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Processes and determinants of rural development in Switzerland

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Abstract

In many countries, lagging rural areas face the challenge of adaptation and structural adjustment to changing economic and social conditions. In peripheral micro-regions 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. Instead of distributive measures aimed at attenuating regional socio-economic disparities, emphasis is given to the competitiveness of rural localities and to local initiatives. This implies an increasing need for policy concepts and analyses based on an integrated view of the processes and actors affecting rural development.

The paper focuses on the local dimension of employment and population dynamics in rural Switzerland and on an ex-ante analysis of development perspectives. The simulation model developed for this purpose is based on the literature in regional economics and rural studies and combined with insights from related fields such as urban dynamics and innovation management. Preliminary model analysis emphasizes the need for national and regional policy concepts that focus on the support of local actors to bring about new development routines.

1 Introduction

In the process of the ongoing economic structural change as well as of social and political changes rural Switzerland faces a differentiation in economic and social conditions. Those locations confronted with a lagging development see their viability become at risk. Population decline and a narrowing economic base not only affect future development perspectives, they also put under threat the fulfillment of the national goal of a decentralized settlement of the country. Coupled to a decentralized settlement is the provision of a series of public goods such as socio-cultural diversity and the maintenance of a cultivated landscape (ERRINGTON 1997: 207-211).

The mosaic of rural regions with winners, in-betweens, and losers raises the question about driving forces behind this pattern. This question has often been posted in the economic literature on the driving factors behind economic performance of countries or regions. In regional economics, for example, the causal interrelationship of forces leading to changes in population numbers, migration and regional income have become examined more intensely (ISARD ET AL. 1998: 3).

Insight into the driving factors behind economic performance of rural regions is not only scientifically of interest, but it is also relevant from a public policy point of view. Swiss regional policy is currently undergoing fundamental changes. Instead of distributive measures aimed at attenuating regional socio-economic disparities, emphasis is given to the competitiveness of rural localities and to local initiatives (see EVD 2004). In structural policy terms this reform is a shift from policies concerned with the maintenance of economic structures toward policies that help to actively adapt structures to changes in economic conditions (see PETERS 1996). Such policies affect actors in different ways. Their conflicting interests are important determinants of the success of any policy.

Two important aspects concerning employment and population decline in lagging rural areas should therefore be considered. On the one hand, these locations are small economies that depend heavily on the economic and political development on the national and international level. It is reasonable to assume that these developments will put more pressure on lagging rural areas in the future. On the other hand and at the same time, development strategies focus more and more on entrepreneurship and innovation capacity in these locations to boost the competitiveness of the local economy. It is equally reasonable to assume, however, that entrepreneurship and innovation capacity of a municipality's population decrease as a consequence of employment decline and out-migration.

The literature suggests that the factors behind the different economic performance of rural regions are related to an interplay of local and global forces, in which territorial, population and globalization processes are thought to be the main determinants (TERLUIN 2003). Rural development therefore emerges from an interaction of effects produced by global forces and local responses. The discussion, however, does not provide a sufficient answer concerning the dynamic nature of this interaction.

The purpose of this paper is therefore to develop an integrated dynamic theory of employment and population development in lagging rural locations in Switzerland. The theory ex-

plicitly takes into account socio-political processes affecting the development of local competitiveness. Based on the observed processes in lagging rural areas (section2) and building on the existing literature we synthesize a model describing the dynamics of employment and population development in section 3. We then translate this framework into a simulation model (section 4). The formal model allows the detailed analysis of the dynamic behavior created by the structures common to the relevant theory (section 5). Implications for the design of effective regional policy measures from model formulation and analysis are described in section 6.

