figure 2-4 in chapter 2.2.1 for the cumulative number of adopters over time. In terms of feedback complexity, the equation describes the interaction of a balancing and a reinforcing feedback loop (see chapter 2.2.1, feedback loop dominance and nonlinearity). The operational logic of the equation is such that it reveals how nonadopters make contacts with adopters, the fraction of those contacts that are adopters and the fraction of those contacts with adopters that convince nonadopters to adopt.

The model in Equation 1 is not designed to explain when innovations occur and how many adoptions a diffusion process will cause. Each potential adopter need not necessarily succumb to group pressure. Threshold models of innovation diffusion assume that potential adopters have varying dispositions against adopting an innovation and that a potential adopter will give in to group pressure to adopt only if the pressure exceeds this potential adopter's threshold (DAVID 1969 in ABRAHAMSON AND ROSENKOPF 1997: 295; ABRAHAMSON AND ROSENKOPF 1993: 496).
Innovation implementation can be defined as the process of gaining targeted organizational members’ appropriate and committed use of an innovation (KLEIN AND SORRA 1996: 1055). Commitment refers to an actor’s attachment or determination to reach a goal by using the newly adopted innovation (REPPENING 2002: 111). The literature about innovation implementation falls mostly within organizational theory. If applied to regional initiatives two points have to be accounted for:

1. The focus of this study is on the rural community as a socioeconomic system. Initiatives always benefit a public good or a community’s population as a whole and not a single firm.

2. As a consequence, the decisive processes for successful development are in the public domain and development strategies result from public decision making. For a regional economy as a whole there are no such actors as a firm’s manager who has the competence to induce whatever change they think is adequate. For this reason, external know-how and external actors are decisive in the innovation implementation process.

If properly implemented, innovation improves regional economic performance. Similar to the organizational context, it cannot be assumed that actors participating in innovations know this. Instead, the process through which participants in the community come to believe or not believe in the efficacy of an innovation is crucial for successful implementation of innovations. REPPENING (2002) reviewed the literature that speaks to the question of what processes determine the effective use of innovations. Synthesizing a framework that captures the main feedback processes running through each of the major theories, he proposed a series of insights into the dynamics of implementation (REPPENING 2002: 119f):

- Motivation threshold: Normative pressure and instrumental motivation to use an innovation are closely interconnected. Instrumental motivation is a social process that, depending on the state of the system, works either for or against successful implementation. Normative sources of commitment provide the external force that can potentially move the system from a reversionary to a regenerative state and, thereby, ensure the success of the effort. The motivation threshold defines the level of commitment that normative forces must achieve to induce this shift.

- The existence of the motivation threshold explains that the impact of normative forces depends on the state of commitment. If commitment is very low, small increases in normative pressure have little impact on commitment due to the lack of instrumental motivation. Similarly, when commitment is above the threshold, normative forces have no influence at all. In contrast, when commitment is near, but below, the motivation threshold, small changes in normative pressure can dramatically influence the outcome of the effort.

- The motivation threshold constitutes a solution to the often observed phenomenon of innovations that produce early results, but fail to achieve sustained use. Norma-
ative sources, while sufficient to produce early results, do not produce enough commitment to push the system over the motivation threshold.

The combination of the literature about collective action and innovation diffusion and implementation provides deeper understanding of the underlying processes concerning actors’ participation in networks and stimulating a community’s self-help capacity. This aspect will be analyzed in detail in the next section.

5.3 Feedback complexity of relevant theories

Section 5.2.2 showed that those theories that are supported by empirical evidence cannot provide unambiguous policy recommendations (Egger 1998: 33). This holds especially true for the case of technological change, the significance of agglomeration effects and quality of life factors.

Contrary to factor-oriented theories that use only few variables and formal models to explain development, in actor-oriented theories a considerable number of variables are introduced but only very few attempts to formally model them have been undertaken so far. This study contributes to the ongoing debate by exploring one possibility to formalize actor-oriented theories. It does so by integrating the formal logic of factor-oriented theories with additional actor-oriented determinants of development. This section lays the basis for the quantitative simulation model (see chapter 6) by analyzing feedback complexity inherent to the theories described above. One defining feature of a feedback perspective is the analysis of processes over time. Reinforcing and balancing processes always require time. The time necessary to move from one stock in the feedback loop to the next depends on the specific characteristics of the process and can differ considerably from other adjustment times in the system. Different adjustment times are one major source of oscillatory behavior and disequilibrium outcomes.

5.3.1 Product market, factor market and population

Rural development is not only concerned with an increase in output but with providing employment opportunities as well. The dynamic interplay between a region’s product market, factor market and population is described in this section.

The product market is characterized by the output of a regional economy (Figure 5-3). The output can also be understood as the supply with regional goods and services. On the product market, the two production factors of labor and capital are used to produce desired output. The desired level of output depends on the ratio between demand and supply. This ratio determines the product price. If demand exceeds supply (demand-supply ratio >1), price and consequently desired output rise. Small rural economies are price-takers on the national and international product market. Price therefore describes much more the degree to which a rural economy can compete on these markets than the exact product price itself. It is the revenue that the region generates with the production of its goods, given its production costs and the national or international price.
An increase in price increases desired output. As a consequence, more labor and capital are used and more output is generated. This lowers the demand-supply ratio and eventually leads to equilibrium. The production of regional goods and services is therefore characterized by the balancing feedback loop $Bl$ – *production adjustment to price*.

**Figure 5-3: Production of regional goods and services**

Variables in a box denote stock variables that integrate change over time. Arrows indicate the direction of causality. Signs (‘+’ or ‘-’) at arrow heads indicate the polarity of relationships; a ‘+’ denotes that an increase in the independent variable causes the dependent variable to increase, ceteris paribus (and a decrease causes a decrease). That is, $X \rightarrow Y \iff \delta Y/\delta X > 0$. Similarly, ‘-’ indicates that an increase in the independent variable causes the dependent variable to decrease; that is, $X \rightarrow Y \iff \delta Y/\delta X < 0$. The loop identifier ($B1$) indicates a balancing feedback loop.

Desired labor is calculated by multiplying desired output with the desired capital-labor ratio. The desired capital-labor ratio is determined by comparing the relative marginal product of capital to the relative cost of capital. If an incremental unit of capital is more productive as labor but less costly, producers profit from substituting capital for labor in new investment projects. By doing so, they lower the relative marginal product of capital until it equals its relative cost and there is no incentive for further substitution. The same holds for labor in the opposite case. The desired capital-labor ratio therefore equilibrates factor input ratios and creates two balancing feedback loops: $B2$ – *labor adjustment to cost* and $B3$ – *capital adjustment to cost* (Figure 5-4). Figure 5-4 describes the feedback loops responsible for bringing about the substitution effect of a change in relative factor prices described in Figure 4-3 on page 57. Iterating $B1$, $B2$ and $B3$ over time generates a new optimal capital-labor ratio.
The production of regional goods and services with the two production factors labor and capital is characterized by cumulative causation effects. Two reinforcing feedback loops bring about economic growth that exceeds the initial increase in output. \( R1 \) – *cumulative causation through multiplier effects* describes the industry’s demand for its own inputs and \( R2 \) – *cumulative causation through scale economies* contains the notion of endogenous technical progress (Figure 5-5).
If desired output increases, more labor and capital are necessary. Labor hiring leads to in-migration thus adding more population to the region. This has two consequences (Figure 5-6):

- The additional labor supply equilibrates with labor demand on the labor market and forms the balancing feedback loop $B_4$ – *population adjustment to available labor*. If labor is laid off, out-migration can be prevented if alternative employment possibilities are available within commuting distance.

- Population adds to local demand for the goods produced in the product market. This demand raises total consumption and via the price mechanism the incentive for producers to increase production. It therefore constitutes a reinforcing feedback loop $R_3$ – *reinforcement population – production*. This reinforcing feedback loop is constrained by the attractiveness of goods provision. When basic services can no longer be provided because a minimum population threshold is passed, it will be difficult to attract in-migrants even if labor demand rises.
Wages increase when labor becomes scarce, i.e. when demand exceeds supply. The equilibrating effect of net migration on the labor market also affects wages. In cases where wages increase, the local demand for goods and services increases because a proportion of the additional income is spent on local consumption. This multiplier and accelerator principle is described with the reinforcing feedback loop \( R4 - \text{income multiplier on output} \) (Figure 5-7).

One balancing feedback loops complements the interactions between product market, labor market and population. \( B5 - \text{consumption adjustment to price} \) in combination with \( B1 - \text{production adjustment to price} \) describe the dynamic interplay of the supply and demand side in an economy.

A series of exogenous variables drive the processes described in the balancing and reinforcing feedback loops. These variables are written in *italics* in Figure 5-7 and express economic forces that could only be made fully endogenous in interregional models. This applies specifically for capital costs as external demand can be stimulated by innovation. This aspect is further explored in the next section.
Analysis of feedback complexity

Figure 5-7: Feedback complexity in the product market, factor market and population

Variables in *italics* indicate exogenous forces.

With this first basic scheme the interactions between the labor market and population are captured. Built into a series of feedback loops, the theory so far describes a cumulative causation process that is summarized in the four reinforcing feedback loops *cumulative causation through multiplier effects, cumulative causation through scale economies, reinforcement population – production and income multiplier on output*. It states that once regional disparities come into existence, a self-reinforcing process starts that, in absence of other events, maintains the status of growing areas and drains lagging areas. A series of balancing feedback loops adjust factor intensities in the production process and supply and demand through the price mechanism.
5.3.2 Regional innovation and local institutional dynamics

This section describes the feedback complexity inherent to the actor-oriented theories concerned with regional innovation and local institutional dynamics.

At the core of regional innovation and local institutional dynamics are the different stages of an initiative (Figure 5-8). Entrepreneurs or external actors generate ideas that, over time, mature into implemented initiatives. The causal path between ideas and planned initiatives closes the gap between the availability of innovation and the capacity to use it (see section 5.2.2 and the gap between the availability of social capital and its use. This empirical finding cautioned policies that focus on increasing the availability of social capital alone). The causal path between ideas and planned initiatives describes the innovation diffusion phase. The innovation implementation phase transfers planned initiatives into implemented initiatives.

Figure 5-8: Stages of local development initiatives

Implemented initiatives stimulate external demand for regional goods and services and induce in-migration and population growth. This forms a reinforcing feedback loop as net migration and population growth contribute positively to entrepreneurial capacity \((R5 \text{- reinforcement capacity \text{- population; Figure 5-9})\). Entrepreneurial capacity describes an aggregate of capacity of policy makers and entrepreneurs to act effectively in formulating and delivering policies as a response to market changes, in supporting local initiatives and in attracting funds and investments. Entrepreneurial capacity is fed by two factors. The link coming from in-migration captures the role of newcomers as potential leaders.\(^{16}\) It also contains the notion of newcomers’ involvement in external networks. The link from population to entrepreneurial capacity accounts for the role of the younger population as potential leaders. An increasing number of people in a community not only raise the average level of know-how and skills, it also implies a higher variety of both internal and external networks. \(R5\) traces the process behind the evolution of innovative milieus.

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\(^{16}\) Leaders, according to TERLUIN AND POST (2000: 186) are newcomers, the young population, political decision makers or entrepreneurs.
The implementation of local development initiatives is characterized by the dynamic interplay of a reinforcing and a balancing feedback loop (Figure 5-10). The key concept in initiative implementation is the commitment of the involved actors. Commitment and success of initiatives influence each other positively (R6 - reinforcement commitment – success). Commitment is also part of a balancing feedback loop (B6 – commitment through motivation) that determines the direction of the reinforcing loop R6. The idea of the balancing loop B6 is that the gap in commitment is closed by entrepreneurs’ effort to motivate actors and to push their commitment over the commitment threshold. An additional decision structure takes into account that in the socio-political realm, this effort cannot necessarily be performed. Whether entrepreneurs’ effort to motivate actors is sufficient to reach the commitment threshold depends on entrepreneurs’ capacity and on external support. Entrepreneurial capacity is, as described above, positively linked to population and in-migration.
The success of past initiatives is also an important factor in the initiative diffusion phase. Innovation diffusion in the context of social innovations differs slightly from the diffusion rate model. Whether an idea will be further discussed and elaborated depends not so much on the number of adopters but on the number of actors who support the initiative in the sociopolitical decision-making process. A community with a history of failed initiatives will face difficulties in getting their population's support for yet another initiative. The societal appreciation of entrepreneurial activities is too low. In this case, the flow from ideas to implemented initiatives is doomed to stop in the diffusion phase and the system is locked-in in bad experience (Figure 5-11).

The balancing feedback loop $B7 - initiatives only under pressure$ represents the limits to growth to the reinforcing feedback loop $R5$ (see Figure 5-12). Groups need incentives or pressure in order to engage in the sociopolitical decision-making process. If a community’s population falls below a critical threshold value, the provision of public
services becomes at risk. Under these circumstances, when pressure is high, actors are more willing to support initiatives. Creating employment opportunities to maintain population and regional output has a public good character. Actor groups are therefore more likely to support an initiative if the pressure is so high that new employment opportunities, created to meet the external demand for regional goods and services, will benefit them directly. Under these circumstances, the interests of the different stakeholders and actors groups become very homogenous. With the situation improving the incentives for actors to become active decline so that support of initiatives drops, too. B7 therefore adds an element of threshold models of innovation diffusion.

Figure 5-12: Limits to local development initiatives

Figure 5-13 summarizes the feedback complexity inherent in actor-oriented theories concerned with regional innovation and local institutional dynamics in the context of regional rural development.
5.4 Conclusions from the analysis of feedback complexity in relevant theories

The analysis of the feedback complexity inherent to theories on rural economic development shows that several reinforcing and balancing processes influence employment and population development. A variety of potential development patterns arise from this. The analysis also implies that these processes occur at different velocities. Labor and capital have different adjustment times and net migration will always lag behind the developments on the product and factor markets. The implications for the development of the simulation model are that the economic system has to be able to account for other development outcomes than equilibriums.

The analyses in this chapter also show that actors face complex choices when making employment and population relevant decisions. According to Simon (1957 in MORECROFT 1985: 901), individuals faced with complex choices are unable to make objectively rational decisions because they cannot generate all the feasible alternative courses of action, they cannot collect and process all the information that would permit them to predict the consequences of choosing an alternative and they cannot value anticipated consequences accurately and select among them.17 There are, however, clear

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17 For an overview of a psychological foundation of economics see FEHR AND SCHWARZ (2002).
Analysis of feedback complexity

concepts for simplifying decision making. The simulation model will also have to account for that.

As shown in chapter 2, reinforcing feedback loops are responsible for lock-in situations. In the context of this study, this is especially relevant for the initiative diffusion and implementation processes. Negative experiences with past initiatives lower the number of potential supporters for a new initiative. Negative experiences also lower the commitment of actors involved in initiatives. With low commitment, success will also be low thus reinforcing negative experiences and low commitment and keeping the system locked-in at low performance.

Balancing feedback loops, on the other hand, are the source of policy resistance and tend to keep the system around some goal value. The price mechanism in the economic system is a prominent example. In the actor-related processes, policy resistance arises in the initiative diffusion phase. When pressure to improve local socioeconomic conditions is high, initiatives move more freely through the different stages. However, when pressure decreases because of favorable developments on the factor and product markets, fewer actors see the necessity to plan and implement ideas that entrepreneurs produce. Engaging in a local initiative brings lower utility to the individual actor and differences in social, political and economic interests between local actors and actor groups become more important. Only when the situation deteriorates, interests become more homogenous again.
# 6 Model specification

Chapter 3 presented an economic analysis of population and employment development in lagging micro-regions in Switzerland. Chapter 5 identified the dynamic implications of empirically grounded theories on this issue. This chapter elaborates a synthesis of the economic and feedback analysis and develops a quantitative simulation model for theory building and policy analysis. The model incorporates several important features that are currently not addressed by other models. These include:

- A disequilibrium economy system with adjustment and perception delays. Delays in labor hiring, capital construction and changing factor intensities prevent instantaneous equilibration of the economy (Fiddaman 1997: 16).

- Inclusion of positive feedback effects which may lead to lock-in of the regional economy to particular innovations. Lock-in arises when positive feedback reinforces the position of a dominant technology or firm (Arthur 1989 in Fiddaman 1997: 15). Principal among these positive loops are learning-by-doing, economies of scale, network or group pressure effects and the development of complementary infrastructure (Fiddaman 1997: 166). These processes have been described in chapter 5.3 for the case of economic development in lagging rural areas.

- Explicit behavioral rules for decision making. Chapter 3 showed that in a complex system such as a rural community with multiple stakeholders and concerned with socioeconomic development, full information of actors cannot be assumed. Instead, actors act and decide according to bounded rationality. For the formulation of the simulation model this means that actors try to improve economic performance by anchoring and adjusting their decisions and by extrapolating trends\(^\text{18}\) (see also Fiddaman 1997: 16).

Section 6.1 gives an overview over model purpose and model structure. Sections 6.2 to 6.6 describe the assumptions, the structure and the key parameters of the model developed for this research. Only selected important equations are presented and discussed. A complete set of equations is listed in the appendix.

## 6.1 Model overview

The purpose of the model is to identify the policy implications of the structures above, so that further research may be better targeted and policy makers may become aware of blind spots in current analyses. The model specifically allows the analysis of implications both from top-down and bottom-up development strategies. It thus takes into account the currently discussed shift in paradigm in Swiss regional policy and the current debate about the effectiveness of different development strategies.

\(^{18}\) Anchoring and adjustment as well as trend extrapolation is relevant for decisions about investment in the capital stock or labor hiring policies.
Model specification

The time horizon of the model is 1985 to 2050. The period since the beginning of the 1980s is considered as the period in which rural regions have completed their transition from an agrarian economy to a modern industrial or services economy (Terluin 2003: 328). The historical period of 20 years provides a useful test of model behavior. The long simulation period of 50 years is necessary for gaining insight into system behaviour and stability. It is not the purpose to make accurate predictions for a specific point in time. Much rather, the length of the time horizon results from the fact that regions are complex socioeconomic systems with partly long adaptation times. One example can be found in the age structure of the population (lag between birth and entrance into the labour market, average length of stay in the labour market). A long time horizon for the simulations allows analyzing system stability as well as capturing delayed reactions, changes in behavior modes and effects of policy measures or of a change in external conditions.

The features of the model were selected on the basis of a detailed inventory of the feedback structure and simulation methods of theories related to the purpose of this study and other regional economic models. Collectively, the features represent an alternative approach to integrative modeling, synthesizing ideas from regional economics, innovation implementation, behavioral decision theory and system dynamics (see chapter 2).

The model represents an integrative regional socioeconomic system. The great majority of structure in the model is endogenous (Table 6-1). Production of economic output, labor hiring, investment, consumption, innovation generation and implementation and migration processes are tightly coupled to one another. Several exogenous variables drive model behavior. They mostly describe elements of the national and international economy. Demographic variables and variables about social developments are also exogenous. The socioeconomic and entrepreneurial typologies of regional economies listed in Table 6-1 are used for the assignment of initial values. Scenario analysis will be carried out in chapter 8 to distill the implications of path-dependencies for the design of effective policies.

A number of economic structures that contribute to disequilibrium are omitted, such as labor pools and cash reserves. Backlogs and inventory are not specifically represented, as they equilibrate quickly relative to the model horizon (Fiddaman 1997: 65). For simplicity, there are no interactions between the regional economy and other regions (no regional disaggregation). Sectoral disaggregation is omitted in the basic version of the model. In chapter 7 the dynamic implications of sectoral disaggregation are tested. Table 6-1 gives an overview of the model boundary and illustrates the most important endogenous, exogenous and excluded structures as described above.
Table 6-1: Model boundary

<table>
<thead>
<tr>
<th>Endogenous</th>
<th>Exogenous</th>
<th>Excluded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic output</td>
<td>Factor productivity</td>
<td>Backlogs</td>
</tr>
<tr>
<td>Consumption</td>
<td>Interest rate</td>
<td>Inventory</td>
</tr>
<tr>
<td>Prices</td>
<td>Support of initiatives</td>
<td>Money stocks and effects</td>
</tr>
<tr>
<td>Wages</td>
<td>Development of regional labor market</td>
<td>Regional disaggregation</td>
</tr>
<tr>
<td>Labor hiring</td>
<td>Public demand for regional goods and services</td>
<td>(Sectoral disaggregation)</td>
</tr>
<tr>
<td>Population growth</td>
<td>Social developments (e.g. consumption preferences, labor participation)</td>
<td></td>
</tr>
<tr>
<td>Migration</td>
<td>Demographic factors (birth and death rate)</td>
<td></td>
</tr>
<tr>
<td>Capital investment</td>
<td>Socioeconomic typology of regional economies</td>
<td></td>
</tr>
<tr>
<td>Attractiveness of goods provision</td>
<td>Entrepreneurial typology of regional economies</td>
<td></td>
</tr>
<tr>
<td>Exports of regional goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commitment to initiatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success of initiatives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The model can be divided into a number of subsystems. Figure 6-1 illustrates the model sectors. The stakeholders identified in chapter 3.2 are relevant in different model sectors: those who work or run a business in rural areas are active in the product and factor market and those who live in rural areas are represented in the population and the initiatives sector. External actors will be of special interest in chapter 8 where different policy measures and development strategies are tested.