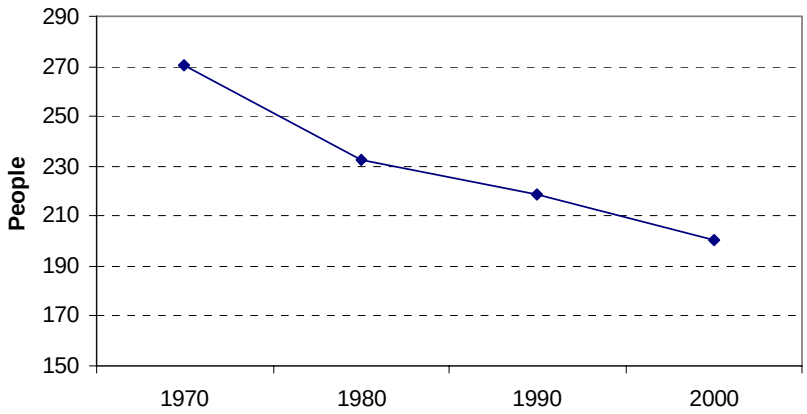
2 Processes in lagging rural areas in Switzerland

The aim of this section is to analyze the main socio-economic trends in lagging rural areas in Switzerland. It serves as a general introduction to the opportunities and threats faced by rural regions and lays the ground for model development in subsequent sections.

There are many ways to define rurality, ranging from spatial classifications to social representations (TERLUIN 2001: 21). For the purpose of this paper, lagging rural areas are defined as areas that have either experienced population decline in the past or that are threatened by it in the near future because the development of their 20 to 64 years old population shows exponential or linear decline (see BUCHLI ET AL. 2004). The level of analysis is the local level and denotes municipalities of an average size of some 250 inhabitants. Of the nearly 3'000 municipalities in Switzerland, almost 10% fall into the category of lagging rural areas according to this definition.

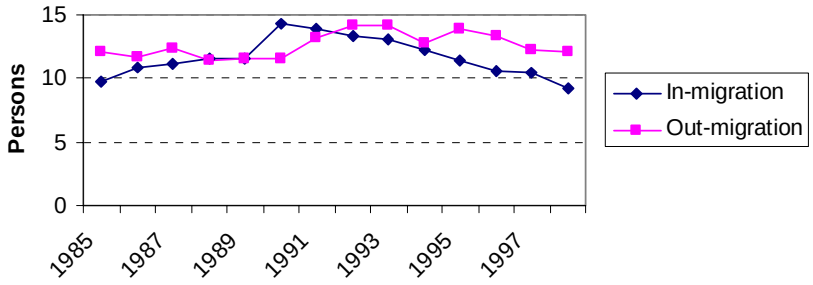
Figure 1 to Figure 5 show some reference modes. The values in the graphs are the average value of the lagging municipalities and show the typical behavior of these entities in the past. The main symptom of the problems in lagging rural areas is population development (Figure 1). Figure 2 and Figure 3 sketch the direct determinants of population, migration, births and deaths.

Figure 1: Long term population development



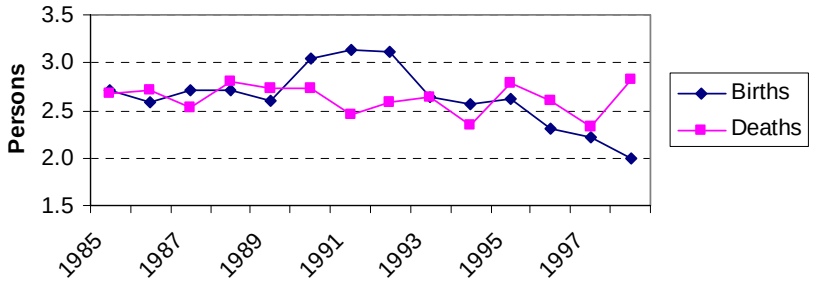
Source: Bundesamt für Statistik, Volkszählung 1970-2000

Figure 2: Development of in-migration and out-migration



Source: Bundesamt für Statistik, Bilanz der ständigen Wohnbevölkerung 1985-2000

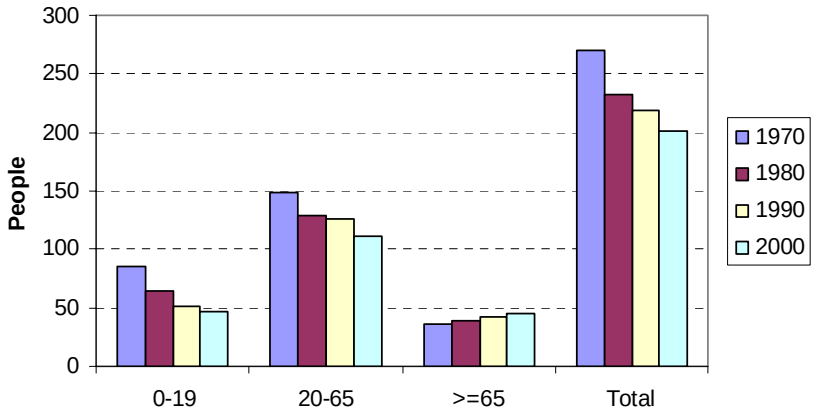
Figure 3: Development of births and deaths



Source: Bundesamt für Statistik, Bilanz der ständigen Wohnbevölkerung 1985-2000

While the trend in births and deaths is less clear, in-migration has steadily fallen below the rate of out-migration since the beginning of the 1990s. The overall population decline has affected age cohorts differently. Figure 4 shows that while the number of younger people (0-65) has fallen, there has been a slight increase in the retired population.

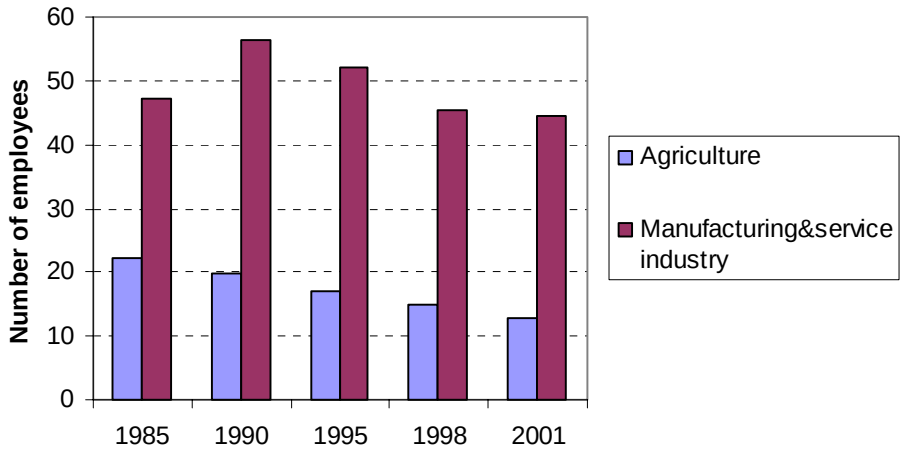
Figure 4: Population development – age cohorts



Source: Bundesamt für Statistik, Volkszählung 1970-2000

One important determinant of migration is the number of available jobs. Figure 5 shows the development of jobs in the primary sector and jobs in the secondary and tertiary sector. Whereas employment in agriculture has declined steadily, employment in the manufacturing and service industry reached a maximum at the beginning of the 1990s and has since decreased, too.

Figure 5: Development of employment in different economic sectors



Source: Bundesamt für Statistik, Eidgenössische Betriebszählung, Strukturerhebung Landwirtschaft

3 Conceptual framework on employment and population dynamics in lagging rural areas

Theories that conceptualize the driving forces behind economic development in rural regions of advanced 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: 328).

The large number of theories in the regional economics debate all focus on explaining the growth of a region's output. They do so by including different factors in the production function describing a region's output. Theories in rural studies are concerned with the more organizational aspects of the rural economy. TERLUIN (2003) elaborated a systematic framework for the comparison of these theories and subsequently analyzed in an international, empirical study which theories are supported by empirical evidence in rural regions (see also TERLUIN AND POST 2000). Theories that are capable of explaining employment and population development in the past relate economic development – given the availability of labor and capital – to a high capacity of local actors and strong internal and external networks. Their implicit dynamic properties are analyzed in this section.