The model sectors ‘product market’, ‘factor market’ and ‘population’ quantify the processes identified in the corresponding theories in chapter 5. The initiatives sector models the processes described in the regional innovation and local institutional dynamics theories.
Model formulation follows the same logic as the development of the conceptual framework in chapter 5. The following sections focus on the formulation of the quantitative model. The model will be formulated in equilibrium. A model is in equilibrium or steady state when the inflows and outflows of each stock variable balance. Each stock is unchanging and as a consequence, all model variables are constant over time. Information and material still flow through the system, but the flows result in no net change in any stock, so all variables remain constant. The model will be subjected to different external shocks and disturbances which generate particular dynamic patterns. Such analyses reveal the essential relationships between system structure and system behavior. Once understood, those relationships can clarify system behavior in the context of general economic growth or decline or other development trends (RICHARDSON AND PUGH 1989: 241).

6.2 Product market

The product market basically consists of two sectors: an aggregate consumer-retail sector and an aggregate supplying sector. The production rate in the supplying sector is determined by the factors of production. The dynamic formulation of the product market and of the factor market in section 6.3 is taken from FIDDAMAN 1997 and MASS 1975 and adapted to the model purpose where necessary.
6.2.1 Goods production

Output is generated by a Cobb-Douglas production function between operating capital, labor and technology (Equation 2). Labor participation is assumed to be constant. Households therefore make no substitution between income and household labor input or leisure time (FIDDAMAN 1997: 81).

Equation 2: \[ Y = Y_0 \cdot T \cdot \left( \frac{L}{L_0} \right)^{\alpha} \cdot \left( \frac{K}{K_0} \right)^{\beta} \]

- \( Y \): gross output
- \( Y_0 \): initial gross output
- \( T \): factor productivity
- \( L \): labor
- \( L_0 \): initial labor
- \( K \): capital
- \( K_0 \): initial capital
- \( \alpha \): value share of labor
- \( \beta \): value share of capital

The parameters \( \alpha \) and \( \beta \) measure how the amount of output responds to changes in the inputs (VARIAN 1993: 306). In a formulation, where \( \alpha + \beta = 1 \), we have constant returns to scale, \( \alpha + \beta < 1 \) gives decreasing returns to scale and \( \alpha + \beta > 1 \) gives increasing returns to scale (VARIAN 1993: A19).

Table 6-2: Output parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value share of labor</td>
<td>( \alpha )</td>
<td>0.5</td>
<td>1 (dimensionless)</td>
<td>MASS 1975: 118</td>
</tr>
<tr>
<td>Value share of capital</td>
<td>( \beta )</td>
<td>1-( \alpha )</td>
<td>1</td>
<td>MASS 1975: 118</td>
</tr>
</tbody>
</table>
| Initial gross output       | \( Y_0 \)       | 13.4e+006 | CHF/year         | Taken from input-output analyses in particularly vulnerable communi-
|                            |                 |           |                  | ties (BUCHLI 2002A and 2002B; BUCHLI ET AL. 2003; DIJKSTRA 2003) and cal-
|                            |                 |           |                  | culated as \( Y_0 = L_0 / \text{factor productivity} \), where aver-
|                            |                 |           |                  | age factor productivity in these communities is 0.01 persons/ 1'000 CHF|
| Initial labor              | \( L_0 \)       | 97        | Persons          | Average of particularly vulnerable communities in 2000 according to BPS 2000 (Landwirtschaftliche Strukturerhebung) and BPS 2001 (Eidgenössische Betriebszählung) |
Economic growth is driven by factor-neutral improvement in productivity as a consequence of technical progress, i.e. $\alpha$ and $\beta$ remain constant. Factor productivity grows at an exogenous fractional rate. The growth rate itself declines exogenously to a constant asymptotic value (Figure 6-2). If the asymptotic growth rate is zero, technical progress eventually ceases. If it is nonzero, factor productivity improvement continues to drive economic growth (FIDDAMAN 1997: 83).

Figure 6-2: Factor productivity

Table 6-3: Factor productivity parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial factor productivity</td>
<td>$T_0$</td>
<td>1</td>
<td>1</td>
<td>FIDDAMAN 1997: 84</td>
</tr>
<tr>
<td>Initial factor productivity growth rate</td>
<td></td>
<td>0.005</td>
<td>1/year</td>
<td>FIDDAMAN 1997: 84</td>
</tr>
<tr>
<td>Fractional productivity growth rate decline rate</td>
<td></td>
<td>0.01</td>
<td>1/year</td>
<td>FIDDAMAN 1997: 84</td>
</tr>
<tr>
<td>Asymptotic rate of technological change</td>
<td></td>
<td>0.0075</td>
<td>1/year</td>
<td>FIDDAMAN 1997: 84</td>
</tr>
</tbody>
</table>

6.2.2 Goods consumption and price

Consumption is determined by the demand for the output generated by production. Demand is the sum of local and external demand for consumer goods, adjusted for the effect of price on demand (Equation 3). The effect of price on demand is the ratio between current and initial price raised to the power of price elasticity of demand.
Model specification

(Equation 4). The demand function therefore has constant elasticity (see KIRSCHEK AND JECHTLITSCHKA 2002: 44).

Equation 3:  \[ D = (LD + ED) \times EPD \]
- \( D \) demand
- \( LD \) local demand
- \( ED \) external demand
- \( EPD \) effect of price on demand

Equation 4:  \[ EPD = \left( \frac{P}{P_0} \right)^{\varepsilon_d} \]
- \( P \) price
- \( \varepsilon_d \) price elasticity of demand
- \( P_0 \) initial price

Price is a stock variable that is formulated as an index so that reference price equals 1. Although the units of analysis in this study are small economies, price cannot be treated as an exogenous variable. While local demand is relatively inelastic, external demand reacts more sensitively to price changes. Price changes reflect changes in the competitiveness of a region relative to other regions. As external demand has a high share in total demand for locally produced goods, the price effects have to be modeled endogenously. Moderate endogenous price changes result from adjustment between desired and current price over the price adjustment time (WHelan AND Msefer 1996: 18f). Desired price depends on the ratio between goods supply and demand.

Price changes also reflect changes in the relative competitiveness of the local economy compared to the situation on surrounding markets. A decrease in price increases the competitiveness of the local economy.

Price itself feeds back into demand as seen in Equation 3 and into production. The effect on production is such that price adjusts desired production which is a one year exponential average of the current production rate. The extent of adjustment is determined by the price elasticity of supply.

Consumption is also constrained by consumers' income and income depends on wages. Additional determinants of consumption are omitted here because the purpose of the analysis is not to develop a detailed model of consumption behavior but, rather, to assess the relative importance of the basic income-consumption link (see discussion about real rural wages in chapter 5.2.1). In the model, wages are compared to initial wages. The resulting ratio is adjusted for the average propensity to consume (Equation 6) and then acts as a multiplier on local demand (Equation 5). The average propensity to consume indicates how much of the overall income is devoted to consumption.

Equation 5:  \[ LD = LDPP_0 \times Pop \times MWLD \]
- \( LDPP_0 \) initial local demand per person
- \( Pop \) total population
- \( MWLD \) multiplier wage on local demand
Model specification

Equation 6: \[ MWLD = \left( \frac{aw}{w_0} \right)^{APC} \]

- \( aw \) average wage over the last 2.5 years
- \( w_0 \) initial wage
- \( APC \) average propensity to consume

Table 6-4: Consumption parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial price</td>
<td>( P_0 )</td>
<td>1</td>
<td>1</td>
<td>Index</td>
</tr>
<tr>
<td>Price adjustment time</td>
<td></td>
<td>0.5</td>
<td>Years</td>
<td><strong>WHELAND AND MSEFER 1996: 32</strong></td>
</tr>
<tr>
<td>Time to perceive price changes</td>
<td></td>
<td>1</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Price elasticity of demand</td>
<td>( \varepsilon^d )</td>
<td>-1.1</td>
<td>1</td>
<td><strong>ARMSTRONG AND TAYLOR (2000: 250)</strong>: Price elasticity of demand for the products of any one region is likely to be high as a result of inter-regional competition.</td>
</tr>
<tr>
<td>Price elasticity of supply</td>
<td>( \varepsilon^s )</td>
<td>1.3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Initial local demand</td>
<td>( LD_0 )</td>
<td>4.01e+006</td>
<td>CHF/year</td>
<td>Taken from input-output analyses in particularly vulnerable communities (BUCHLI 2002A and 2002B; BUCHLI ET AL. 2003; DJIKSTRA 2003). Equals 30% of total output and includes intermediate and final demand.</td>
</tr>
<tr>
<td>Initial external demand</td>
<td>( ED_0 )</td>
<td>9.35e+006</td>
<td>CHF/year</td>
<td>Taken from input-output analyses in particularly vulnerable communities (BUCHLI 2002A and 2002B; BUCHLI ET AL. 2003; DJIKSTRA 2003). Equals 70% of total output.</td>
</tr>
<tr>
<td>Time to average production rate</td>
<td></td>
<td>3</td>
<td>Year</td>
<td>Longer than MASS (1975: 36)</td>
</tr>
<tr>
<td>Average propensity to consume</td>
<td>( APC )</td>
<td>0.9</td>
<td>1</td>
<td><strong>MASS 1975: 85</strong></td>
</tr>
<tr>
<td>Time to average wage</td>
<td></td>
<td>2.5</td>
<td>Years</td>
<td><strong>MASS 1975: 84</strong></td>
</tr>
<tr>
<td>Effect of demand-supply ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>on price</td>
<td>Nonlinear function (see appendix 1)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.2.3 Summary product market

Figure 6-3 visualizes the processes in the product market and shows the dynamic interaction between the different substructures described in the above sections. The loop names correspond to the ones in chapter 5.3.1, and the numbers in brackets to the equations in this section. Compared to chapter 5.3.1, the following elements were only implicitly integrated into the simulation model:
Model specification

- **R1** – cumulative causation through multiplier effects. Multiplier effects due to induced demand are already included in the income multiplier on output.

- **R2** – cumulative causation through scale economies. Scale economies on the regional level arise from the fact that the value shares in the Cobb-Douglas function add up to a value bigger than one.

*Figure 6-3: Overview of the dynamics of the product market*

6.3 Factor market

Two factors of production, labor and capital, are used to generate desired production. Desired factor proportion is determined by the ratio between the relative marginal product and relative cost of capital or labor, respectively. These processes are described in the following sub-sections.
6.3.1 Labor

Labor is a stock variable that is varied by the net hiring rate (Equation 7). The net hiring rate corrects the gap between labor and desired labor (Equation 8).

Equation 7: \( L(t) = L_0 + \int NHR(t) dt \)

\[ L \text{ labor} \quad L_0 \text{ initial labor} \]

\[ NHR \text{ net hiring rate} \]

Equation 8: \( NHR = \frac{DL - L}{TAL} \)

\[ DL \text{ desired labor} \quad TAL \text{ time to adjust labor} \]

Desired labor is anchored on the actual labor stock and adjusted for the relative cost and marginal product of labor (see below). Desired labor also responds to expectations of growth in demand. Such expectations reflect an extrapolation of current trends in production and the propagation of optimism or pessimism that alters growth expectations (MASS 1975: 45).

The regional labor market, i.e. the labor market within commuting distance, is captured by another stock variable which captures commuter labor demand. Like labor, commuter labor demand is varied by a net hiring rate that corrects the gap between commuter labor and desired commuter labor. Unlike labor on the local labor market, desired commuter labor is exogenously determined by the development of the regional labor market, i.e. by an exogenous increase or decrease in commuter labor demand (Equation 9).

Equation 9: \( DCL = CL \times FCLCR \)

\[ DCL \text{ desired commuter labor} \quad CL \text{ commuter labor} \]

\[ FCLCR \text{ fractional commuter labor change rate} \]

Table 6-5: Labor parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to adjust labor</td>
<td>TAL</td>
<td>0.5</td>
<td>Years</td>
<td>MASS 1975: 44</td>
</tr>
<tr>
<td>Long run output trend time</td>
<td></td>
<td>5</td>
<td>Year</td>
<td>Shorter than in FIDDAMAN (1997: 247) because relevant for production decisions</td>
</tr>
<tr>
<td>Historic output growth</td>
<td></td>
<td>0</td>
<td>1/year</td>
<td>Value of zero to ensure model is in equilibrium</td>
</tr>
<tr>
<td>Initial commuters</td>
<td>CL _0</td>
<td>5</td>
<td>Persons</td>
<td>Estimated average for particularly vulnerable communities according to BrS 2000 (Pendlerbilanz)</td>
</tr>
<tr>
<td>Fractional commuter labor change rate</td>
<td>FCLCR</td>
<td>In equilibrium: 0</td>
<td>1/year</td>
<td></td>
</tr>
</tbody>
</table>
6.3.2 Capital

Capital for goods production increases with investment and is discarded after a fixed average lifetime (Equation 10). The depreciation process behaves like a first-order exponential decay (Fiddaman 1997: 87).

Equation 10: \( K(t) = K_0 + \int (I(t) - \delta K(t)) dt \)

- \( K \): capital
- \( I \): investment rate
- \( \delta \): fractional depreciation rate

The investment rate responds to three pressures (Equation 11; Fiddaman 1997: 87). Orders first replace depreciation. They also correct the gap between desired and actual capital (Equation 12). Desired capital is anchored on the actual capital stock and adjusted for the relative cost and marginal product of capital (see below). Finally, orders augment the capital stock in order to anticipate growth in output; otherwise capital would continuously lag its optimal value.

Equation 11: \( I = (\delta K + K \times G) \times KC \)

- \( KC \): capital correction
- \( G \): expected growth rate in production

Equation 12: \( KC = f\left(\frac{K}{DK}\right) \)

- \( DK \): desired capital

Capital correction is formulated as a nonlinear, asymptotically declining function that corrects the gap between desired and actual capital (see Appendix 1 for the nonlinear functions in the model). The slope of the function was chosen so that the investment rate responds in the same way to a change in desired capital no matter whether a goal gap formulation (gap between desired capital and capital over a capital correction time) or a nonlinear function is used. The nonlinear function was applied because it is robust under extreme conditions, i.e. when desired capital is so small that the investment rate would be negative with a goal gap formulation.

Table 6-6: Capital parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital lifetime</td>
<td>1/8</td>
<td>15</td>
<td>Years</td>
<td>Fiddaman 1997: 88</td>
</tr>
<tr>
<td>Capital correction</td>
<td>KC</td>
<td>Nonlinear function</td>
<td>1</td>
<td>Adjusted so that reaction of the investment rate equals reaction with a goal gap formulation</td>
</tr>
</tbody>
</table>

6.3.3 Labor – capital interactions

Desired production is generated by a combination of the two factors of production labor and capital. In the optimal solution, the choice of factors minimizes production costs. This is the case when the technical rate of substitution equals the factor price ratio (Equation 13 to Equation 15; Varian 1993: 334).
Equation 13: $MP_L(L, K) = \frac{\Delta Y}{\Delta L}$ and $MP_K(L, K) = \frac{\Delta Y}{\Delta K}$

$MP_L(L, K)$ marginal product of labor

$MP_K(L, K)$ marginal product of capital

Equation 14: $TRS(L, K) = \frac{\Delta L}{\Delta K} = -\frac{MP_L(L, K)}{MP_K(L, K)}$

$TRS(L, K)$ technical rate of substitution

Equation 15: $TRS(L, K) = -\frac{w}{r}$

$w$ wage (price of labor)  $r$ interest rate (price of capital)

The procedure to determine desired capital and desired labor to generate desired production follows this logic and is shown in Figure 6-4 for the case of capital.

Figure 6-4: Desired capital

B3: capital adjustment to cost
Average capital intensity is defined as a fifteen-year exponential average of actual capital intensity, which in turn is defined as the ratio of the capital stock to the average production rate. The smoothing time for average capital intensity is identical to the fifteen-year normal lifetime of capital. The formulation prevents a rapid adjustment of the aggregate capital-output ratio in the face of changing factor costs. It presumes that existing capital equipment is characterized technologically by a relatively fixed capital-labor ratio and that an adjustment in aggregate capital intensity takes place predominantly through new and replacement investment that embodies changed factor proportions. The long averaging time subsumes the time required to shift from one production technique to another (Mass 1975: 120f).

The multiplier from factor cost on capital is a nonlinear function that increases desired capital intensity when the relative return to capital exceeds one. Such a value indicates that capital is relatively more productive than labor, thereby raising desired capital intensity. Analogously, the multiplier lowers desired capital intensity when the relative return to capital falls below one (Mass 1975: 121).

The relative return to capital is defined as the relative marginal product of capital divided by the relative cost of capital. Thus, for example, if an incremental unit of capital yields twice as much output as an additional unit of labor but capital is twice as costly, relative return to capital equals one and producers would have no incentive to substitute capital for labor or labor for capital. On the other hand, if capital is twice as productive as labor but only one and one-half times as costly, producers would profit from substituting capital for labor in new investment projects (Mass 1975: 122). The relative marginal product of capital describes the ratio of the two production factors labor and capital (Equation 16) whereas the relative cost of capital captures the ratio of the factor prices (Equation 17).

\[ \text{Equation 16: } RMPK = \frac{L}{K} \]

\[ RMPK \text{ relative marginal product of capital} \]

\[ \text{Equation 17: } RCK = \frac{ACK}{ACL} \]

\[ RCK \text{ relative cost of capital} \quad ACL \text{ annual cost per labor unit} \]

\[ ACK \text{ annual cost per capital unit} \]

The annual cost per capital unit consists of two parts: an annual interest charge and a charge for fixed capital depreciation (Equation 18; Fiddaman 1997: 120). The annual cost per labor unit depends on the annual wage for the workforce. Under reference conditions (in equilibrium) the labor to capital ratio equals the ratio between annual cost of capital and annual cost of labor. Reference wages are therefore calculated as in Equation 19.
**Equation 18:** \( ACK = r + \delta \)

\( \begin{align*}
ACK & \quad \text{annual cost per capital unit} \\
r & \quad \text{interest rate} \\
\delta & \quad \text{fractional depreciation rate of capital}
\end{align*} \)

**Equation 19:** \( w_0 = \frac{K}{L} (r + \delta) \)

\( w_0 \quad \text{initial wage} \)

Wages rise when labor in the region is scarce and fall when labor is abundant. This relation is captured by the effect of labor to job condition on migration from the population sector in the model (see section 6.4) that modifies the reference wage. It is important to emphasize that the absolute value of wages has little meaning. Interest rate is an index with a reference value of 1. For the wage variable, relative changes due to the interplay of labor market and population are of interest for the purpose of this study.

**Table 6-7:** Factor intensity parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate</td>
<td>( r )</td>
<td>1</td>
<td>1/year</td>
<td>Index</td>
</tr>
<tr>
<td>Time to average capital intensity</td>
<td></td>
<td>15</td>
<td>Years</td>
<td>MASS 1975: 121</td>
</tr>
<tr>
<td>Time to average labor intensity</td>
<td></td>
<td>3</td>
<td>Years</td>
<td>Shorter than MASS (1975: 142)</td>
</tr>
<tr>
<td>Multiplier from factor cost on capital intensity</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
<td>MASS 1975: 121</td>
</tr>
<tr>
<td>Multiplier from factor cost on labor intensity</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
<td>MASS 1975: 143</td>
</tr>
<tr>
<td>Effect of labor supply to demand condition on wages</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
<td>Same function as 'effects of labor supply to demand condition on immigration' (Table 6-8), but slope much less steep.</td>
</tr>
</tbody>
</table>

**6.4 Population**

The total population of a community is a system controlled by two types of rates: natural changes (births and deaths) and migration (in and out) (see Alfeld and Graham 1976: 87). The annual number of births and deaths depends on the size of the population and of its demographic characteristics. Population is divided in two stocks as the distinction between economically active and retired population has important implications for the initiatives and self-help sector of the model. As for the purpose of this study, migration is understood as a consequence of the processes on the product and factor markets - restrained by additional factors – only the stock of the economically active population (0-65) is affected by migration.
Formally, population is a stock variable that integrates natural changes and migration (Equation 20 for the stock of the economically active population).

*Equation 20:* \( \text{Pop}(t) = \text{Pop}_0 + \int (NBR(t) + IM(t) - OM(t)) dt \)

- **Pop** population
- **Pop\(_0\)** initial population
- **NBR** net birth rate
- **IM** in-migrating
- **OM** out-migrating

The rate of in-migration depends on both the size of the community’s current population and the internal conditions of the area. Three factors are distinguished (Equation 21):

1. Labor supply to demand ratio: If labor demand is relatively bigger within than outside an area and other conditions are equally attractive, people are more likely to find out about the jobs and move to the area.

2. Goods provision: If a rural area is well known for its low quantity and diversity of goods and service provision, people are less willing to attempt to move into that area (see the concept of voting by feet in chapter 5.2.1).

3. Carrying capacity: The attractiveness for in-migration is also affected by the cost of living and the availability of housing. Contrary to urban areas, population density is not so much a problem of overloading an area’s resources by pollution, traffic congestion, crowded housing, or unemployment. Instead, there is normally only limited area available for construction. Population increase is therefore limited by the availability of additional land.

*Equation 21:* \( IM = \text{Pop} \times NI \times \text{ELSD} \times \text{EGP} \times \text{ECC} \)

- **NI** normal in-migration
- **ELSD** effect of labor supply to demand condition on in-migration
- **EGP** effect of goods provision on in-migration
- **ECC** effect of population density on in-migration

If one rural community is very attractive compared with its environment, in-migration will be very large and the local population will grow. If the area is very unattractive in comparison with its environment, in-migration will be very small and the relatively larger out-migration rate could soon reduce the population (Alfeld and Graham 1976: 89). Contrary to in-migration, out-migration is only driven by the relative scarcity of jobs, i.e. out-migration is higher when more people supply labor but the economy does not demand as much.
### Model specification

#### Table 6-8: Population parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial population 0-65</td>
<td>Pop(_0)</td>
<td>203</td>
<td>People</td>
<td>Average of particularly vulnerable communities in 2000 according to BFS 2000 (Volkszählung)</td>
</tr>
<tr>
<td>Initial retired population</td>
<td></td>
<td></td>
<td></td>
<td>Else: 44 (Average of particularly vulnerable communities in 2000 according to BFS 2000 (Volkszählung))</td>
</tr>
<tr>
<td>Time in active population</td>
<td>TAP</td>
<td>50</td>
<td>Years</td>
<td>Calibrated to data; In-migrants do not enter the system at 0 years of age so that TAP is lower than 65 years</td>
</tr>
<tr>
<td>Fractional net birth rate</td>
<td>FNBR</td>
<td></td>
<td>1/year</td>
<td>Else: 0.016 (average of births in particularly vulnerable communities 1990 and 2000 according to BFS 1990 and 2000 (Volkszählung; ESPOP), average fractional death rate 0-65 according to BFS 1996 (Sterbetafeln))</td>
</tr>
<tr>
<td>Fractional death rate retired</td>
<td>FDRR</td>
<td>0.09</td>
<td>1/year</td>
<td>Calibrated to data about retired population</td>
</tr>
<tr>
<td>Normal in-migration</td>
<td>NI</td>
<td>0.08</td>
<td>1/year</td>
<td>Average of particularly vulnerable communities in 1990 and 2000 according to BFS 1990 and 2000 (Volkszählung; ESPOP)</td>
</tr>
<tr>
<td>Normal out-migration</td>
<td></td>
<td>0.08</td>
<td>1/year</td>
<td>Average of particularly vulnerable communities in 1990 and 2000 according to BFS 1990 and 2000 (Volkszählung; ESPOP)</td>
</tr>
<tr>
<td>Maximum population</td>
<td></td>
<td>600</td>
<td>People</td>
<td>Derived from the fact that additional available land for construction, by law, is about twice as much as available today</td>
</tr>
<tr>
<td>Effect of population density on in-migration</td>
<td>ECC</td>
<td>Nonlinear function</td>
<td>1</td>
<td>Concept taken from ALFELD AND GRAHAM (1976: 100 )</td>
</tr>
<tr>
<td>Effect of goods provision on in-migration</td>
<td>EGP</td>
<td>Nonlinear function</td>
<td>1</td>
<td>Concept taken from ALFELD AND GRAHAM (1976: 100 )</td>
</tr>
<tr>
<td>Effects of labor supply to demand condition on in-migration</td>
<td>ELSD</td>
<td>Nonlinear function</td>
<td>1</td>
<td>ALFELD AND GRAHAM 1976: 118 Calibrated to data</td>
</tr>
<tr>
<td>Effect of labor supply to demand condition on out-migration</td>
<td></td>
<td>Nonlinear function</td>
<td>1</td>
<td>Inverse of ALFELD AND GRAHAM 1976: 118 Calibrated to data</td>
</tr>
</tbody>
</table>
The population sector of the model contains several non-linear functions. Figure 6-5 shows an example of these functions.\textsuperscript{19}

\textit{Figure 6-5: Functional relationship between labor market and in-migration rate}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{fig6_5}
\end{figure}

There are two major assumptions embodied in the relationship shown in Figure 6-5. First, the effect of labor market conditions on in-migration slopes downward – the less favorable the labor market the less in-migration. Second, the s-shape represents the assumption that near the right and the left limits, small changes in labor market conditions have little effect on in-migration. If employment conditions are extremely unfavorable, small changes do not change the attractiveness of the region for potential in-migrants. Similarly, if employment conditions are extremely favorable, small changes in job availability do not substantially alter the region’s attractiveness. In the centre of the curve, where the ratio of labor supply and labor demand equals 1.0, employment conditions within the area are normal and the multiplier on in-migration also equals 1.0. When the multiplier equals 1.0, the normal rate of migration into the area is neither restricted nor augmented (ALFELD AND GRAHAM 1976: 117).

\textsuperscript{19}For the formulation of nonlinear functions see STERMAN (2000: 551ff).
Figure 6-6 summarizes the processes related to population change described in this section. The loop name corresponds to the name in chapter 5.3.2.

**Figure 6-6: Overview of the dynamics of population**

6.5 Initiatives

The different stages in the innovation process are formulated as an aging chain (see Sterman 2000: 469ff; and for the specific case of innovations e.g. Milling 2002). Two stocks are defined: potential initiatives and implemented initiatives. For each stock, there are two outflows: Initiatives either move on in the aging chain or are dismissed. The aging chain is fed by the initial inflow, the creation of potential initiatives (Equation 22).
Model specification

Equation 22: \( CPI = NICR \times EECC \)

- \( CPI \) creation of potential initiatives
- \( NICR \) normal initiatives creation rate
- \( EECC \) effect of entrepreneurial capacity on creation

The subsequent flows that move initiatives either through or out of the system are described in Equation 23 to Equation 27.

Equation 23: \( DPI = \frac{PI}{STPI} \times (1 - FPLI) \)

- \( DPI \) dismissing potential initiatives
- \( PI \) potential initiatives
- \( STPI \) survival time of potential initiatives
- \( FPLI \) fraction of initiatives taken up for planning

Ideas for initiatives are heavily influenced by the prevailing regional policy paradigm. The survival time of potential initiatives is therefore closely related to this paradigm.

Equation 24: \( PPI = \frac{PI}{STPI} \times FPLI \)

- \( PPI \) planning initiatives

Equation 25: \( FPLI = NFPLI \times PP \times WP \)

- \( NFPLI \) normal fraction of initiatives taken up for planning
- \( PP \) pressure to plan
- \( WP \) willingness to plan

Equation 26: \( LUI = \frac{II}{TEI} \times (1 - FSI) \)

- \( LUI \) losing unsuccessful initiatives
- \( II \) implemented initiatives
- \( TEI \) time to evaluate initiatives
- \( FSI \) fraction successful initiatives

Equation 27: \( BAED = \frac{II}{TEI} \times FSI \)

- \( BAED \) becoming additional external demand

Equation 28: \( EDFI = BAED \times EDPI \)

- \( EDFI \) external demand from initiatives
- \( EDPI \) external demand per initiative

The initiatives aging chain is linked to the population sector in two ways: The creation of potential initiatives is driven by entrepreneurial capacity (Equation 29 to Equation 111).
31); and the decision whether to plan or to dismiss potential initiatives depends on the pressure to counteract demographic changes (Equation 32). Finally, the fraction of successful initiatives depends on the implementation process which is described in section 6.6.

Equation 29: $EECC = f\left(\frac{EC}{EC_{\text{opt}}}\right)$

$EECC$ effect of entrepreneurial capacity on creation

$EC$ entrepreneurial capacity

$EC_{\text{opt}}$ $EC$ under optimal conditions

Optimal conditions refer to a population size of a community where the population endogenously generates the normal initiative creation rate. Entrepreneurial capacity is modeled as a co-stock with co-flows (see STERMAN 2000: 497ff) to the stock of the economically active population (Equation 30).

Equation 30: $EC(t) = EC_0 + \int \left((GEC_{\text{NL}}(t) + GEC_{\text{IM}}(t)) - (LECRP(t) + LECOM(t))\right)\,dt$

$EC_0$ initial entrepreneurial capacity

$GEC_{\text{NL}}$ generating $EC$ through new local population

$GEC_{\text{IM}}$ generating $EC$ through in-migrants

$LECRP$ losing $EC$ through retiring population

$LECOM$ losing $EC$ through out-migrants

An example of a coflow is given in Equation 31 for the case of $EC$ generation through new local population. The other coflows that are integrated into $EC$ are formulated according to the same logic.

Equation 31: $GEC_{\text{NL}} = IM \times ACIM$

$ACIM$ average capacity of in-migrants

Equation 32: $PP = f\left(\frac{Pop}{Pop_{\text{min}}}\right)$

$Pop_{\text{min}}$ minimum population for the maintenance of a local primary school

In Figure 6-7 all these processes are summarized and shown in their dynamic interplay.
### Model specification

**Table 6-9: Regional innovation parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal initiative creation rate</td>
<td>NICR</td>
<td>1</td>
<td>Initiatives/year</td>
<td>NICR, NFITP and NFSI are calibrated such that under normal conditions, one initiative is successfully implemented in ten years.</td>
</tr>
<tr>
<td>Survival time of potential initiatives</td>
<td>STPI</td>
<td>2</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Normal fraction of initiatives taken up for planning</td>
<td>NFPLI</td>
<td>0.2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Normal fraction of successful initiatives</td>
<td>NFSI</td>
<td>0.5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Time to evaluate initiatives</td>
<td>TEI</td>
<td>5</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Initial value potential initiatives</td>
<td></td>
<td></td>
<td>Initiatives</td>
<td></td>
</tr>
<tr>
<td>Initial value implemented initiatives</td>
<td></td>
<td></td>
<td>Initiatives</td>
<td></td>
</tr>
<tr>
<td>Average capacity of immigrants</td>
<td>ACIM</td>
<td></td>
<td>1/person</td>
<td>Else: 1.2 (index) Assumed to be lower than ACM because capacity is assigned to the birth rate and it thus takes time to develop capacity</td>
</tr>
<tr>
<td>Average capacity of new local population</td>
<td>ACLP</td>
<td>1</td>
<td>1/person</td>
<td>Assumed to be lower than ACM because capacity is assigned to the birth rate and it thus takes time to develop capacity</td>
</tr>
<tr>
<td>Initial entrepreneurial capacity</td>
<td>EC₀</td>
<td>Pop₀*ACLP</td>
<td>1/person</td>
<td></td>
</tr>
<tr>
<td>Entrepreneurial capacity under optimal conditions</td>
<td>ECopt</td>
<td>400</td>
<td>1</td>
<td>Refers to a situation with a total population of 500 people, 400 of which below retiring age.</td>
</tr>
<tr>
<td>Minimum population for the maintenance of a local primary school</td>
<td>Popₘᵢₙ</td>
<td>195</td>
<td>People</td>
<td>Minimum number of kids for maintaining kindergarten: 6; 195 is derived from extrapolating this number to the entire stock of the 0-65 years old population stock under the assumption of a uniform distribution within the stock</td>
</tr>
</tbody>
</table>
Model specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to perceive population trend</td>
<td></td>
<td>5</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Effect of entrepreneurial capacity on creation</td>
<td>EECC</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pressure to plan</td>
<td>PP</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Willingness to plan</td>
<td>WP</td>
<td>Nonlinear function</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>External demand per initiative</td>
<td>EDPI</td>
<td>100'000</td>
<td>CHF/initiative</td>
<td>Additional external demand assumed to be the equivalent of one job and average productivity of one job found to be 0.01 (people/1'000.- CHF)</td>
</tr>
</tbody>
</table>

Figure 6-7: Overview of the dynamics of regional innovation

R5 reinforcement capacity – population   B7 initiatives only under pressure
6.6 Implementation dynamics

The fraction of successful initiatives depends on the commitment of the actors involved in the initiative. Commitment is a stock variable that depends on a biflow adjusting commitment to success and support and it is drained by losing commitment (Equation 33). Losing commitment behaves like a first-order exponential decay.

Equation 33: \( COM(t) = COM_0 + \int (NCC(t) - COM(t) \times \lambda) dt \)

\( COM \) commitment \( COM_0 \) initial commitment \( \lambda \) fractional commitment loss rate \( NCC \) net commitment change rate

The net commitment change rate adjusts commitment to indicated commitment over the commitment adjustment time (Equation 34).

Equation 34: \( NCC = \frac{ICOM - COM}{TAC} \)

\( ICOM \) indicated commitment \( TAC \) time to adjust commitment

Indicated commitment responds to two pressures: commitment from success and commitment from motivation (adapted from Repenning 2002: 115f).

Equation 35: \( ICOM = COM_{su} + COM_{mo} \)

\( COM_{su} \) commitment from success \( COM_{mo} \) commitment from motivation

Commitment from success is a nonlinear function. Current success is compared to the threshold level of success that has to be achieved in order to increase commitment (Equation 36). Commitment from motivation is determined by the need for motivation and the quality of motivation (Equation 37).

Equation 36: \( COM_{su} = f(\frac{SUC}{TSC}) \)

\( SUC \) success \( TSC \) threshold success for commitment

Equation 37: \( COM_{mo} = NFM \times QM \)

\( NFM \) need for motivation \( QM \) quality of motivation

Necessary motivation increases with commitment falling below the threshold commitment for success. The quality of motivation is directly linked to the stock ‘entrepreneurial capacity’ described in Equation 30 or to the ratio of available to optimal capacity, respectively (Figure 6-7).

---

20 A biflow can be both, an inflow and an outflow. The direction of the flow depends on the gap between the value of the stock and the value of some goal variable.
Table 6-10 lists the parameters related to local institutional dynamics and Figure 6-8 visualizes the processes.

**Table 6-10: Local institutional dynamics parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Alias</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to lose commitment</td>
<td>$1/\lambda$</td>
<td>3</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Commitment adjustment time</td>
<td>TAC</td>
<td>3</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Initial value commitment</td>
<td>COM$_0$</td>
<td>In equilibrium: equal to TCS</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Threshold commitment for success</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threshold success for commitment</td>
<td>TSC</td>
<td>In equilibrium: equal to TCS</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Effect of commitment on success</td>
<td></td>
<td>Nonlinear function</td>
<td>1</td>
<td>REPENNNG 2002: appendix</td>
</tr>
<tr>
<td>Effect of success on commitment</td>
<td></td>
<td>Nonlinear function</td>
<td>1</td>
<td>REPENNNG 2002: appendix</td>
</tr>
<tr>
<td>Time to change success perception</td>
<td></td>
<td>2</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Time to perceive need for motivation</td>
<td></td>
<td>3</td>
<td>Years</td>
<td></td>
</tr>
<tr>
<td>Time to perceive change in motivation</td>
<td></td>
<td>3</td>
<td>Years</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6-8: Overview of local institutional dynamics

- TIMETO NEED FOR MOTIVATION
- TIME TO PERCEIVE NEED FOR MOTIVATION
- THRESHOLD COMMITMENT FOR SUCCESS
- COMMITMENT ADJUSTMENT TIME
- TIME TO CHANGE SUCCESS PERCEPTION
- TIME TO LOSE COMMITMENT
- TIME TO PERCEIVE CHANGE IN MOTIVATION

- Reaction to need for motivation
- Quality of motivation
- Commitment to Initiative
- Net commitment change rate
- Indicated commitment
- Effect of success on commitment
- Recent success
- Success condition
- Threshold success for commitment

- Commitment from motivation
- Commitment through support
- Reinforcement capacity - population
- Reinforcement commitment - success
Seite Leer /
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7 Model testing and evaluation

This chapter presents partial model analysis and model behavior tests. The purpose of these tests is to further calibrate and validate the model to such an extent that it can be used for policy analysis in chapter 8. However, many of the tests already incorporate important policy implications. Partial model tests (section 7.1) ensure that individual model sectors reproduce the behavior predicted by the theories incorporated in these sectors. Behavior reproduction tests (section 7.2) analyze the behavior of the entire model for the time between 1985 and 2000. These tests examine whether the model is capable of reproducing the behavior of interest in the past. The model will be considered sufficiently valid when it is able to endogenously generate the symptoms of difficulty motivating this study and the various modes of behavior observed in different community types and in selected specific communities. A last set of tests (7.3) analyzes the dynamic implications of changing the model boundary, i.e. of disaggregating the economy into several sectors. The insights gained from the model tests lead to a set of conclusions about important driving forces of model behavior, about development patterns in different community types and about potential leverage points for policies. These insights are summarized at the end of this chapter in section 7.4.

7.1 Partial model tests

In this section, the focus is on partial model testing (see MORECROFT 1985: 903). Partial model testing is not only useful to debug subsystem models prior to whole model simulations. It also plays an important role by exposing the intended rationality of decision making. Intended rationality means that decision making is rational within the context of the premises supplied to the decision makers and the limits of their computing capacity. On this basis it is possible to decompose a complex simulation model into pieces and to expect simulation runs of the pieces to reveal intuitively clear and plausible behavior. The partial tests should then show that local decisions are well adapted to achieving local goals. The behavior of the whole system, however, is not necessarily well adapted to the many goals of the stakeholders. Dysfunctional behavior is quite possible but it is a systemic problem resulting from the coupling of decision functions.

For the partial tests the model will be initialized to equilibrium. Submitting the model to step increases and decreases in parameter values allows identifying the range of behavior mode that the model generates. If the model was fed by data at this stage it would be difficult to differentiate between behavior modes resulting from model structure and disturbances induced by data.
7.1.1 Partial model testing of the model sectors ‘product market’, ‘factor market’ and ‘population’

Following the details described in chapter 6, population reacts to policies that affect natural changes through births and deaths and to policies that affect migration. The product and factor markets of the economy are influenced by production policies, labor-hiring policies and capital-acquisition policies. A series of parameters are important in the context of these policies. This section tests the sensitivity of three kinds of parameters:

1. Parameters with highly uncertain data. The sensitivity of model behavior to a plausible range of uncertainty in the values of these parameters will be analyzed. These tests affect the parameters ‘value share of labor’, ‘value share of capital’, ‘price elasticity of demand’ and ‘price elasticity of supply’.

2. Nonlinear functions with uncertainty regarding their form and slope. The sensitivity of model behavior to plausible changes in the form and slope of these functions will be analyzed. This test affects the nonlinear function ‘effect of supply demand ratio on price’.

3. Parameters assessed to be important in the economic literature. Partial model analysis will evaluate whether these parameters induce the behavior described in the economic literature. Partial model analysis will therefore provide an extended structure-verification test (see Forrester and Senge 1980: 212). Parameters affected by this test are ‘interest rate’ and ‘factor productivity’.

A selection of results from partial model tests will be reported and commented in the next section. Additional results will be summarized at the end of partial model tests of the model sectors ‘product market, factor market and population’.