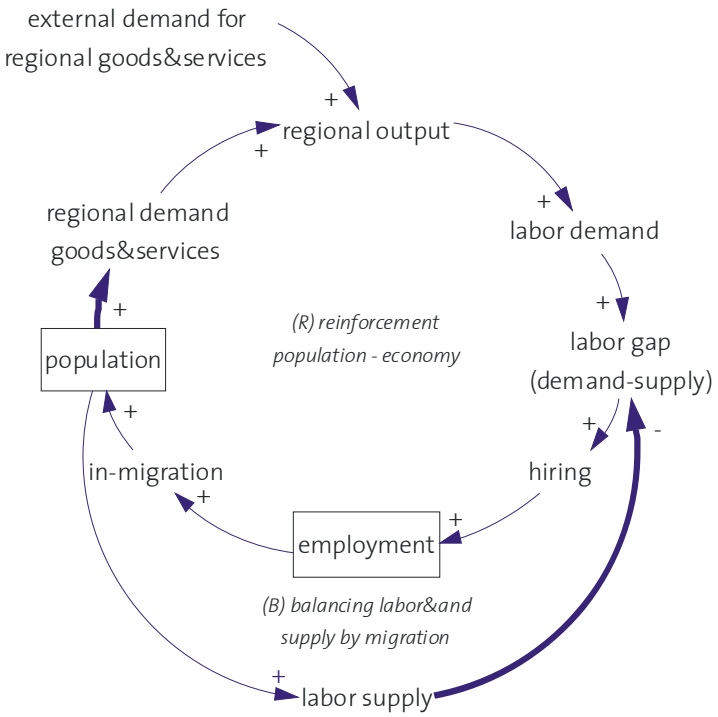
3.1 Basic mechanisms of a regional economy

The key notion of theories on economic development is the growth of a region's output (ARMSTRONG AND TAYLOR 2000: 1). While economic growth clearly cannot be equaled to development it is nevertheless an important component of it.

Rural development policy is not only concerned with an increase in output but with providing employment opportunities as well. The relation between output and employment in a region can be captured by the demand for labor necessary to produce the output. The output of a region's economy is itself determined by the region's own demand for goods and services and the demand from other regions. Employment growth leads to in-migration, thus adding more population and labor supply to the region. These linkages are displayed in Figure 6. For further explanations of this basic scheme of the regional economy see ARMSTRONG AND TAYLOR (2000).

In order to distill the dynamic processes that cause population, the product market, and the labor market to co-evolve over time we add the two bold links to the diagram in Figure 6. The first relates population to the local demand for goods and services thus creating the positive feedback loop *reinforcement population – economy*. It represents the logic contained in regional multiplier analysis (e.g. ARMSTRONG AND TAYLOR 2000: 18-20). The second link connects labor supply to employment via the labor gap. It states that an increase in labor supply due to an increase in population closes the gap between necessary and available labor for the production of the region's output. As a result, it depicts the negative feedback loop *balancing labor supply and demand by migration*.

Figure 6: Basic scheme of the regional economy



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 positive feedback loop *reinforcement population – economy*. 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 in a success to the successful archetype (see MYRDAL 1957).

The existence of this loop is supported by the literature on new growth theory (for an overview, see NIJKAMP AND POOT 1998) and new economic geography (KRUGMAN 1995, FUJITA ET AL. 1999). At the core of these theories is the notion of increasing returns to economic activities in a region that set the positive feedback loop *reinforcement population – economy* into motion.

New growth theory also emphasizes the importance of innovation in economic growth. Innovations can act as a development impulse and provide the region with a competitive edge. They are therefore able to shift loop direction in the *reinforcement population – economy* loop. This aspect is further explored in the next section.

3.2 Dynamics of initiatives

Since the works of SCHUMPETER (1934), innovation has been considered as one of the most important drivers behind economic growth. 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).