Sensitivity analyses will be repeated and further elaborated in chapter 8. In nonlinear systems, sensitivity analysis requires tests for multiple operating points and conditions as system behavior can be quite insensitive to a relationship in one operating regime (i.e. under the dominance of one feedback loop) but highly sensitive to the same parameter under different conditions, i.e. when another feedback loop dominates (Sterman 2000: 561). Sensitivity concerns numerical values, behavior mode or policy implications. Numerical sensitivity indicates the confidence bounds of specific output variables as a result of variations in the input variable. A model whose basic modes of behavior change as assumptions about the input variable are varied over a plausible range of uncertainty is said to exhibit behavior mode sensitivity. Changes in the desirability of policies as a result of variations in the assumptions indicate policy sensitivity (Sterman 2000: 861).
Model testing and evaluation

Sensitivity analysis of parameters with high uncertainty concerning data

The first set of experiments concerns parameters with high uncertainty concerning data. This is especially the case for the production function

\[ Y = Y_0 \cdot T \cdot \left( \frac{L}{L_0} \right)^\alpha \cdot \left( \frac{K}{K_0} \right)^\beta \]  

(see page 97).

For these simulations, the model is initialized to equilibrium and starts simulating in the year 1985. The model is then subjected to a 2% step increase in overall factor productivity in the year 1990. The base run result is shown in Figure 7-1.

The figure illustrates the behavior of the production factors labor and capital (left hand side of the figure, y-axis) and of total population (right hand side of the figure, y-axis) over time (x-axis). The legends below the figure display the variable name (e.g. labor or total population), the name of the simulation run (baserun), the representation of the variables in the graph (e.g. a line marked -1- for labor and a line marked -2- for capital) and the units of the corresponding variables (e.g. people or CHF).

As factor productivity increases, total production and thus supply rises. Production becomes relatively less expensive and price drops slightly. This, in turn increases demand and decreases desired production. As demand adjusts faster to new price conditions than supply the short term effect is a further increase in production which results in a slight increase in the two factors used for production, labor and capital. In the long run, however, supply equilibrates. As a consequence of the increase in factor productivity, less labor and capital input are used to produce the same amount of output. The resulting loss in labor leads to out-migration and a further decline in demand. This sets the reinforcing feedback loop reinforcement population – production in motion. Population loss after the initial minimum overshoot is moderate in extent thanks to the fact that total production is significantly driven by external demand. In the long run, the production factors and population equilibrate.

*Figure 7-1: Base run for sensitivity analyses for parameters with high uncertainty concerning data*
For the value share of labor and capital, no data are available for lagging rural regions in Switzerland. The value share of labor was calculated for the agricultural sector (Fat 2002) and on this basis estimated for the entire economy (BFS 1997). In a first set of experiments, the sensitivity to the exponents in the Cobb-Douglas function is analyzed. Figure 7-2 shows the reaction of the factor stocks and total population to a step increase in factor productivity. Simultaneously, the value share of labor was varied from zero to one and, with the switch on constant returns to scale the value share of capital was adapted accordingly.

The results of sensitivity testing are displayed in terms of confidence bounds. The x-axis in the figure displays the time horizon of the model. A graph is generated showing confidence bounds for the output variables labor, capital and total population when the value share was randomly varied around its normal value. The outer bounds of uncertainty (100%) show maximum and minimum values that the system can adopt. The shaded area (light grey to black) indicates the range of outcomes in 200 simulations when the parameter values are varied.

Figure 7-2: Reaction of factors and population to a productivity increase and to variations of the value shares of labor and capital

Figure 7-2 shows that the variations in the output variables due to variations in the value shares of labor and capital emphasize the slight oscillatory behavior in the base run. In the long run, the equilibrating reaction in the base run is replaced by damped oscillation. Maximum variation, however, is around 5% above or below the base run.
value. It can therefore be concluded that the sensitivity to the exact value of the two parameters $\alpha$ and $\beta$ is rather low.

Similar to the exponents in the production function, no data are available for the exact values of price elasticity of demand and supply. A second set of experiments therefore analyzes the impact of variations in the values of the two elasticities. Figure 7-3 shows the reaction of the factor and population stock to a step increase in factor productivity and to a variation of the elasticities from 0.2 to 2 on the supply side and -0.2 to -2 on the demand side. The univariate sensitivities showed the same behavior as when supply and demand elasticities were varied at the same time. Variation at the same time leads to an increased variation range but not to a variation in the behavior pattern. Figure 7-3 therefore only reports the combined results.

*Figure 7-3: Reaction of factors and population to a productivity increase and to variations of price elasticity of demand and supply*

Figure 7-3 reveals slight behavior mode sensitivity. The behavior modes reach from overshoot to higher order decay at the lower confidence bound of labor. Despite the variations in the short run, labor, capital and total population are goal seeking in the long run and converge towards the base run value except for the last 5% of the variation range. Under extreme values, the overshoot and decay pattern is enforced but no additional behavior modes occur.
Model testing and evaluation

Analysis of behavior predicted by economic theory

This section contains a set of experiments that test whether the model, consisting of product market, factor market and population, is able to generate the behavior predicted by economic theory. Two aspects of behavior are covered: substitution between the production factors as a reaction to changes in the factor cost ratio and the effect of continuous growth in factor productivity. For this purpose, the model is again initialized to equilibrium and then subjected to a step increase in specific parameter values.

First, the substitution effects between labor and capital are analyzed. The interest rate, which is the determinant of capital cost, is raised by 2% in the year 1990. The resulting model behavior is shown in Figure 7-4. The figure also shows the reaction of the two stocks when the interest rate is lowered to the same amount and at the same time.

*Figure 7-4: Reaction of capital and labor to a step increase and decrease in capital costs*

Capital and labor exhibit the expected reaction to a change in factor costs. When capital becomes relatively less expensive than labor, capital is substituted for labor and the reverse holds true when capital is relatively more expensive than labor. The dynamic simulation explicitly highlights the different time span for equilibration. As the time to adjust capital is much longer than the time to adjust labor, labor reaches a new equilibrium relatively soon while capital needs almost the entire simulation time for doing so.

A second experiment tests whether increasing factor productivity is able to drive economic growth as suggested by economic theory. The base run in Figure 7-1 gives a first direction for answering this question. It was shown that in small economies, the stimulating effect of increased factor productivity in the short run is followed by economic decline in the longer run. Figure 7-5 shows the results when factor productivity grows continuously.
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Figure 7-5: Reaction of factors, population and supply to continuous growth in factor productivity

Figure 7-5 illustrates that in the case of continuous growth in factor productivity, supply increases during the first two decades of the simulation period. This is well in line with economic growth theory.

Population declines after a period of near equilibrium. As demand adjusts faster to price conditions than supply, the short term reaction to growth in output is increased consumption which further stimulates production. Consumption, however, does not grow infinitely so that production adjusts to consumption. Due to the continuously growing productivity less and less labor and capital are used for producing a given amount of output. This leads to out-migration as a consequence of which population drops. In the long run, population decline even manages to bring down production because local private demand becomes so small that the output level cannot be maintained.

This experiment shows that, if economic growth is understood as growth in output, there is a considerable trade-off for small economies such as lagging rural regions. As long as the additional demand generated by increased productivity and thus increased relative competitiveness is lower than the additional demand necessary for employing the redundant labor force, pressure on out-migration grows. In this case, growth in output is traded for declining population which in turn also brings down output.
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The behavior mode of the factor and population curves implies that there are shifts in loop dominance. Initially, the balancing feedback loop consumption adjustment to price keeps the reinforcing feedback loop reinforcement population – production working in an upward direction. After a short period, the balancing feedback loop production adjustment to price limits further growth and eventually leads to a shift in the direction of the reinforcing feedback loop reinforcement population – production. Once there is not sufficient demand for employing the redundant labor (i.e. the labor not used anymore because of increasing productivity), the resulting out-migration reduces the population stock and thus local demand and eventually production.

Summary of additional partial model tests

Table 7-1 and Table 7-2 summarize the results from additional partial model tests. The sensitivity of model behavior to changes in parameter values and to changes in the form and slope of nonlinear functions were analyzed.

For sensitivity analyses of parameters with uncertainty concerning data (Table 7-1), the respective parameters were varied from 50% above to below their assumed values. Their impact on system behavior was evaluated by observing the changes in the stock variables (labor, capital and active population). A high numerical sensitivity range indicates that the variations in the parameter values led to variations of the stock variables of more than 10% above or below the base run value. The last column indicates the parameters that were able to change behavior patterns of the stock variables as a result of changes in parameter values (behavior mode sensitivity).

Table 7-1: Summary of partial model tests for uncertainty concerning data

<table>
<thead>
<tr>
<th>Uncertainty in data</th>
<th>Sensitivity range</th>
<th>Behavior mode sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low to moderate</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Initial operating capital</td>
<td>Asymptotic factor productivity growth rate (minimum sensitivity)</td>
</tr>
<tr>
<td></td>
<td>Maximum population</td>
<td>Factor productivity growth rate decline rate (minimum sensitivity)</td>
</tr>
<tr>
<td>Low to moderate</td>
<td>Average time in active population</td>
<td>Labor force fraction (high sensitivity)</td>
</tr>
<tr>
<td></td>
<td>Fractional net birth rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fractional death rate retired</td>
<td></td>
</tr>
</tbody>
</table>

Table 7-1 shows that no parameter produces a high sensitivity range even if uncertainty in data is high. Three parameters induce behavioral sensitivity. Of these three parameters, only the labor force fraction leads to high sensitivity ranges.

Sensitivity analysis of nonlinear functions consisted in varying the form (e.g. linear vs. exponential vs. S-shaped growth) and slope of nonlinear functions (see appendix 1 for an overview of the nonlinear functions). A high sensitivity range again indicates that the stock variables changed to 10% or more as a result of changes in the nonlinear function.
Table 7-2: **Summary of partial model tests for uncertainty concerning form and slope of nonlinear function**

<table>
<thead>
<tr>
<th>Uncertainty of function</th>
<th>Sensitivity range</th>
<th>Behavior mode sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Low to moderate</td>
<td>Effect of supply demand ratio on price</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effect of labor supply to demand on wages</td>
</tr>
<tr>
<td>Low to moderate</td>
<td>Capital correction Multiplier from factor cost on capital intensity Multiplier from factor cost on labor intensity Effect of labor supply to demand on in-migration Effect of labor supply to demand on out-migration Effect of population density on in-migration</td>
<td>Effect of goods provision on in-migration (minimum sensitivity)</td>
</tr>
</tbody>
</table>

Table 7-2 shows that uncertainty about form and slope of nonlinear functions has little impact on model behavior. No changes in the functions resulted in big variations in the value and behavior of the stock variables. The only nonlinear function that led to behavior mode sensitivity proved to introduce only minimum sensitivity.

### 7.1.2 Partial model testing of the model sectors ‘initiatives’ and ‘implementation dynamics’

The model sectors ‘initiatives’ and ‘implementation dynamics’ mainly contain variables that describe qualitative factors such as support and commitment. For these variables, there are no data available so that they have to be estimated. While the exact values are of subordinate importance the ratio between the initial value of commitment and threshold commitment for success, for example, is decisive for model behavior. Tests in this section explore the reactions of the partial model to changes in these ratios. The results of the tests contain important insights into the policies governing regional innovation and local institutional dynamics.

The number of initiatives that are created and flow through the system until they end as determinants of endogenously created external demand depends on initiative creation, initiative support and initiative implementation decisions. The successful implementation of initiatives is coupled to actors’ commitment to the initiatives. Commitment is influenced by the success of (past) initiatives and the motivation that actors experience during the implementation phase.

A first set of experiments varies parameters responsible for initiative creation and initiative support. The system is initialized to equilibrium. The first simulation raises the normal initiative creation rate to 150\% its equilibrium value in the year 1990. This
normal initiative creation rate to 150% its equilibrium value in the year 1990. This simulation (more creation) investigates the effect of a hypothetical situation where more ideas for development initiatives are brought into a community, either by external or by internal actors. The second simulation (more support) raises the normal fraction of supported initiatives to 150% of its equilibrium value in the year 1990. This simulation analyzes the effect of an improved general innovation climate where new ideas are met with less skepticism. The experiment can also be understood as comparing a more conservative sociopolitical milieu with a more liberal milieu. The results of these two simulations are shown in Figure 7-6.

Figure 7-6: Reaction of the initiatives stocks to changes in initiative creation and initiative support

The left half of Figure 7-6 illustrates the effect of increased idea generation and the right half the effect of increased support. Increasing the initiative creation rate to 150% its equilibrium value (left hand side of Figure 7-6) results in an increase in actually implemented initiatives. The increase, however, is much smaller than 150% because the fraction of supported initiatives remains at its initial value.

If on the other hand, the initiative creation rate remains at its initial value but the fraction of supported initiatives is increased, implemented initiatives raise to a comparable level as in the left hand side of Figure 7-6.

This experiment contains important policy implications. It shows that only increasing the number of potential development initiatives has little effect on final development activities. Internal mechanisms within the community that raise the fraction of supported initiatives can have the same impact. For considerable increases in implemented initiatives, the two strategies therefore have to be combined, i.e. more ideas have to be created and more attention has to be paid to the mechanisms leading to more support.

A second set of experiments varies parameters responsible for change in commitment and change in motivation (Figure 7-7). The system is initialized to equilibrium i.e. threshold commitment and commitment are equal and threshold success and success are also identical. At time 1990, the partial model is hit with a step increase (high success threshold) and a step decrease (low success threshold) in the threshold value for
success. The threshold value for success can be understood as a proxy for homogeneity in actors’ interests. If stakeholders’ interests are homogenous, necessary success for commitment is low. If, on the other hand, interests are heterogeneous, initiatives have to promise high rewards for actors to contribute to them. The step in threshold is a twenty percent increase or decrease of the equilibrium value (0.5).

Figure 7-7: Reaction of commitment and success to changes in stakeholders’ interest homogeneity

Figure 7-7 shows that the variables commitment and success exhibit the characteristics of an unstable equilibrium. Once the system is pushed out of its initial equilibrium it seeks a new equilibrium at the extreme ends, either at maximum commitment or minimum commitment. The system always seeks the new equilibrium at the extreme ends, independent of the extent of the change in the threshold value. A big change increases the speed and thus the slope with which the new equilibrium is reached but not the final value of the new equilibrium.

If commitment and success are at minimum levels, the reinforcing feedback loop reinforcement commitment – success keeps the system at minimum performance. A shift in loop direction can only be caused by the balancing feedback loop commitment through motivation. If commitment is lower than the threshold commitment for success, motivation is necessary to raise commitment. Necessary motivation increases the lower the ratio between current and necessary commitment is. Entrepreneurial capacity and external support determine the level of available motivation which in turn determines whether commitment can be sufficiently raised or not. A third set of experiments therefore analyzes the reaction of commitment to changes in necessary and available motivation. For this purpose, the system is initialized to equilibrium and hit with a step increase in necessary success as above. Available motivation is varied between 0.2 (low motivation) and 0.8 (high motivation).

This experiment can be interpreted as varying entrepreneurial capacity either by increasing management skills, political and administrative support or improving communication infrastructure. The results are presented in Figure 7-8. In the plot, the vertical axis represents the outcome variable of interest (in this case actors’ commitment to an initiative) and the horizontal axis represents time. Each line captures the reaction
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of commitment to the input variable being manipulated in the experiment (in this case the degree of motivation that local actors experience). Reading from left to right, any given line shows the time path of the output variable given a specific input variable.

Figure 7-8: Reaction of commitment to changes in capacity to motivate actors involved in an initiative

Figure 7-8 shows that the success of initiatives (resulting from actors’ commitment) depends critically on the motivation that actors experience. The behavior is determined by the interaction between the reinforcing loop reinforcement commitment → success and the balancing loop commitment though motivation. As a reaction to the step increase in the success threshold, the reinforcing loop works in a downward direction and thus drains commitment and success. As some entrepreneurs start motivating the actors involved in the initiative, the reinforcing loop is less of a drain on commitment. If motivation is high enough, commitment continues to grow and success becomes sufficient to generate more commitment. At this point, the reinforcing loop shifts direction and begins to work in an upward direction. Once this shift occurs, reinforcement commitment-success generates rapid growth in commitment.

The figure also shows that there is an implicit goal seeking structure for commitment. The shift in loop direction has to be strong enough to generate growth in commitment. In an intermediate region, motivation manages to bring up commitment, but the system still works towards the initial equilibrium so that commitment starts oscillating slightly around that equilibrium point.

Motivation has a qualitative and a quantitative aspect. The qualitative aspect refers to the capacity to motivate actors. The quantitative aspect indicates the frequency with which a motivation effort is undertaken. To a certain degree, quantity can be substituted for quality, i.e. motivation can be lower when motivation efforts take place more often. This does not mean that a new idea is introduced every time a motivation effort is performed. Instead, it implies that interactions between leaders and participants of an initiative have to be repeated several times because a single pulse effort is rarely enough to generate enough commitment for a successful implementation of initiatives.
Summary of additional partial model tests

There are additional factors that influence the behavior identified in the preceding tests. As they affect the design of effective policies more than actual model testing, they will be discussed in more detail in chapter 8.

The weight on commitment from success relative to the weight on commitment from motivation, for example, determines whether motivation efforts have a potential for shifting the direction of the reinforcement commitment – success loop. If the effect of motivation is low compared to the effect of success, motivation efforts are more likely to fail.

As described in chapter 6.6, commitment is drained by a natural loss of commitment. Commitment that has grown either from success or motivation has a half-life and does not last forever. If time to adjust commitment to success and motivation is higher than the time to lose commitment, it is difficult to generate any commitment at all. In such a situation, commitment is lost faster than it is created.

7.2 Behavior reproduction tests

Behavior reproduction tests analyze whether the model produces the behavior of interest in the system. The model has to endogenously generate the symptoms of difficulty motivating this study and it also has to generate the various modes of behavior observed in the real system. The family member test, which is closely related to behavior reproduction tests, examines whether the model generates the behavior observed in other instances of the same system (Sterman 2000: 860). In the context of this study, this means:

- The behavior of interest refers to endogenous push- and pull-forces on employment and thus on population. This means that the model has to identify and track the main interactions between the population and the local economy. It thus shows the reactions on the product and factor markets when population changes and how these reactions feed back into population. The focus on endogenous forces implies that computed employment and population development can differ from the development reflected by data. This is the case when development is mainly influenced by exogenous forces. Interregional competition on the labor and product market, for example, is such an exogenous force which will constitute the basis for the scenarios in chapter 8.

- The various modes of behavior observed in the real system refer to employment and population development in particularly vulnerable communities of different socioeconomic development types. If the model is capable of generating these various modes of behavior, insights into the main driving forces behind the symptoms of difficulty can be gained and the main driving forces in different community types can be compared.
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- The behavior observed in other instances of the same system refers to employment and population development in communities with similar initial conditions as particularly vulnerable communities, but with a more successful development trajectory in the past. If the model is capable of generating the behavior in other instances of the same system, insights into the main driving forces behind reversing the symptoms of difficulty can be gained. Again, the main driving forces in different community types can be compared.

Behavior reproduction tests are performed for the time between 1985 and 2000. Model behavior is compared to data about population and employment development during this time. Data refers to three units of analysis: the average of particularly vulnerable communities, particularly vulnerable communities of different community types and selected case study communities. For these tests, the model is not initialized to equilibrium anymore. Instead, statistical data about parameters and initial values are used. The tests are implemented in three steps:

1. In a first step, the model is driven by exogenous time series for the in- and out-migration rate. As a consequence, the two parameters 'time in active population' and 'fractional net birth rate' can be calibrated to data. In this form, the model computes the development on the product and factor markets as a direct consequence of population development. It therefore computes labor and capital demand as well as goods supply resulting from internal dynamics. The differences between computed labor and labor reflected by data indicates changes in external demand. If computed labor is smaller than real labor, external demand increased during the simulation period (low push-forces or high relative competitiveness of regional goods on national markets). If, on the other hand, computed labor is bigger, external demand decreased (high push-forces). The resulting simulation run will be called *exogenous migration*.

2. In a second step, the in- and out-migration rates are computed endogenously, but these rates are driven by an exogenous time series about labor demand (reflected in data about employment development). In this form, the model computes population development resulting from the dynamics on the local labor market. The differences between computed population development and population development reflected by data indicate changes in exogenous forces such as changes in the relative attractiveness of the region compared to other regions, changes in the availability of commuters on the local labor market as well as availability of commuter jobs on the regional labor market (pull-forces or relative attractiveness of the region). The resulting simulation run will be called *exogenous labor*.

3. In a third step, the model is driven entirely by endogenously computed processes. The model is considered to be sufficiently accurate when the endogenously computed labor demand shows a close fit to labor demand resulting from step 1. In this case, the model reproduces the internal dynamics. The differences between computed population development and population development reflected by data are the combined effect of changes in external push- and pull-forces. The resulting simulation run will be called *endogenous flows*.
7.2.1 Particularly vulnerable communities

As described above, the model was analyzed in three steps. Figure 7-9 shows the resulting population and employment development with exogenous migration (line 1), endogenous migration and exogenous labor (line 2) and endogenous migration and labor (line 3). The computed developments are compared to data that reflect the behavior of the system in the past (line 4 – smoothed labor from data or smoothed population from data).

Data are not available on a yearly basis. Employment censuses, for example, take place every three to five years. The data are therefore smoothed over a period of five years. For this reason, it is possible that the actual numbers of jobs or people are represented in the graph with a slight delay. In the population sector, the stock of the 0 to 65 years old population is compared to data of this age group. The retired population adds private demand for local goods and services. There are, however, no significant interactions between the retired population and policies concerning the local economy and migration. The 0 to 65 years old population, on the other hand, is active in the economy and reacts to changes in push- and pull-forces either by migrating or initiating local development activities.

Figure 7-9: Population and employment development between 1985 and 2000 with exogenous and endogenous flows

Data about population and employment development between 1985 and 2000 indicate that population declined constantly while labor increased between 1985 and 1990 and then decreased, too. The increase in labor in the second half of the 1980s is mainly caused by the development in peripheral communities (not visible in Figure 7-9). Employment in the manufacturing sector and the private services peaked in 1990. This peak is, however, not reflected in the population development. Peripheral communities are all situated at the border to Italy and show a high share of Italian in-commuters in their local economies. It can therefore be assumed that the additional labor during peak time was supplied by in-commuters. The exogenous labor run (step 2) confirms this fact. If population had risen in accordance to the employment growth it would have followed the development trajectory depicted by line 2.
Model testing and evaluation

One important driver of economic development is the relative competitiveness of a region. The relative competitiveness is reflected in the external demand for regional goods and services. The difference between line 1 and 4 on the labor market is caused by variations in external demand. For the simulation runs in Figure 7-9, external demand was left constant with minor endogenous adjustments to price. These adjustments were only minimal and reflect changes in the competitiveness of a region if other regions remain constant. In other words, they reflect the region’s own influence on its relative competitiveness. An additional and potentially more important determinant of the relative competitiveness of a region compared to other regions is the development of these other regions. If they grow the relative competitiveness of a region decreases and as a consequence, external demand for regional goods and services decreases. For external demand there are no country-wide data and especially no time-series available. The outcome of a loss in relative competitiveness should be reflected by a decline in employment in vulnerable regions and a corresponding gain in employment in leading regions. Figure 1-1 in chapter 1 confirms this hypothesis.

Between 1985 and 1990 external demand obviously increased. Starting from 1990 labor decreased continuously. The fact that the difference between data (line 4) and endogenously computed labor development (line 3) remained approximately the same indicates that external demand did not change very much during this period. Labor decline sets the reinforcing feedback loop reinforcement production – population in motion and eventually leads to accelerated population decline in the second half of the 1990s.

Overall, the model seems to capture the development trend as well as the observed behavior modes and thus the basic dynamics of population and employment development. As emphasized in chapter 5, the relative competitiveness of a region depends on a variety of factors. Structural deficits in the economy, lack of physical capital and productive knowledge as well as unfavorable location are all seen to be important. The next sections therefore examine how different initial conditions in these factors influence development perspectives of rural communities. Three community types are analyzed: agrarian communities, residential communities with services and tourist communities. According to Table 3-4 in chapter 3.5.2, these community types have the highest share of particularly vulnerable communities. Rural communities with strong manufacturing and industry are not included because they have similar characteristics as agrarian and tourist communities. They only differ in their sectoral composition (predominant manufacturing sector instead of predominant agriculture or private services, respectively) and they are located less peripherally.
7.2.2 Agrarian communities

Agrarian communities are located rather peripherally. Local employment is characterized by a high share of agricultural jobs and there are only very few out-commuters (see chapter 3.5.1).

Figure 7-10 shows employment and population development in the average agrarian community. Figure 7-11 presents the example of a specific agrarian community, Safien in the canton of Grisons. This example compares the average development with the development in a single community of the same community type. Comparing the average and the case study example offers an additional assessment of the validity of the model and also the opportunity of identifying very concrete reasons for the development reflected by data.

Figure 7-10: Population and employment development in agrarian communities between 1985 and 2000 with exogenous and endogenous flows

Figure 7-10 shows a very close fit between computed development and development reflected by data. Step 1 (migration from data) indicates a slight decrease in external demand and thus a slight decrease of relative competitiveness as labor development computed from exogenous migration exceeds real labor development.

Step 2 (endogenous migration, labor from data), on the other hand, shows that population development computed from exogenous labor falls below real population development. This gap must have been filled by an increase in out-commuters and reflects a satisfying relative attractiveness of agrarian communities compared to other communities (low pull-forces). If relative attractiveness was low, the loss in employment would be reflected in a corresponding loss in population. The ongoing labor decline since 1990, however, puts population more and more under pressure. This general development pattern is also reflected in the case of a single agrarian community, Safien (Figure 7-11).
Figure 7-11: Population and employment development in the agrarian community of Safien between 1985 and 2000 with exogenous and endogenous flows

According to Figure 7-11, the simulation run with exogenous migration approximates population development as reflected by data. The remaining difference between computed and real data is caused by a series of years with a fractional net birth rate above average. In the second half of the 1990s, fractional net birth rate declines and computed population becomes identical with data about population development again.

The exogenous labor run shows that population (line 4) remained more constant than would have been expected given the distinct decline in employment (line 2). The number of commuters changed only little between 1985 and 2000. Commuter development therefore only partially explains the difference between employment and population development. Another reason is that the job loss between 1985 and 2000 was mainly caused by a marked decline in agricultural employment. A last, statistical reason is the way in which population data are collected. For the population census, which takes place every ten years, every person who pays taxes in Safien is counted as an inhabitant of Safien. People who work somewhere else and also live there during the week are still counted as inhabitants of Safien. In the year 2000, around 45 persons, mainly between 15 and 25 years of age, belonged to this category (compared to the overall population of 308 people).

The example of Safien illustrates the difficulties of modeling a single, specific community. The age structure of the population can cause the model to deviate from measured data even if migration is exogenously given. Additionally, as particularly vulnerable communities have an average population size around 250 people, every decision an actor makes becomes visible in the system and is reflected by data. It is impossible to capture all these decisions in the model as they are often of random nature. It is nevertheless possible to detect development trends and important driving forces and thus to identify generic processes.
7.2.3 Residential communities with services

Residential communities with services are characterized by a high share of commuters on the total working population. Local employment is mainly in the service sector, especially the service and restaurant industry. The demographic structure tends towards a high share of old people. Figure 7-12 shows the development trajectories of residential communities with services for the different steps of analysis.

*Figure 7-12: Population and employment development in residential communities with services between 1985 and 2000 with exogenous and endogenous flows*

Step 1 computes more labor than was actually demanded during the simulation period. The decline in employment was mainly caused by a loss of agricultural jobs (not visible in Figure 7-12). This loss is not necessarily tied to a decrease in external demand. The difference between computed and real labor demand might much rather be that more goods and services are consumed on the regional market than in other communities. Commuters make their daily and non-daily purchases more often on the regional market than the local population.

The importance of the commuters for residential communities is emphasized by step 2. The comparison of population computed by exogenous labor (line 2) and population reflected by data (line 4) shows that population was stabilized by some other force than local employment. This other force is very likely an increase in available commuter labor, i.e. the jobs lost in the course of structural change in agriculture were compensated by alternative jobs within commuting distance.

One crucial factor for population development in residential communities is the attractiveness of the community compared to other communities. Relative attractiveness depends, among others, on the local provision of goods and services. Commuters only migrate into a community if they are satisfied with the provision. Step 3 shows that this might indeed have been important as computed population exceeds real population development. Low attractiveness dampens the effect of the reinforcing feedback loop *reinforcement production – population*. 
7.2.4 Tourist communities

Tourist communities are defined by the service and restaurant industry as well as by tourism. They are located rather peripherally so that there are not many out-commuters. Figure 7-13 shows the results for the three simulation runs for the case of the average tourist community.

Figure 7-13: Population and employment development in tourist communities between 1985 and 2000 with exogenous and endogenous flows

In the case of the average tourist community, Figure 7-13 shows a close fit between simulated and real development. Similar to agrarian communities, computed labor exceeds labor reflected by data in step 1. This indicates a slight loss in relative competitiveness, especially between 1985 and 1990. Step 2, on the other hand, shows that relative attractiveness is comparatively high as computed population lies below real population.

7.3 Boundary adequacy tests

The political discussion about the development of particularly vulnerable communities often centers on the question how the provision of basic services can be maintained. Underlying this discussion is the community framework presented in chapter 3.3 and the idea that a certain range of goods and services have to be available for ensuring long term development perspectives of a community.

For the analyses so far, the local economy was treated as one entity. This section tests whether model behavior changes when several economic sectors are distinguished. Four sectors are introduced:

1. Agriculture that produces non-durable goods with its immobile production factor land. Demand for agricultural goods is price inelastic while factor productivity grows at an intermediate rate (PETERS 1996: 42). The value share of labor in the disaggregated production function is approximately 0.3.

2. Manufacturing and industry, a sector that produces a high share of its output, durable consumer goods, for regional demand. The energy and building industry also
belong to this sector. Price elasticity of demand is low but factor productivity grows at a high rate (Peters 1996: 42). The value share of labor in the production function, according to BfS (1997), is approximately 0.3.

3. Private services are important determinants for the attractiveness of a community as a place to live. The provision of private services is influenced to a high degree by tourist demand. Commerce, the repair industry, the hotel and restaurant industry, traffic, telecommunication, banks and insurances, consulting services and real estate services belong to this sector. Price elasticity of demand for private services is high while productivity grows at a low rate (Peters 1996: 42). The value share of labor is approximately 0.4 (BfS 1997).

4. Public services often have a stabilizing effect on the development of a community. Public administration, national defense, the education system as well as health and social services belong to this sector. Demand for public services is price inelastic and productivity grows at a very low rate. The value share of labor is about 0.5 (BfS 1997).

Figure 7-14 compares population development over the entire time horizon of the model with aggregated (left hand side of Figure 7-14) and disaggregated economy (right hand side of Figure 7-14). Minor numerical differences in population arise towards the last two decades of the time horizon. These differences are caused by the fact that in the aggregated model, the economy is driven by average factor productivity. In the disaggregated model, on the other hand, factor productivities grow at different rates in the four economic sectors. The value shares of labor and capital as well as price elasticity of supply and demand also vary between the four sectors. Apart from these minimum numerical differences no behavior differences arise. The disaggregated model also passes the behavior reproduction test as shown in Figure 7-16.

Figure 7-14: Population development in the aggregated and the disaggregated model

Population development, especially the development of the 0 to 65 years old population, is characterized by periods of equilibrium, transition and equilibrium again. At the outset of the simulation, population remains stable because initially, productivity increases can be equilibrated by increasing demand. When further increases in demand are restricted redundant labor raises the pressure on out-migration. In a transition
phase, people leaving the communities reduce local demand further which leads to less employment and even more out-migration. As the ratio between local and external demand decreases, this process slows down and employment as well as population losses are absorbed by external demand. The system reaches an almost equilibrated state again.

Line 2, which represents the retired population, experiences only slight changes. This confirms the stabilizing effect of the retired population in a community. The share of the retired population on total population increases over the time horizon. It continuously leads to the familiar phenomenon of an ever growing share of retired people in lagging rural areas.

Figure 7-15 shows the development of the two production factors labor and capital during the simulation period. While factor productivity grows continuously, capital is substituted for labor in a first period. The substitution is caused by the different adjustment times for the two production factors and not by differences in factor costs. The labor force can be adjusted to changes on the product and factor market much faster than capital. Capital, on the other hand, has an average lifetime of 15 years and the stock can only be varied by the inflow, i.e. the investment rate. Once investment has taken place, the capital stock only decreases through the depreciation process.

Employment in the agriculture and manufacturing sector decreases considerably. The decline in agriculture is due to relatively high productivity growth on the one hand and restricted output growth on the other. Agricultural land is limited and production cannot exceed its carrying capacity. Production is also restricted by political regulations. As a result of growing factor productivity, the same amount of output can be produced using less input (labor and to a lower degree, capital). The manufacturing sector experiences high growth in factor productivity. It also reacts very much to changes in the population of a community because private demand has a high share of total output. The manufacturing sector is therefore especially affected by the dominance of the reinforcement population – production feedback loop.

Figure 7-15: Development of the production factors labor and capital in the disaggregated model
The results in Figure 7-14 and Figure 7-15 show that disaggregating the economy does not provide additional behavior insights. However, it clarifies the driving forces behind observed behavior patterns. It shows which economic sector dominates overall employment development and it also shows how different sectors are affected differently by external push- and pull-forces. Figure 7-16 highlights this by comparing employment and population development between 1985 and 2000. The results were generated following the three step procedure of section 7.2: (1) exogenous migration, (2) endogenous migration and exogenous labor, (3) endogenous migration and endogenous labor. For the labor stock, only results from step 3 are shown. Including results from step 1 and 2 would render the figure unreadable.

Figure 7-16: Population and employment development between 1985 and 2000 in the disaggregated model with exogenous and endogenous flows

Figure 7-16 shows that the agricultural sector (labor_check a) and the private services (labor_check b) were not much affected by changes in external push-forces. There was some growth in external demand during the general economic boom period in the second half of the 1980s. This temporary increase in external demand was particularly high in the manufacturing sector (labor_check a). Public services (labor_check b), on the other hand, grew considerably during the 1990s. This is mainly due to the fact that more and more duties are being transferred to the communal level.
Model testing and evaluation

The next section compares two examples of communities that undertook different activities to maintain their population and provide alternatives to agricultural employment. The process and its outcome can be better understood with the disaggregated model because employment decline in one sector lead to initiatives in another sector. The disaggregated model enables the detailed analysis of the volume of activities that is necessary to compensate for job loss in specific economic sectors.

7.3.1 Selected communities with endogenous activities

There are many more communities that were active in the past. The communities chosen as examples for this section are both agrarian communities and the activities of the last years are described in RIEDER (2005) for the case of Vrin and SCHULER (1999) for the case of Isenthal. The analyses in this section constitute both a behavior reproduction and a family member test. Vrin and Isenthal are agrarian communities. Isenthal, however, does not belong to the category of particularly vulnerable communities. This section therefore investigates whether the simulation model is capable of generating behavior that constitutes a transformation away from a particularly vulnerable community. It also analyzes the preconditions for a successful transformation because internal and external actors in Vrin have implemented several projects but the community still counts as particularly vulnerable.

Vrin

Vrin lies at the very end of the Lugnez valley in the canton of Grisons. In 2000, 260 people lived in the community, most of which were farmers. Between 1985 and 2000, employment in the manufacturing sector and in the private services slightly increased. This increase was partly due to combined efforts of external actors and the local population. These efforts have their origin in the unique architectural features of the community. They are complemented by efforts to diversify the local economy which is highly dependent on agriculture.

Figure 7-17 illustrates employment and population development in Vrin between 1985 and 2000. It consists of two diagrams that compare employment development with and without endogenous economic activities. The diagram on the left hand side compares computed labor (step 3 with endogenous flows) to labor represented by data for the manufacturing sector and the private services. These two sectors are displayed because they are the sectors where local employment-related initiatives have an impact. The diagram on the right hand side shows computed labor when the model is parametrized for a creative milieu. The difference between the figures therefore only lies in the values of the initiative creation rate, support of potential initiatives and low success threshold for commitment.
Figure 7-17: Population and employment development in the agrarian community of Vrin between 1985 and 2000 with exogenous and endogenous flows

The diagram on the left hand side in Figure 7-17 shows that employment in the manufacturing sector and the private services increased considerably in the 1990s (line 3 and 4). It did so after a period of marked decline which the simulation model cannot reproduce. The diagram on the right hand side illustrates that the growth tendency can be captured by the model if it is parametrized for an innovative milieu. The comparison of the computed employment and employment reflected by data in the two diagrams shows once again that it is very difficult to trace the exact development in a community as small as Vrin.

Isenthal (UR)

Isenthal is situated in the canton of Uri in a remote high valley. In 2000, 540 people lived in Isenthal, of which the majority was employed in the agricultural sector. Between 1985 and 2000, agricultural employment was almost cut in half. As a result, population declined. However, population decline would have been much more intense without improvements in transportation infrastructure, favorable economic conditions and continuous self-help. The share of out-commuters has increased constantly.

As in the case of Vrin, Figure 7-18 has two components. The diagram on the left hand side compares computed labor (step 3 with endogenous flows) to labor represented by data for the manufacturing sector and the private services. The diagram at the right hand side shows computed labor when the model is parametrized for a creative milieu.
The comparison of employment development in the manufacturing sector and the private services in Figure 7-18 shows that if the model is parametrized for high innovation potential, it is capable of reproducing the behavior in a community that does not belong to the category of particularly vulnerable communities.

Population development as reflected by data (not shown in Figure 7-18) indicates that the additional employment opportunities created in the private services contributed to population stabilization. The data, however, also show that this was not the case during the entire simulation period and that population could even have increased if it had closely followed the developments on the labor market. Despite the opportunity of accepting employment in commuting distance, the relative attractiveness is too low to keep all potential out-commuters living in the community.

7.4 Behavior and policy insights from model testing

In this chapter, several model tests were performed. Partial model analysis resulted in the identification of sensitive model parameters and nonlinear functions. The partial models proved to be capable of generating the behavior predicted by economic theory and previous innovation implementation studies. Behavior reproduction and family member tests showed that the model generates the observed behavior in the past with sufficient accuracy. The tests not only allowed verifying and validating the model. Instead, they also generated a series of policy insights.

The tests on the ‘initiatives’ and ‘implementation dynamics’ sectors showed that these model sectors behave in line with previous studies about the dynamics of innovation implementation (especially REPPENNING 2002). REPPENNING also identified an unstable equilibrium for commitment. The model sector ‘implementation dynamics’ was built according to these previous studies. However, decision structures were added that account for the sociopolitical setting within which local initiatives are created and implemented. Implementation dynamics, represented by changes in the success threshold

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and the quality of the motivation effort, generates behavior that adds to the findings of Repenning (2002). Contrary to a corporate setting, the motivation effort can vary in quality and in binding character. As a consequence, commitment not only reaches either its maximum or minimum value. In a third possibility, it oscillates around the initial equilibrium point without gaining enough momentum to grow to its maximum.

The central insight of partial model analysis in the model sectors 'initiatives' and 'implementation dynamics' is that for a development strategy based on local initiatives to be a success, motivation must engender sufficient commitment to shift direction of the reinforcement commitment-success feedback loop. While the exact degree of motivation and success are highly dependent on the chosen parameters, the general result is not. As long as conditions are adverse and commitment and success drain each other, this shift must occur for the system to reach adequate success.

Partial model analysis of the model sectors 'product market, factor market and population' showed that increases in factor productivity cannot maintain economic growth in lagging rural regions in the long run. The difference between leading and lagging regions lies in the direction of the loop reinforcement population – production. In leading regions, the loop works in an upward direction whereas it drains employment and population in lagging regions. There are several factors that are capable of causing a shift in the direction of this loop. Inter- and intraregional knowledge diffusion, as suggested by Bretschger (1999) is outside the boundary of this model. Relative competitiveness of regional goods on national markets, on the other hand, is within the model boundary. Relative competitiveness has an endogenous and an exogenous component in the model. The endogenous component is covered by price changes as a reaction to changes in the supply-demand ratio. The exogenous component consists in changes in external demand in addition to changes arising from price changes. This result confirms the observed vulnerable nature of small economies to processes on the surrounding markets and to trade shocks.