There is, however, also a policy resistance aspect involved in the innovation process. On the one hand, innovations, in addition to their beneficial effect on competitiveness, also imply difficult sectoral, social and regional restructuring (MAIER AND TÖDTLING 1996: 120). On the other hand, the production of technological change via innovation is characterized by strong external effects (MAIER AND TÖDTLING 1996: 103). These two aspects taken together lower the incentives for firms to innovate.

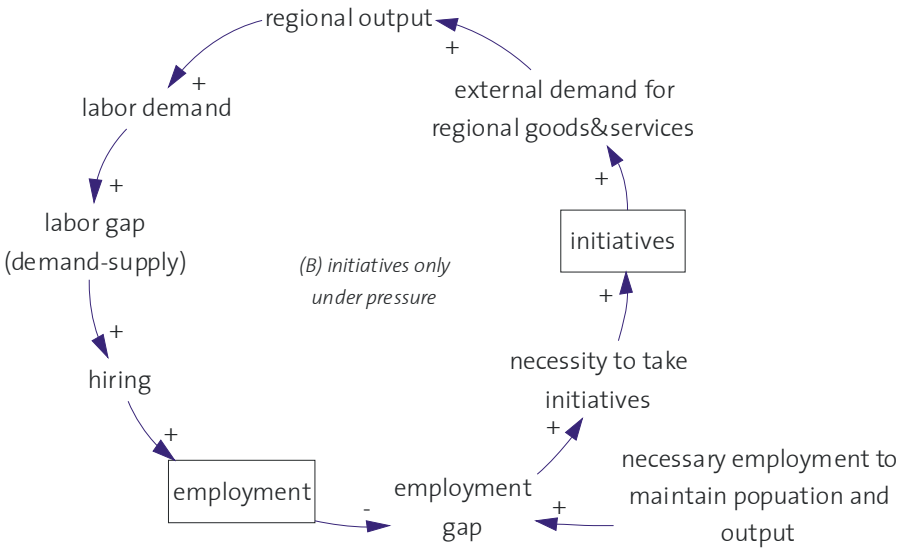
Given the volume and density of economic activities in lagging regions, it seems more appropriate to focus on innovation imitation and adoption, and the exploitation of market niches. There are neither clusters of firms in lagging rural areas nor sufficient infrastructure such as universities to enable the existence of big companies with research and development departments so that the region's firms could offensively engage in innovation activities (e.g. MAIER AND TÖDTLING 1996: 142).

While rural regions clearly cannot catch up rapidly in the production of new technologies, they can and must catch up rapidly in the utilization of these technologies (CAMAGNI 1992: 15). For this purpose we use the term of taking initiatives with which we characterize the process of deciding to adopt an existing innovation and implement it in the region under consideration by blending the best technologies with traditional and local organization practices. Ini-

tiatives in this sense encompass a series of activities designed to improve employment conditions in the region.

The feedback loop depicted in Figure 7 reflects the two aspects concerning initiatives discussed in this section. The stock initiatives accounts for the potential of initiatives to trigger the reinforcement population – economy loop from Figure 6. The balancing feedback loop *initiatives only under pressure* represents the policy resistance aspect involved in the innovation process. It takes its legitimization from the microeconomic concept of public goods which states that public goods are only provided if the marginal benefit for the individual exceeds the marginal costs (e.g. VARIAN 1993: 583). Creating employment opportunities to maintain population and regional output has a public good character. Actor goups are therefore more likely to take the initiative if the pressure is so high (i.e. the employment gap so big) that new employment opportunities, created to meet the external demand for regional goods and services, will benefit them directly.