Steps 1 to 3 in the behavior reproduction tests identified external push- and pull-forces that influenced employment and population development between 1985 and 2000 in addition to internal processes. Figure 7-19 summarizes the results for the different units of analysis.
Model testing and evaluation

**Figure 7-19: Development trajectories of particularly vulnerable communities between 1985 and 2000**

<table>
<thead>
<tr>
<th>Push-forces</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Average particularly vulnerable community 1990-2000</td>
<td>Average particularly vulnerable community 1985-1990</td>
</tr>
<tr>
<td></td>
<td>Agrarian communities 1990-2000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tourist communities 1990-2000</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Average particularly vulnerable community 1985-1990</td>
<td>Residential communities with services 1990-2000</td>
</tr>
<tr>
<td></td>
<td>Agrarian communities 1985-1990</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tourist communities 1985-1990</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Residential communities with services 1985-1990</td>
<td></td>
</tr>
</tbody>
</table>

Push-forces are high when external demand decreases. The result of decreasing external demand is a loss in the relative competitiveness of regional goods on national markets. Pull-forces, on the other hand, are high when other regions are relatively more attractive for the local labor force and population than their own community.

Also in the course of behavior reproduction tests, development patterns between 1985 and 2000 were analyzed for the average particularly vulnerable community as well as for communities of different socioeconomic development types. The reinforcement production – population feedback loop proved to be predominant for the entire simulation time and for all community types. The basic problem that vulnerable communities face is therefore that the forces that are potentially capable of shifting the direction of this reinforcing feedback loop have to be very strong for such a shift to occur. The forces with the highest leverage differ between community types:

- Important exogenous forces that drive model behavior for all community types are external demand and factor productivity. Increasing factor productivity implies that less labor is used to produce the same amount of output. In order to compensate for this loss in employment, external demand has to rise.

- Agrarian communities with their high share of agricultural employment are particularly affected by increasing factor productivity. This means that a considerable number of jobs are lost every year. The examples of Vrin and Isenthal, both agrarian communities, showed how difficult it is to compensate for this loss. Vrin experienced considerable external support, both financially and in terms of motivation for the implementation of local initiatives. The necessary increase in external demand was nevertheless too high to fully counteract agricultural job loss. While Isenthal succeeded in stabilizing its population, it did only through local initiatives in combination with increased commuting activity. In addition to continuous efforts for the improvement of local employment opportunities, commuter labor increased between 1985 and 2000.

- Local employment in residential communities is equally affected by structural change in agriculture. While residential communities can stabilize their population through the attraction of out-commuters, their relative attractiveness depends cru-
Model testing and evaluation

...cially on the viability of the local economy. The provision of local goods and services is one of the main decision factors for potential in-migrants. If provision is unsatisfactory, the availability of commuter employment is not able to contribute to population, i.e., to slow the downward trend in the reinforcement production—population loop or even to shift its direction.

External demand repeatedly proved to be an important determinant of employment and population development. The examples of Vrin and Isenthal showed that external demand can be influenced in several ways. The possibilities reach from price or export subsidies to investment in either physical or social capital. The effects of these policies are analyzed in the next chapter.
8 Scenario and policy analysis

This chapter analyzes model behavior under different scenarios (section 8.2) and tests a series of policies (section 8.3). Scenarios as well as policies are compared to the base run behavior of the system (section 8.1). Scenarios refer to plausible developments in exogenous variables, i.e. to developments that the stakeholders in the system cannot influence. Policies, on the other hand, are decisions within the control of the stakeholders. By differentiating between policies and scenarios it will be possible to analyze under which external conditions policies will prove to be effective and robust. These reflections are summarized in section 8.4.

Scenarios and policies are difficult to quantify. It is therefore important to emphasize that the behavioral outcome and the policy implications of the simulation runs are of greater significance than the absolute values.

8.1 Base run

As a basis for scenario and policy analysis in the subsequent sections, Figure 8-1 presents the base run behavior of the model. The base run shows how the system develops if external forces remain unchanged. It specifically means that the observed factor productivity growth rate is extrapolated into the future. Population development is equivalent to Figure 7-14 (chapter 7.3) and labor development equals Figure 7-15 (chapter 7.3).

The figure shows how the two core indicators employment (left hand side, y-axis) and population (right hand side, y-axis) evolve over the time horizon of the simulation model (x-axis). The legends below the figure display the variable name (e.g. labor or total population), the name of the simulation run (4s_base), the representation of the variables in the graph (e.g. a line marked -1- for employment in agriculture and a line marked -2- for employment in the manufacturing sector) and the units of the corresponding variables (people).

Figure 8-1: Population and labor development in the base run scenario
A more detailed interpretation of the base run behavior can be found in chapter 7.3. The most important feature of the base run behavior is the equilibrium – transition – equilibrium pattern that arises from growing factor productivity. The 0 to 65 years old population and employment in the agricultural and manufacturing sector hint that the equilibrium at the end of the simulation period might be followed by another transition period.

8.2 Scenarios

Scenarios are internally consistent stories about the future and they are useful if they are relevant to the concerns of the decision makers (Chermack and van der Merwe 2003: 447). The systematic variation of the unknown or uncertain parameters in the model creates a number of trajectories and some of these trajectories are selected as scenarios to characterize different possible futures (Tietje 2005: 419). Following the findings in chapter 7, important trajectories in the context of employment and population dynamics are characterized by exogenous push- and pull-forces. The simulation model contains a series of parameters relevant for scenarios. Figure 8-2 specifies push- and pull-forces in more detail.

- Scenario variables describing push-forces or the relative competitiveness of regional goods on national markets, respectively: 'external demand'. A region is relatively competitive on national markets when production costs are lower than or equal to national production costs. If production costs are higher and no further value is added, external demand decreases.

- Scenario variables describing pull-forces or the relative attractiveness of a community, respectively: 'normal out-migration', 'effect of goods provision on in-migration'. A community is relatively attractive if the opportunity costs of living there are low. The opportunity costs increase when the national economy grows and offers better wages and when the quality of local goods and service provision decreases.
Scenario and policy analysis

**Figure 8-2: Push-and pull-forces**

*Push high*

- **Local economy not competitive:**
  - Bad economic structures,
  - Production costs higher than national average,
  - Technical progress leads to employment decline

- **Community not attractive:**
  - Costs of low wages higher than costs of not migrating,
  - Goods and service provision not satisfactory compared to other communities

- **Community attractive:**
  - Wages high enough,
  - Goods and service provision satisfactory compared to other communities,
  - Annual in-migration above average

- **Local economy competitive:**
  - Good economic structures, production costs lower than or equal national average, external demand grows and is able to compensate employment decline in the course of technical progress

*Push low

The scenario variables can be grouped along two axes (see also JANSSEN ET AL. 2004: 18). Two extremes are chosen for push- and pull-forces. The combination of two extremes for two variable sets leads to a total of four scenarios (Figure 8-3).

**Figure 8-3: Scenarios derived from different combinations of scenario variables**

- **Push-forces high:**
  - **Scenario 1:** Attractive but not competitive
  - **Scenario 2:** Restrained development potential

- **Pull-forces high:**
  - **Scenario 3:** Competitive but not attractive

- **Push-forces low:**
  - **Scenario 4:** High development potential

- **Pull-forces low:**
  - **Scenario 1:** Attractive but not competitive
Scenario 1 combines low pull-forces with high push-forces. Such a combination occurs when national employment grows faster than regional employment, e.g. in a situation where technical progress is not fully available or not fully used in lagging rural regions. This is also the case in scenario 2. The situation in scenario 2 is especially unfavorable for lagging rural areas because also the relative attractiveness of rural areas is low. Wages outside the region are higher than in the region and general socioeconomic development trends favor life in more central locations where the goods and service provision is more diversified. In scenario 3, rural areas also face low relative attractiveness, but in this scenario, the local economy grows. Scenario 4 combines very favorable development perspectives as the local economy grows and life in rural areas is attractive. Table 8-1 contains the parameter values for the four scenarios defined in Figure 8-3. The development of the population, labor and capital stock in the four scenarios is shown in Figure 8-4 to Figure 8-6.

Table 8-1: Parameter values for the four scenarios

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>External demand</td>
<td>Base -1% per year</td>
<td>Base -1% per year</td>
<td>Base +1% per year</td>
<td>Base +1% per year</td>
</tr>
<tr>
<td>Normal out-migration</td>
<td>Base -5%</td>
<td>Base +5%</td>
<td>Base +5%</td>
<td>Base -5%</td>
</tr>
<tr>
<td>Effect of goods provision on in-migration</td>
<td>Base +5%</td>
<td>Base -5%</td>
<td>Base -5%</td>
<td>Base +5%</td>
</tr>
</tbody>
</table>
According to Figure 8-4, population reacts mainly to changes in push-forces. In scenario 1 and 2 push-forces are high. At the same time, factor productivity grows continuously. Similar to the base run, population shows the equilibrium – transition – equilibrium behavior. The difference between scenario 1 (diagram a) and 2 (diagram b) lies in the short term reaction. In scenario 1, where the region is relatively attractive, people initially migrate into the community. As long as push-forces are high, however, the relative attractiveness is not sufficient to keep people in the community. In the long run, the initial slight population increase is replaced by population decline which reaches an almost identical final level as population in scenario 2 with high pull-forces. Scenarios 1 and 2 show that the relative attractiveness of a community (pull-forces) has only very little impact on its population development when push-forces are high. In this case, it is only effective in the short run.

In scenario 3 (diagram c) and 4 (diagram d), where push-forces are low and regional goods are relatively competitive, population remains at least at the level of the year 1985. In scenario 3, the low relative attractiveness leads to minor population decline in the short run. This decline can be absorbed by the growing external demand. In scenario 4, there even is a distinct increase in population. The combination of high relative attractiveness and high relative competitiveness leads to a higher final population.
level than in scenario 3 with low relative attractiveness. In scenarios 3 and 4, the relative attractiveness of a community is more effective in shaping the development path than in scenarios 1 and 2, where push-forces are more dominant.

Figure 8-5: Development of the production factor labor in scenario 1 to 4

Labor follows similar development patterns as population, as can be seen in Figure 8-5. Productivity grows at a relatively high rate in the agricultural and manufacturing sector (lines 1 and 2 in Figure 8-5). The manufacturing sector is much more determined by local population development and closely follows the trajectories of the population curves from Figure 8-4. Private services, on the other hand, react very sensitively to changes in external demand. Growing external demand in scenario 3 and 4 manages to compensate the effects of increasing factor productivity.

In the case of the production factor capital, growing external demand eventually leads to levels of infrastructure in all four economic sectors that are higher than their initial values (Figure 8-6). Compared to labor, Figure 8-6 also shows the delayed reactions in capital due to the longer adjustment time for this production factor.
The development trajectories resulting from the four scenarios show that push-forces are more significant in shaping the development path of a rural region than pull-forces. Push-forces determine the overall development trajectory while pull-forces shape the detailed behavior mode in the short run. The development space resulting from the scenarios leads to the question if there are policies that are capable of fully stabilizing population and labor. This question will be explored in the next section.

### 8.3 Policies

Model testing and evaluation in chapter 7 resulted in the identification of two tipping points. On the product and factor market, there is a threshold value for the ratio between growth in factor productivity and growth in external demand. Above this threshold value, further increases in factor productivity not only lead to output growth but also to growth in employment and thus in population. This is the case when the relative competitiveness of the local economy is equal to or above the national average and when the national economy grows. Below this threshold, productivity growth leads to population decline in the long run. In the innovation sector, there is a tipping point above which success and commitment drive each other towards maximum values of success and commitment. Below the threshold, the opposite occurs.
The existence of these two tipping points leads to a series of questions that add to the research questions formulated in chapter 3.6. These questions will be addressed in the remainder of this chapter.

- Under which conditions do employment and population assume extreme values?
- How do policies have to be designed to stabilize employment and population, i.e. to reach equilibrium?
- Under which conditions do initiatives make it through the different stages in the innovation diffusion and implementation process?
- How do policies have to be designed to compensate external push-forces by endogenous activities that add to the relative competitiveness of a community?

The policies are always described following the same pattern: introduction to the policy experiment, results of the policy experiment, interpretation of the results from a feedback perspective and, if necessary, policy implications of the experiment.

8.3.1 Policies to shape structural change

Chapter 3.4 showed that regional rural development is shaped by structural change. Structural change is understood as changes in the relative contributions to economic activity provided by different sectors of the economy (ROBERTS AND THOMSON 2003: 63). The drivers of structural change either stem from changes in final demand, changes related to relative input prices or changes in production technology. The policies tested in this section follow these drivers.

Changing external demand

A major implication of scenarios 1 to 4 is that external demand is high when the local production is relatively competitive on the national market. Figure 8-7 shows the development space of the 0 to 65 years old population when the fractional change rate in external demand is varied from -5% to +5% per year. The purpose of this experiment is to analyze under which conditions growth in external demand is sufficient to bring about population growth. It also shows how sensitive population reacts to reductions in external demand.

Regional policy options to stimulate growth in external demand are mostly financial incentives targeted at firms (see Table 4-3). Changes in external demand are, however, mainly caused by developments in the national and international sociopolitical realm. An important determinant of external demand on the national level is the purchasing power of the national population. International trade-related negotiations such as the negotiations with the European Community or the World Trade Organization determine the export potential for national and therefore also for regionally produced goods. The exchange rate controls the purchasing power of international stakeholders. In the context of this study, the purchasing power of tourists is of special significance.
Figure 8-7: Population development as a reaction to changes in external demand

Figure 8-7 illustrates that population reacts differently to increases and decreases in external demand. Decreases lead to simple higher order decline while increases lead to slightly more varied behavior modes. If population grows, it does so by following the equilibrium – transition – equilibrium pattern identified before. For population to grow over the entire time horizon external demand has to grow at least by 2% per year. A decline of 2% per year, on the other hand, already leads to a near erosion of the entire 0 to 65 years old population.

The system therefore needs considerable demand growth for population growth while at the same time, a much smaller loss in demand is sufficient to produce a collapse. One reason for these differences is the existence of nonlinear relationships in the model. In this case, the nonlinear relationships governing migration decisions are particularly important.

The limit to population growth is defined by the available physical space within which settlements can be built in a community. While the absolute value of this limit depends on the specific location, the existence of physical and political bounds does not.

In Figure 8-7, external demand was varied uniformly among the four economic sectors. External demand is the sum of export demand, tourist demand and public demand (e.g. BUSER 2005). External demand has different impact potentials in the four economic sectors and the effectiveness of a given sector depends on a series of factors. In the first place, the community type determines which sector is predominant in the local economy. Agriculture, for example, prevails in agrarian communities whereas in tourist communities a majority of the workers are employed in the private services. Different economic sectors also have different development potentials. External demand in agriculture, for instance, is to a very high share public demand that is compensated by direct payments. Direct payments, however, are very unlikely to increase in the future (BLW 2003: 260). Export of agricultural products is limited by inelastic demand. At the same time, agriculture is the one sector where productivity growth cannot lead to
significant employment growth because output is limited by natural and political factors. The job loss in the agricultural sector therefore has to be compensated by increasing external demand in other economic sectors. This raises the additional problem of job compatibility and necessary training for alternative employment which is especially critical in agrarian communities.

External demand in public services is also predominantly public demand by regional and national governments. The growth potential of external demand in this sector is therefore limited as well. The highest growth potential of external demand is in the manufacturing and private services sector. Figure 8-8 shows the results of an experiment where external demand in the manufacturing as well as in the private services sector is doubled after in the year 2005. This experiment can be understood as testing the short and long term effects of a business development strategy that focuses on the attraction of big investor companies into the community.

Figure 8-8: Employment and population development as a reaction to a step increase in external demand in the manufacturing and private services sectors

Doubling external demand is an extreme case which is very unlikely to happen. Figure 8-8, however, shows that not even such an extreme intervention is capable of stabilizing labor and population in the long run.

The step increase in external demand manages to shift the direction of the reinforcement population – production feedback loop in an upward direction. At the time where productivity growth exceeds the effect of the additional external demand, however, the direction is shifted once again towards a downward development.

If keeping employment and population at an approximately constant level in the long run is a development goal, the experiment from Figure 8-8 has important policy implications, especially when compared to Figure 8-7. It shows that small but continuous increases in external demand are more effective than introducing a voluminous economic activity that multiplies external demand at one point in time but does not give rise to further activities that continue stimulating external demand. Development strategies that aim at attracting big investor companies into the region should take this long term perspective into account.
Scenario and policy analysis

Changing infrastructure

Regional policy instruments from the old regional policy paradigm (see chapter 4.4.1) such as the investment aid regulation, the support of the hotel and restaurant industry or business development strategies focus on enabling capital investment. In terms of regional policy instruments from Table 4-3, these are infrastructure measures targeted mostly at the population and at political/institutional entities. The intended consequence of these investments is an improvement in the provision of basic infrastructure. The goal of these instruments is also to stimulate economic activity. Capital provision forms the basis for activities aimed at generating additional external demand and thus employment.

Capital provision can be encouraged in several ways. Figure 8-9 shows the effect of variations in the interest rate between -50% to +50%. The changes in the interest rate are introduced in the year 2005 and represent a positive or negative subsidy on the production factor capital.

*Figure 8-9: Population development as a reaction to changes in the interest rate*

Figure 8-9 elaborates the insights from model testing in chapter 7.1.1 further. Figure 7-4 in that chapter demonstrated that labor and capital are substituted for each other when the factor price ratio changes. The variation in the interest rate in Figure 8-9 has the same effect. A higher relative interest rate implies substitution of labor for capital and vice versa. If labor is substituted for capital, employment rises. This leads to immigration and therefore adds to population. Cheapening capital leads to more investment in the capital stock and to a reduction in employment. As a consequence, population declines.

Figure 8-9 shows that the population effect of changes in capital cost depends on the direction of the change. Reductions in the interest rate lead to a bigger net population change than increases in the interest rate). Several nonlinear functions are responsible for this outcome. In addition to the multipliers on migration, the effect of relative return to capital on desired capital plays an important role. The sensitivity of changes in
population therefore depends on the inherent assumptions in these nonlinear functions about the elasticities of the capital–labor substitution and the growth effect induced by cheaper capital.

Another possibility of supporting capital provision than lowering or increasing capital price is to make the necessary capital directly available. Investment grants and venture capital initiatives are examples of instruments for such a development strategy. Figure 8-10 summarizes the population effect of variations in the inflow into the capital stock. The inflow into the capital stock is, according to chapter 6.3.2, determined by the depreciation rate, the ratio between current and desired capital and the fraction of available capital investment goods. In Figure 8-10, the fraction of available capital goods is varied between 0.5 and 1.5, i.e. from half its normal value to 150% of it.

The results are presented in the form of a three-dimensional response surface. In the plot, the vertical axis represents the outcome variable of interest, in this case the 0 to 65 years old population. The horizontal axis represents time and the third axis, which extends into the page, captures the input variable being manipulated in the experiment, in this case the fraction of available capital goods. Reading from left to right along the horizontal axis, any given line shows the time path of the outcome variable given a specific input variable. Reading from front to back along the input variable axis, any given line shows how the value of the outcome variable, at one specific point in time, changes in response to changes in the input variable. Viewing the resulting surface presents a dynamic view of how the evolution of the outcome variable is influenced by changes in the input variable.

*Figure 8-10: Population development as a reaction to changes in available capital investment goods*

Figure 8-10 contains several implications. It shows that making more capital goods available results in a better-before-worse behavior pattern of the 0 to 65 years old population. Restricting capital availability to half of the desired value generates constant population decline. The normal equilibrium – transition – equilibrium development pattern is almost completely suppressed. Increasing the availability of capital
above its desired value, on the other hand, leads to an initial population increase. After a short growth period, however, population starts to decline and drops below the value of the situation with restricted access to capital goods. In the long run, population recovers to a level that is approximately identical for all the values in the fraction of available investment goods. If investment in the capital stock is not followed by massive investment in an adequate increase in external demand the costs of maintaining the capital stock become too high after the initial growth period.

A comparison between Figure 8-9 and Figure 8-10 implies that lowering the price of capital is not sufficient to generate sustained investment. Investing more than the system requires, on the other hand, leads to an unstable situation with better-before-worse behavior. The inability of sustaining the short term effect confirms an earlier finding that increasing the relative attractiveness of a community is not capable of generating a long term effect.

Better-before-worse behavior as shown in Figure 8-10 bears important policy implications. If population stabilization or population growth are development goals, a strategy based on increasing the availability of capital goods results in initial success. The unintended consequence of it is, however, that the initial success is not sufficient to keep population at such a high level. After an initial growth period, a distinct decline occurs.

Figure 8-11 and Figure 8-12 therefore analyze the robustness of such a development strategy under the two extreme case scenarios. In both cases, the fraction of available capital goods is 150% its desired level. Figure 8-11 shows the results for scenario 4. Scenario 4 is the best case scenario for lagging rural areas with increases in both external demand and relative attractiveness (see section 8.2). Figure 8-12 contains the results for scenario 2, the worst case scenario where external demand and relative attractiveness decline over time.

**Figure 8-11: Employment and population development in scenario 4 (best case) and with available capital investment goods above average**
Figure 8-12: Employment and population development in scenario 2 (worst case) and with available capital investment goods above average

Figure 8-11 shows behavior similar to the behavior at the upper extreme in Figure 8-10. Thanks to the favorable external conditions, population decline after the initial overshoot period can be brought to equilibrium after a transition period. In Figure 8-12, on the other hand, where external conditions put a strain on the development potential of a rural community, excess investment in capital leads to near erosion of the labor and population stocks.

The capital goods provided by facilitated investment cannot be financed over a longer period of time. This increases the economic decline tendency inherent to this scenario and makes the system collapse almost completely.

**Changing technology**

Factor productivity has repeatedly proved to be a sensitive influencing factor on model behavior. If factor productivity grows at a certain fractional rate, the equilibrium - transition - equilibrium behavior can be observed. This behavior itself is insensitive to the initial value of factor productivity and to the exact value of the fractional growth rate.

Productivity growth has to be seen in relation to growth in external demand. As long as external demand grows more or faster than productivity, employment and population are prevented from dropping too much or they even grow.

Figure 8-13 shows the effects of a development strategy that is based on slowing productivity growth down. This experiment can be interpreted as a structural policy aimed at conserving economic structures (see chapter 4.2). The implications of this experiment are particularly important in the context of agricultural policy. The social and political discussion about the development of the agricultural sector very often centres on the conservation of agricultural structures. The difference between the agricultural sector and the other economic sectors, however, is mainly that arguments in favor of structural conservation are made more explicitly (PETERS 1996: 147ff).
The fractional productivity growth rate is initially set half its usual value. As of the year 2020, the fractional growth rate is tripled. This multiplier simulates the effect of structural disruptions, i.e. of fast structural adaptations as a consequence of delayed structural change. Approximately 70% of local GDP in particularly vulnerable communities depends on external demand. External demand, however, drops if local production becomes less and less competitive. A development strategy based on slowing productivity growth down is therefore not feasible in the long run. Tripling the fractional productivity growth rate in this experiment accounts for this fact.

*Figure 8-13: Effect of structural disruptions on labor and population as a consequence of inhibited technical progress*

Figure 8-13 exhibits no sudden reaction in employment or population to structural disruptions. Population and labor follow similar development trajectories as in the base run scenario. In the base run scenario, productivity has to start growing at its usual value, i.e. the base run value and productivity needs at least to be doubled in the course of the time horizon to bring labor and population down to near depletion (not visible in Figure 8-13). If the productivity increase occurs earlier than 2020, employment and population decline set in earlier but the final levels of these stocks do not differ significantly from Figure 8-13. They also change only little in the most unfavorable scenario 2. The effects of a structural disruption on employment and population are even smaller when the disruption affects only some sectors and not the entire economy.

In scenario 3 and 4, however, a structural disruption leads to changes in the behavior mode of employment and population (Figure 8-14). In scenario 3 and 4, the external push-forces are low, i.e. the local economy is relatively competitive.

In an environment with low push-forces, a structural disruption brings the system out of its equilibrium. After the initial stabilization phase where slow productivity growth keeps labor and population at high levels, the disruption leads to marked employment and population decline towards the end of the time horizon. While the absolute employment and population levels at the end of the time horizon are higher than in Figure 8-13, the system is in a distinct decline phase which introduces a high potential for destabilization.
Figure 8-14 identifies a situation where the system is forced to a transition from above to below the economic tipping point. In an initial phase, the local economy grows at least as much as the surrounding markets. As a consequence of the structural disruption, however, the economy loses its relative competitiveness and falls below the national average. Under these conditions, productivity growth leads to employment and population decline.

Concluding from these results, the system seems to be rather robust to sudden increases in factor productivity. As long as external demand remains unchanged, increasing factor productivity leads to employment and population decline. Within a certain range (up to a disruption of twice the initial value of the base run scenario), the behavior mode and the absolute value of this decline are only little affected by the exact extent of productivity growth. This applies for the base run situation and the scenarios with low relative competitiveness. In a situation with high relative competitiveness, however, structural disruptions manage to reverse system behavior. Relative attractiveness, again, has little impact on long term system behavior.

The results from policies to shape structural change confirm findings in related studies (especially ROBERTS AND THOMSON 2003) about the most important drivers of structural change. The predominance of final demand, especially external demand, in vulnerable rural communities suggests that policies that affect aggregate demand patterns are a much more significant force in shaping the development path of a rural region than policies affecting relative input prices or technology. Contrary to ROBERTS AND THOMSON (2003), the contributions made by changes in relative input prices (i.e. changes in infrastructure) to structural change were found to be a more significant driver of structural change than changes in technology. This only becomes visible from a dynamic, feedback-rich perspective. The dynamic simulation identified better-before-worse behavior for capital provision strategies that could not have been identified with a static approach.
8.3.2 Policies to enhance innovation capacity and to compensate external forces

As discussed above, the highest growth potential of external demand is in the manufacturing and in the private services sector. These are also the economic sectors with small and medium enterprises (SMEs). Arguments favoring a regional policy targeting SMEs have been and continue to be the subject of great controversy. Despite the instability of the SME sector and the many barriers to growth, there are, however, some reasons to continue backing SMEs (ARMSTRONG AND TAYLOR 2000: 273f):

- In an attempt to cut costs, many large firms chose to concentrate on their core business. In doing this, they partly subcontract work and buy outside. This process greatly encourages the establishment of specialist SMEs supplying larger firms.

- Rising incomes of consumers have encouraged the demand for specialized products. This has enabled small firms to survive by serving niche markets.

This study investigates the process through which new economic activities are created from a collaborative effort of actors within the community and external actors. The result of this process is not necessarily the creation of new SMEs. The economic activity can also be implemented in the form of a cooperative or some other formal organization.

Partial model tests in chapter 7.1.2 revealed that the effectiveness of the innovation diffusion and innovation implementation process depends on the decision which stage in the process policies aim at. This question is also one of the key dilemmas, which currently hinders the creation of an effective regional SME policy. Helping entrepreneurs to get started will result in pouring resources into firms of which most will not survive. On the other hand, helping only the survivors simply raises new concerns. To do so may result in some projects with excellent long-term prospects simply never getting off the ground. There is also the problem of deciding which survivors to help. Many small firms have no desire to grow (ARMSTRONG AND TAYLOR 2000: 281ff). To a large extent, the question whether to help new starts or survivors can also be posed in the context of collaborative initiatives. This aspect will be explored in the next section.

Effectiveness of the innovation diffusion and implementation process

Instruments to support SMEs range from the provision of investment grants and venture capital to advisory services and management consulting (ARMSTRONG AND TAYLOR 2000: 292; see also Table 4-3). Venture capital initiatives mainly focus on new starts while the other instruments are suitable for new starts and survivors alike.

In Figure 8-15, the effect of an increase in the initiative creation rate is analyzed. The figure compares employment and initiatives development under base run conditions ('4s_base') and under the support of new starts ('creation'). This experiment tests the impact of a development strategy based on the support of new starts. For this purpose,
the initiative creation rate is raised to twice its normal value in the year 2005. This policy is related to the experiment in chapter 7.1.2 (Figure 7-8) but here, the model sectors 'initiatives' and 'implementation dynamics' are coupled to the rest of the model. Thus, interactions between the different model sectors in the course of the innovation process become visible.

*Figure 8-15: Reaction of employment and initiatives to an increase in the creation of new economic activities*

According to Figure 8-15, the direct employment impact of doubling the initiative creation rate is negligible. The impact is not significantly raised either when the initiative creation rate is combined with a moderate investment policy as in Figure 8-10 (not visible in Figure 8-15). The number of potential initiatives slightly declines after the initial increase (right hand side in Figure 8-15). The initial increase is a reaction to the increase in the initiative creation rate. Population, however, cannot be significantly affected by increased initiative creation. As a consequence, population decline cannot be prevented. With the number of out-migrants, entrepreneurial capacity is lost in the community which adversely affects the initiative creation rate.

In Figure 8-16, the support of new starts is complemented by policies that enhance the entrepreneurial capacity of local leaders. In addition to venture capital and investment grants, advisory services and management consulting are provided. Figure 8-16 therefore tests the effects of a development strategy based on the support of new starts and survivors alike ('cr_success').
According to Figure 8-16, the employment effect of a strategy that combines support of new starts and support of survivors proves to be significantly higher than in the case where only new starts are supported. The exact amount of the employment effect depends on the volume of the implemented initiatives, i.e. of the size of external demand that they generate. The support of survivors increases the fraction of successful initiatives. As a result, the number of implemented initiatives increases and employment loss in the manufacturing and the private services sector can be slowed down.

An increase in the fraction of successful initiatives has several consequences. In the first place, successfully implemented initiatives provide employment alternatives, which can be seen in the left half of Figure 8-16. Successfully implemented initiatives also add to the general innovation climate which is an important factor in the planning stage of new initiatives.

Local institutional dynamics

The planning stage of new initiatives combines competing forces. These forces together determine whether actors decide to support a new initiative and become active in its implementation. The fraction of initiatives that is taken up for planning depends on the pressure to plan and the willingness to plan. The pressure to plan follows the theory of collective action (chapter 5.2.2). Contributing to rural development has the character of a public good (chapter 1.1). Individual actors therefore only become active when their individual contribution benefits them directly. In the model, pressure to plan rises when population declines and threatens further provision of basic goods and services. The willingness to plan, on the other hand, depends on the experience a community has made with initiatives. The willingness to engage in new initiatives is higher the more successful initiatives were in the past.

Figure 8-17 shows the development of these competing forces for different policies. The policy ‘creation’ in the legend of the figure represents a policy based on investment in new starts and ‘cr_success’ stands for combined investment in new starts and
in survivors. The units of the variables in Figure 8-17 are all dimensionless because the variables are either fractions or qualitative variables such as ‘pressure to take a risk and plan (pressure)’ and ‘willingness to take a risk and plan (willingness)’.

Figure 8-17: Developments in the decision to support an initiative under base run conditions, investment in new starts and investment in new starts and survivors

A central insight from Figure 8-17 is that the fraction of initiatives that are taken up for planning only increases considerably when the initiative implementation phase (‘cr_success’ as opposed to ‘4s_base’ and ‘creation’) is supported. In a first period, the fraction increases due to the successful implementation of other initiatives (willingness to plan). In a second period, the fraction increases even more as a result of the rising pressure to plan. The pressure to plan follows population development and increases when population declines. The pressure to plan and the willingness to plan compete in the sense that the fraction of initiatives taken up for planning (‘fr planned’) starts to stagnate around year 2020. At this point in time, the successful implementation of initiatives manages to create alternative employment (see Figure 8-16). As a consequence, the pressure to engage in even more initiatives declines. Although initiatives keep being successfully implemented (resulting in a high willingness to plan), no additional initiatives are taken up for planning.
If no attention is paid to the implementation process and initiatives result in failures, the opposite development as in Figure 8-17 sets in. In this situation, the low willingness to plan has the effect that no more initiatives are taken up for planning even though the pressure to plan would be high. In this situation, the system is locked-in in bad experiences.

In this context, it is important to distinguish between different reasons for policy failure. Figure 8-16 showed that two conditions have to be fulfilled for these policies to be successful. In the first place, the volume of the newly created economic activities has to be high enough to have a noticeable employment effect. If too much energy is spent on too small activities, the general employment and population decline trend cannot be slowed down. Second, special emphasis has to be put on the implementation phase. If entrepreneurial capacity and motivation experienced by the interaction with external actors are too low, commitment is not sufficient for success. Success of an initiative, in turn, is central for further activities.

Policy failure can therefore have two reasons: underinvestment and wrong choice of policy. The results in this section so far show that development strategies based on strengthening local collaborative activities have the potential to influence employment and population development and that policy failure mainly arises from underinvestment in management skills and entrepreneurial capacity.

External demand generated by endogenous development activities has to be very high to compensate for job loss in the course of productivity growth. The processes identified in this section are nevertheless important because the success of capital investment strategies and export oriented strategies critically depend on the willingness of local actors to support these strategies and on their commitment in implementing them so that enduring economic growth can be reached.

8.3.3 Policies for a transition towards steady state

Figure 8-7 showed that there is no combination of a given growth rate in external demand and a given growth rate in factor productivity that results in a perfect equilibration of population. A dynamic system is in equilibrium when the inflows of each stock variable equal the outflows of the same stock. The labor and population stocks are not only affected by changes in external demand. This section therefore tests policies that bring the population stock near equilibrium. These analyses are performed for the average particularly vulnerable community and two of the three community types from chapter 7.2, agrarian communities and residential communities with services. Agrarian communities and residential communities with services show a broad spectrum in locational and socioeconomic characteristics. Tourist communities, on the other hand, mainly differ from agrarian communities in their sectoral composition. They are therefore not included in the analysis of effective development strategies.
Average particularly vulnerable community

In Figure 8-18, external demand in the manufacturing sector and in the private services grows at a rate of 1% per year. Under these conditions, population remains at least constant over the entire simulation period. Steady state, however, cannot be achieved.

Figure 8-18: Employment and population development with constant growth rates in external demand in the average particularly vulnerable community

Figure 8-19 shows the necessary variations in the fractional growth rate in external demand for keeping population development in steady state. The vertical axis in Figure 8-19 represents the annual growth rate in external demand which is necessary to stabilize population over the entire simulation period. In order to analyze the effect of the optimal fractional growth rate in external demand on employment, Figure 8-20 shows employment development in the base run and employment development as it is shaped by the optimal growth in external demand.

Figure 8-19: Optimal development of external demand growth for steady state in the average particularly vulnerable community
According to Figure 8-19, productivity growth is sufficient for keeping population and employment on a constant level in an initial phase. However, external demand has to be raised considerably while employment is still constant. Without this increase, further productivity growth induces the transition phase exhibited in the base run situation. Once the transition phase sets in, growth in external demand cannot compensate this development fast enough even if external demand grows at extreme values. In the further course of the simulation, growth in external demand does not have to be that high anymore. For population to remain constant, the growth rate in external demand has to be adjusted regularly. In addition, these adjustments have to be made in an early stage of development. Changes in external demand only have the desired stabilizing effect after a delay of five to ten years.

The existence of this delay explains another source of policy failure in regional economic development policy. Development strategies based on increasing export activities prove to have very high leverage. Policy failure arises when investment in strengthening export activities are stopped after too short a time. Policy failure also arises when export activities are only strengthened after decline has set in. A critical success factor for export activities is therefore a long term perspective.

Figure 8-20 illustrates employment development and changes in the sectoral composition of the economy in particularly vulnerable communities for the case of constant population levels over the entire simulation time ('4s_var_ext dem'). Employment is also compared to the development under base run conditions ('4s_base').

Figure 8-20: Employment development in the base run and for population steady state in the average particularly vulnerable community

Comparing employment in the four economic sectors in the base run and under equilibrium conditions ('4s_var_ext dem') shows that in the second case, a shift in the relative shares of the individual sectors occurs. Agriculture continues to lose jobs while employment decline in the manufacturing sector can be decelerated and employment in the private services grows. Employment in the public services remains relatively constant which confirms the stabilizing effect of this economic sector.
Agrarian communities

If external demand is the only source of population growth and if it grows at a constant rate, external demand in the manufacturing sector has to grow at 2% per year and in the private services at 3% so that population never declines in agrarian communities. Figure 8-21 shows that this development eventually leads to population increase, but only after more than 30 years of near equilibrium.

*Figure 8-21: Employment and population development with constant growth rates in external demand in agrarian communities*

As in the case of the average particularly vulnerable community, Figure 8-22 shows the variations in the fractional growth rate in external demand that are necessary for keeping population at a constant level. The figure distinguishes development of external demand for the manufacturing sector and for the private services.

*Figure 8-22: Optimal development of external demand growth for steady state in agrarian communities*
Figure 8-22 has two main implications. In the first place, it shows that compensating the effect of productivity growth in agrarian communities entails very high annual growth rates of external demand in the manufacturing sector and private services. The growth rates are up to four times as high as in the case of the average particularly vulnerable community. Second, Figure 8-22 also implies that stabilizing population is a very difficult task in the sense that the necessary growth rates in external demand have high amplitudes over time and show considerable variations.

The sectoral composition of the local economy that arises from such a development strategy in the course of the simulation period is shown in Figure 8-23 on the right hand side. The left hand side again presents base run employment behavior.

*Figure 8-23: Employment development in the base run and for population steady state in agrarian communities*

Figure 8-23 shows that the sectoral composition in agrarian communities changes fundamentally when population remains stable over the entire simulation period. The communities change their socioeconomic features and lose their predominantly agrarian characteristic. Depending on the specific development, agrarian communities
transform into rural communities with strong manufacturing and industry, into tourist communities or in special cases into residential communities.

**Residential communities with services**

In line with the analysis of the average particularly vulnerable community and of agrarian communities, Figure 8-24 illustrates the effect of constant growth rates in external demand that prevent population from declining at any point in time during the simulation period. Under these conditions, external demand in the manufacturing sector and in the private services has to grow at a rate of 2% per year so that population never declines. As illustrated by Figure 8-24, this development eventually leads to population increase, but only after more than 40 years of near equilibrium. If the manufacturing sector does not grow, population initially declines slightly and then exhibits the same growth behavior (not visible in Figure 8-24). In residential communities with services the private services are the sensitive economic sector in which external demand dominates overall population development.

*Figure 8-24: Employment and population development with constant growth rates in external demand in residential communities with services*

Following the same structure of analysis as for the average particularly vulnerable community and for agrarian communities, Figure 8-25 shows the optimal development of external demand growth. Figure 8-26 subsequently compares the employment effect of the optimal growth rate in external demand to the base run behavior of employment.
Figure 8-25: Optimal development of external demand growth for steady state in residential communities with services

Figure 8-26: Employment development in the base run and for population steady state in residential communities with services

In residential communities, one main determinant of population development is the development of the labor market within commuting distance. Figure 8-27 shows the effect of an annual increase in commuter labor demand of 1% (left half of the figure) and 3% (right half of the figure). A growth rate of 1% is sufficient for stabilizing population after the transition phase caused by the development on the local labor market. Preventing population from decreasing at any point in time needs an annual increase of commuter labor demand of 3%. In the long run, such an increase leads to exponential population growth. However, it takes several decades for this effect to set in.
A last experiment for residential communities with services explores a combination of commuter labor and external demand that leads to a steady state in local population. Figure 8-28 reports the optimal curve for external demand growth when commuter labor demand grows at 1% per year. Higher commuter labor demand growth inhibits steady state behavior and lower commuter labor demand growth leads to a curve for external demand growth similar to Figure 8-25.

Figure 8-28 shows that with a combination of growth in external demand and growth in commuter labor demand, the necessary growth rate in external demand is significantly lower than in Figure 8-25. Towards the end of the time horizon, steady state in population development requires no additional growth in external demand. The resulting sectoral composition of the local economy, shown in Figure 8-29, is less dominated by private services. However, local employment is also lower as in Figure 8-26.
The development illustrated in Figure 8-29 needs a lower fractional growth rate in external demand and combines two development strategies. This potentially adds stability to the community’s development. On the other hand, the local economy grows less than in the case of a development strategy that is uniquely based on export activities (Figure 8-25 and Figure 8-26). The dependency on the developments on the regional labor market adds instability to the community’s development and shows a case of trade-off of two development strategies.

8.4 Conclusions from scenario and policy analysis

Table 8-2 summarizes the results from scenario and policy analysis and interprets them from a feedback perspective. The first column contains the main policy issue and the last column describes the main findings related to this issue.

<table>
<thead>
<tr>
<th>Main policy issue</th>
<th>Important loops</th>
<th>Main determinants of the strength of the loop</th>
<th>Main factors influencing the determinants</th>
<th>Main findings</th>
</tr>
</thead>
</table>
| Migration         | Reinforcement population - production | - Labor demand  
- Attractiveness of goods and service provision | - Local demand  
- External demand | Relative competitiveness/push-forces more important for shaping the long term development path of a rural region than opportunity costs/pull-forces |
| Employment        | Reinforcement population - production | - Desired production | - Local demand  
- External demand | Continuous growth in external demand more effective than big step increase |
| Production        | Labor adjustment to cost | - Desired labor | - Relative marginal product of labor  
- Wages | |
|                   | Reinforcement population - production | - Labor demand  
- Capital demand  
- Factor productivity | | |
<table>
<thead>
<tr>
<th>Initiative</th>
<th>Production adjustment to price</th>
<th>Consumption adjustment to price</th>
<th>Capital investment adjustment to cost</th>
<th>Reinforcement commitment - success</th>
<th>Commitment through motivation</th>
<th>Reinforcement capacity - population</th>
<th>Initiatives only under pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supply - demand ratio</td>
<td>Multiplier wage on local demand</td>
<td>Desired capital</td>
<td>Threshold value success for commitment</td>
<td>Commitment adjustment time</td>
<td>Entrepreneurial capacity</td>
<td>Population</td>
</tr>
<tr>
<td></td>
<td>Price</td>
<td>Wages</td>
<td>Relative marginal product of capital</td>
<td>Commitment half-life</td>
<td>Weight on commitment from success</td>
<td>Capacity from local population</td>
<td>Attractiveness of goods and service provision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average propensity to consume</td>
<td>Price elasticity of demand</td>
<td></td>
<td></td>
<td>Capacity from immigrants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Price</td>
<td></td>
<td></td>
<td>Training and advisory multiplier on entrepreneurial capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Commitment</td>
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</tr>
</tbody>
</table>

- Risk of employment and population collapse as a consequence of capital investment in a situation of high push-forces
- Structural disruptions also bear the potential of collapse but in situations of low push-forces
- Policy failure of endogenous development strategies when underinvestment in management skills and entrepreneurial capacity
- Shift in the direction of the reinforcement commitment - success has to occur for sustained success of endogenous development strategies
- Support capacity to implement initiatives, not only to develop ideas for new projects
- Ensure that enough external demand is generated by endogenous development initiatives
9 Conclusions

This study is concerned with the main driving forces behind employment and population development in lagging rural areas in Switzerland. One major reason for the interest in employment and population dynamics stems from the currently discussed reform in regional policy. While there is consensus about a shift from top-down to bottom-up development approaches little is known about how to effectively support the latter.

Communities in rural areas vary in terms of their locational characteristics, their economic and demographic structure. Depending on the combination of these features, different development patterns can be observed. It was shown that communities which experienced comparable employment and population decline in the past belong to different socioeconomic development types. The development patterns and socioeconomic development types arise from generic processes about the interaction between a community's economy and its population. These processes were identified by analyzing existing theories from a feedback perspective. They describe the role of production factors in rural development (factor-oriented theories) and the role of actors to bring about endogenous change (actor-oriented theories). The processes were subsequently translated into a dynamic simulation model.

The results from the theoretical analysis and the model simulations lead to a series of findings. Section 9.1 reflects on the policy implications of the model simulations while section 9.2 summarizes the insights gained from applying a feedback perspective. Section 9.3 concludes this chapter by pointing out directions for further research.

9.1 Policy implications

Model simulations confirmed the vulnerable nature of lagging rural communities to national and international market forces. Factor-oriented theories proved to be crucial for understanding general development trends that apply to the aggregated level of a specific type of community.

However, model analyses showed that internal mechanisms also have leverage potential. These processes can only be understood if actors are included in the analysis. Local policy makers and entrepreneurs play an important role in designing and implementing development strategies to counteract exogenous forces. Whether they succeed in their effort or not depends on the specific local conditions and does not hold for the aggregated level of a specific community type anymore. While not all communities show the same behavior, simulations based on actor-oriented theories still identify the basic mechanisms and preconditions for successful design and implementation of development strategies.

The policy implications for lagging rural areas facing a deterioration of socioeconomic conditions differ between factor-oriented and actor-oriented theories. Factor-oriented theories only allow for exit-solutions, i.e. for out-migration as a reaction to a narrow-
ing economic base. Actor-oriented theories, on the other hand, focus more on voice-solutions, i.e. on how actors put pressure on decision-makers to improve local conditions. Voice-solutions in the context of actor-oriented theories refer to both the social and the corporate level.

9.1.1 Principles for regional rural development strategies

The key factor for reaching sustained economic growth and as a consequence of it, employment and population stabilization or growth in particularly vulnerable communities is growth in external demand through investment in export activities. For a successful implementation of this leading development principle, the behavior of the system under different combinations of push- and pull-forces has to be taken into account.

Push-forces refer to the relative competitiveness of a local economy. Push-forces grow when external demand decreases. Pull-forces, on the other hand, refer to the relative attractiveness of a community. If pull-forces are low, the opportunity costs of living and working in this specific community are low. This is illustrated in Figure 9-1 and specified in development principle 1 to 6.

Figure 9-1: Regional rural development strategies under different external conditions

Push high

!!!no overinvestment in capital!!!

Investment in export activities

Endogenous development

Capital investment & Endogenous development

!!!no conservation of economic structures!!!

Pull high
Principle 1: The relative attractiveness of a community is only effective in the short run, especially when the local economy is not competitive.

In the long run, the main determinant of the migration decision is the relative competitiveness of the local economy. If competitiveness remains below the national average, structural adaptations in the course of technical change lead to employment decline. For this reason, export activities have to be expanded. If total demand grows more than productivity, employment decline can be compensated. The investment strategy should consider that small but continuous growth in external demand is more effective to bring about economic growth than a sizeable, one-time increase in external demand. Business development strategies that aim at attracting investor-firms into the region have to account for that. The attraction of big firms leads to a one-time step increase in external demand. This has a considerable employment effect. However, total demand also has to continue to grow in the long run. The repeated attraction of smaller firms can therefore have a bigger effect on sustained economic growth.

Principle 2: In cases of high push- and pull-forces, export activities have to be created as much as possible.

In this situation, the development potential of a community is restrained. Exogenous forces lead to an accelerated downward transition of employment and population in the course of factor productivity growth. The development potential can only be increased by investment in external demand. The internal preconditions for the implementation of export activities are favorable in the sense that the pressure to actively counteract exogenous development trends is very high. A purely endogenous development strategy, however, has little potential as the necessary volume of the new economic activities is very high.

Policy makers have to ensure that the initial increase in external demand is high and that demand continues to grow over several years. Once this strategy leads to the desired take off in economic development, external intervention can be reduced. Monitoring economic development nevertheless remains an important issue also after this withdrawal because employment and especially population react with a delay of several years to the developments in the local economy. Employment equilibrium in the short run does not necessarily mean that the forces leading to employment decline in the long run have lost their strength. Stopping investment in export activities too early would therefore only delay job loss and further employment decline would hamper a successful transition towards economic growth.

Capital investment strategies, on the other hand, are particularly dangerous. Overinvestment in the capital stock can lead to a near collapse of the entire socioeconomic system in the long run. With a rising capital stock as a consequence of capital investment activities, the costs for maintaining the capital stock rise accordingly. When the local economy stagnates, it is very difficult to generate the revenue necessary to cover these costs. This adds to the already existing pressure on the local economy and accelerates employment and population decline.
Principle 3: In a situation where the local economy is relatively competitive but the community is relatively unattractive, moderate capital investment strategies have high leverage.

If no activities are undertaken to counteract the effect of high pull-forces, it is difficult to attract newcomers or keep potential out-commuters as residents in the community. Capital investment strategies can improve the local goods and service provision and thus raise the attractiveness of the community as a place to work and live.

The effectiveness of the strategy can be improved if it is coupled with endogenous development. The successful design and implementation of collaborative efforts not only improves the attractiveness of the community. It also leads to a favorable innovation climate. This is an important precondition for sustained endogenous economic growth.

Principle 4: With low push- and pull-forces, there is a high potential for employment and population growth.

Under these circumstances, it is possible that employment and population grow in the course of productivity growth and that the community shifts from a lagging to leading region. However, attention has to be paid to the long term development perspective. Investments in export activities are problematic once employment and population decline sets in. Because of the delayed reactions in employment and population an export-oriented strategy only has a visible effect after a few years. During this period, population continues to decline so that the necessary growth in external demand becomes even higher.

In a situation of favorable external conditions, a combined development strategy is most promising. Strengthening endogenous economic activities leads to sustained employment growth and builds a success tradition of collaborative projects between internal and external actors. Such a success tradition lessens the effect of a sociopolitical process that limits sustained endogenous growth. This process favors initiatives when pressure is high. Once economic conditions improve other goals become more important to the individual actors and the diversity of socioeconomic interests hampers further collaborative efforts.

Principle 5: As long as the local economy is relatively competitive, it is crucial to continuously adjust economic structures.

Conserving economic structures continuously builds a pressure to adjust the structures within a very short time frame. As a consequence of the structural disruption and the high adaptation costs, the local economy loses its competitiveness on the national market. Once competitiveness sinks below the national average, demand does not grow enough to compensate the job loss in the course of technical progress. The growth tendency of the local economy reverses and turns into a state where productivity growth leads to employment and population decline.
Principle 6: Effective regional rural development strategies have to be differentiated for different community types

Development strategies in agrarian communities are of special delicacy. Diversifying the local economy implies substantial expansion of export activities in the manufacturing sector and in the private services. Long-term support of these activities is equally necessary as careful monitoring because economic development in agrarian communities is particularly sensitive to changes in external demand.

Accompanying agrarian communities in this process implies that a transformation of the economic character of these communities occurs. In the course of a combined export and capital investment strategy, agrarian communities develop into either rural communities with strong manufacturing and industry or into tourist communities.

Development strategies for residential communities have to weigh different sources of dependencies. Population growth either entails increasing dependency on the regional labor market or on the development of external demand for local goods and services. The decision affects the future socioeconomic character of the community and entails a social decision making progress.

9.1.2 Implications for the new regional policy paradigm

External demand is the main driving force behind regional rural development strategies that are based on local economic activities. Demand results from willingness to pay and from preferences. External demand is influenced by policies on the national as well as on the local level.

- An important determinant of external demand on the national level is the purchasing power of the national population. The purchasing power can be influenced to some degree by economic policy.
- International trade-related negotiations such as the negotiations with the European Community or the World Trade Organization determine the export potential for national and therefore also for regionally produced goods.
- The exchange rate controls the purchasing power of international stakeholders. In the context of this study, the purchasing power of tourists is of special significance.
- In order to meet the preferences of external stakeholders, communities and regions have to produce goods that are unique and exhibit high income elasticity of demand. Unique goods arise from the assignment of values to regional resources. These goods have to be supplied following the development principles described above.

Effective regional policy strategies have to address these leverage points. New regional policy emphasizes especially the local and regional level. It is therefore important that integrative development policies account for the spatial implications of economic policy, international negotiations and monetary policy.
Conclusions

New regional policy focuses on entrepreneurship, innovation and competitiveness of regions. In order to reach maximum effectiveness in particularly vulnerable areas, it has to account for two aspects.

(1) Decision makers have to ensure that the volume of the projects generated by the regions is sufficiently high. Small projects which are unable to significantly raise external demand have little effect on local employment and therefore cannot contribute to a reduction of socioeconomic disparities between regions.

(2) Endogenously developed projects need sufficient external support over a sufficiently long period of time. Supporting projects only at an initial stage leads to a high risk of failure of the project. Failures, however, negatively affect the willingness to engage in future endogenous activities so that a community or region gets locked-in in a situation where unfavourable development perspectives and adverse innovation climate keep employment and population development at low performance.

9.1.3 Implications for the maintenance of a decentralized settlement of the country

By following the principles for regional rural development strategies and the implications for the new regional policy paradigm communities and regions have the potential to succeed in maintaining their economic and demographic base. However, the necessary growth in external demand is too high for such a strategy to be successful in all regions. Similar to the findings in ARE (2004), this study emphasizes the need for alternative development strategies for lagging rural areas.

(1) Stabilizing employment and population in all particularly vulnerable communities through local economic activities is not possible without very high public support. The necessary support is so high that it is unlikely that every community be maintained.

(2) Where locational characteristics allow commuting, local economic activities have to be combined with attracting newcomers who work in other communities and especially in regional centres. This implies strengthening regional centres to create and maintain employment possibilities while at the same time raising the attractiveness of the surrounding rural areas as residential places. However, a development strategy based exclusively on commuting and thus on increased mobility entails considerable ecological problems.

(3) Development strategies for particularly vulnerable communities and for lagging rural areas have to be coupled to development strategies for regional centres. Only if the rural areas surrounding regional centres become an important asset for the development of these centres can rural areas be stabilized.
9.2 Conclusions from applying a feedback perspective

Employment and population development in lagging rural areas is dominated by the positive feedback loop reinforcement population – production. This loop describes how an increase in population stimulates local demand and thus local production. All else equal, the additional labor used for generating desired production adds to population by means of in-migration. In particularly vulnerable communities, this feedback loop works in a downward direction, i.e. less population leads to less labor demand and thus to even less population. The model simulations showed that this loop is dominant in a majority of system states and that it is very difficult to shift its direction. The shift in loop direction can be brought about by several endogenous processes and exogenous forces that vary between the different community types (see section 9.1).

A second case of feedback loop dominance occurs in the ‘implementation dynamics’ sector. One reinforcing and one balancing feedback loop control the evolution of entrepreneurship and local initiatives as a development strategy. Model analysis showed that the defining feature for the success of such a strategy is that the positive feedback loop reinforcement commitment – success shifts direction, changing from a vicious cycle that works against the effort to a virtuous cycle that supports it. Simulation experiments also highlighted the interactions with other features of the system that are required for this shift to occur. This specifically concerns encouragement from upper administrative levels or other external actors to support local actors in their developing routines. An important source of policy failure in this context is underinvestment in management skills and entrepreneurial capacity so that the shift in loop dominance cannot be brought about.

Identifying feedback loop dominance and shifts in loop dominance proved to be crucial for understanding employment and population dynamics in lagging rural areas and for uncovering additional sources of policy failure. Economic growth is driven by technical progress and the resulting improvement in productivity. In situations where a local economy is relatively less competitive than the surrounding economies, growth in factor productivity leads to a better-before-worse development. The initial moderate increase in employment and population is followed by a distinct transition phase with employment and population decline which stabilizes only in the long run. Capital provision strategies reinforce this behavior pattern if investments in the capital stock are not followed by massive investment in an adequate increase in external demand.

The initial overshoot in the better-before-worse behavior is caused by different adjustment times. When factor productivity grows, demand adjusts faster to changes in the supply-demand ratio than production and leads to the initial expansion of production, employment and population. Different adjustment times also lead to a substitution of labor for capital in the course of productivity growth which is caused by the delay in the adjustment of capital and not by a difference in factor costs.
Thus, the contributions of applying a feedback perspective to the issue of employment and population development in lagging rural areas are:

1. An understanding of the effect of different adjustment times on system behavior and system stability,
2. The identification of better-before-worse behavior and
3. An alternative explication of policy failure by applying the concept of feedback loop dominance and shifts in loop dominance.

9.3 Implications for further research

This study synthesized a theoretical framework describing the dynamics of population and employment development in lagging rural regions. On this basis, it developed a formal simulation model that allowed the detailed analysis of the dynamic behaviors created by the structures common to the relevant theory. The focus was on endogenous processes, i.e. on the internal mechanisms within a particularly vulnerable community. In addition, the vulnerability of these small economies to exogenous forces and trade-shocks was analyzed. On this basis, the crucial influencing factors on employment and population development could be identified and the effectiveness of the new regional policy paradigm could be evaluated. A key factor in the development of particularly vulnerable communities was found to be its competitiveness relative to surrounding economies. Model simulations also highlighted the existence of a tipping point above which a community grows in the course of productivity growth. This tipping point determines the leading or lagging character of a community.

In addition to the policy implications described in section 9.1, simulating employment and population dynamics from a feedback perspective highlighted directions for further research. These directions mainly arise from extending the focus of this study on related issues.

9.3.1 Further research for theory

The focus of the study was to synthesize existing theories into an integrative framework and to elicit the dynamic implications of the structures described in the theories. This approach enabled the identification of generic development patterns in the different community types and policies to compensate the effect of productivity growth and employment decline. Differences in the development trajectories between individual communities of the same community type arise, among others, from the specific sociopolitical characteristics of a community. For the analysis of the decision making process in the ‘initiatives’ and ‘implementation dynamics’ sectors, the forces affecting the decision to engage in an initiative were implicitly assigned the same weights. The same applies to the forces affecting the generation of commitment for an initiative. These forces are a combination of commitment from success and commitment from
Conclusions

motivation. However, the same population pressure does not necessarily result in the same perceived pressure in two communities. The same success history can also have different impacts on the extent to which actors are willing to engage in new activities. Similarly, the economic and social interests in a community can be so diverse that success hardly affects commitment at all. A more thorough dynamic understanding of the sociopolitical processes within a community would therefore enhance the predictive and prescriptive capability of the simulation model in the realm of non-employment related aspects of migration decisions and for the application in specific communities.

9.3.2 Further research for modeling

The interactions between leading and lagging regions and between several lagging regions could be analyzed in detail by a spatial interaction model. Nijkamp and Poot (1998), for example, reflect on how spatial interdependencies in the form of trade, factor mobility and innovation diffusion in new models of economic growth influence technical progress and growth. The theoretical analysis leads to the insight that the dynamic impact of spatial interdependence depends on the specification of the model. Spatial convergence, a steady state with persisting spatial differences in growth rates and unstable growth are all theoretically possible. Spatial interaction models are also applied in New Economic Geography (see Fujita et al. 1999). Bretschger (1999), on the other hand, analyzes how free trade in goods affects the development of regions in the context of interregional knowledge diffusion and total factor productivity.

The tipping point identified in this study suggests that the interaction between a community's population and economy can lead to population decline in the course of growth in factor productivity. Neither of the theories underlying the spatial interaction models explicitly incorporates population. Further research in the modeling domain would therefore have to focus on an integration of spatial interaction models and the model developed in this study.

9.3.3 Further research for policy

Decision making in regional economic development is a multi-faceted process which involves economic, social and political issues. The current political discussion about the new regional policy paradigm shows that different stakeholders evaluate the outcome of regional rural development in a fundamentally different way. This study provided decision support by identifying the most important processes and determinants of regional rural development and by highlighting the interactions between the different aspects of development. In the course of scenario and policy analysis, a series of development strategies was tested.

As an introduction see for example issue 2, volume 76 of the journal "Die Volkswirtschaft" which focuses on the new regional policy in Switzerland.
As economic development planning and implementation processes also involve political judgments, the findings from the model simulations have to be combined with a multi-objective decision making device for final applications in public policy. There are several analytical tools to help decision makers formulate development policies. The Analytical Hierarchy Process (AHP) integrates the outcomes of quantitative analytical studies with qualitative, situation specific social and political factors and thus produces a policy relevant decision framework.\(^2\) DINÇ ET AL. (2003) describe the application of AHP in the context of regional economic development planning. AHP, in their study, builds on a combined set of models to prioritize sectoral support policies.

Further research in the policy domain would therefore consist in adding a multi-objective decision making device to the results generated by this study. This is especially important because the political concept of 'maintenance of a decentralized settlement of the country' remains unclear. There exists neither an accepted definition of the term decentralized settlement nor a normative statement about the desired extent of decentralization. At the same time, the discussion about the maintenance of a decentralized settlement of the country was one of the main issues that motivated this study.

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### 10.1 Statistical data


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Appendix 1: Nonlinear functions

Appendix 1 documents the nonlinear functions in the simulation model. The shape of the functions reflects the assumptions about the nonlinear relationships between two variables. Changes in the input variable (x-axis) induce the nonlinear changes in the output variable (y-axis). The most important features of the nonlinear functions are the shape of the graph as well as the maximum and minimum value of the output variable. The assumptions underlying the shape of the function were described in chapter 6. An example of how to interpret a nonlinear function was given on page 109.

Appendix 1.1: Nonlinear functions in the model sector ‘product market’ (pages 96ff)

Appendix 1.2: Nonlinear functions in the model sector ‘factor market’ (pages 101ff)
Appendix 1.3: Nonlinear functions in the model sector ‘population’ (pages 96ff)

- First diagram: Effect of perceived labor supply to demand condition on migration.
- Second diagram: Effect of perceived labor supply to demand condition on emigration.
- Third diagram: Effect of population density on immigration.
Appendix 1.4: Nonlinear functions in the model sector ‘initiatives’ (pages 96ff)
Appendix 1.5: Nonlinear functions in the model sector 'implementation dynamics' (pages 96ff)
Appendix

Diagram showing the effect of success on commitment as a function of success condition.
Appendix 2: Curriculum Vitae

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