Figure 7: Initiatives as a trigger of economic growth

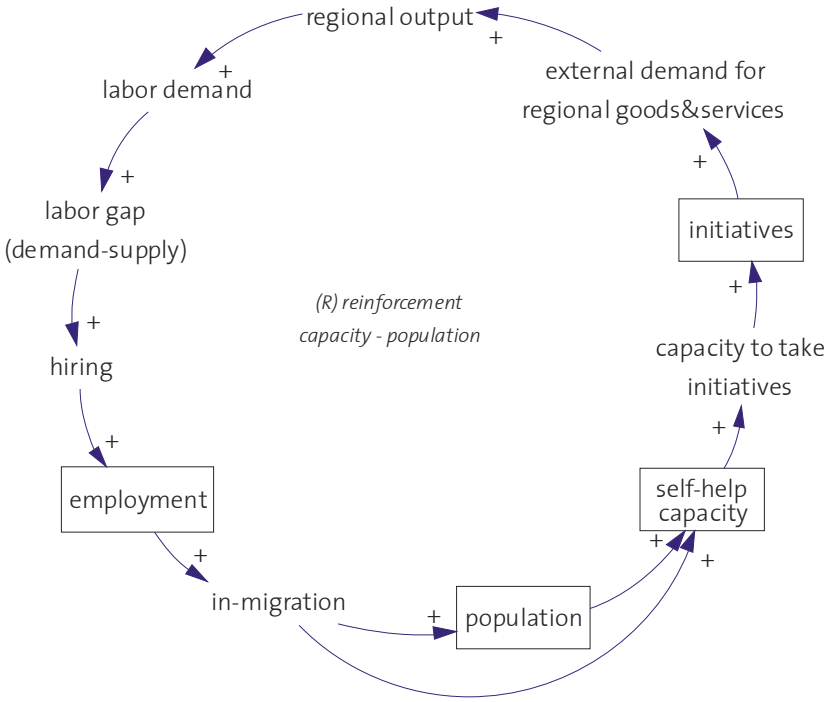


3.3 Self-help capacity linking population, economy and initiatives

Innovation is generated by entrepreneurs and induces a process of economic growth (NIJKAMP 2003: 396). Whether the necessity to take initiatives in Figure 7 really leads to more initiatives depends on a series of additional factors in the local milieu. Skills of the labor force, technical and organizational know-how, and social and institutional structures affect the revenues from the input of labor and the diffusion of innovation. The factors that were identified to be significant in this context (TERLUIN 2003: 341) are all related to networks. An active role of local actors in internal and external networks seems to increase the self-help capacity of municipalities and to stimulate employment growth. Initiatives arise mainly from leaders in these networks, leaders being newcomers, the young population, political decision makers, or entrepreneurs (TERLUIN AND POST 2000: 186).

Figure 8 captures these ideas by relating the self-help capacity of a municipality to its population. Self-help capacity itself enables actors to take initiatives. The capacity then determines whether the necessity to take initiatives in Figure 7 can be translated into actual initiatives. The existence of this link establishes the reinforcing positive loop *reinforcement capacity – population*. Self-help capacity is fed by two factors. The link coming from in-migration captures the role of newcomers as potential leaders. It also contains the notion of newcomers' involvement in external networks. The link from population to self-help capacity accounts for the role of the younger population as potential leaders. An increasing number of people in a municipality not only raises the average level of know-how and skills (see BRETSCHGER 1999 for the role of knowledge diffusion in the development of regions), it also implies a higher variety of both internal and external networks.

Figure 8: Self-help capacity and initiatives



With the introduction of self-help capacity that links population, initiatives and employment the model describes a dynamic hypothesis about employment and population dynamics in lagging rural areas that encompasses the feedback loops displayed in Figure 6 to Figure 8.

4 Analytical framework on employment and population dynamics in lagging rural areas

In this section, the dynamic hypothesis is translated into a quantitative simulation model. The purpose of the model is to

- Trace the basic processes that influence employment and population development.
- Analyze the socio-political processes affecting the development of local competitiveness.
- Assess the impact of future development trends and policy measures on employment and population.

The modeling effort is concerned with theory building in the first place. The model is, however, also used for communication with key decision makers in regional rural policy. The time horizon covers a period of twenty years into the past and 50 years into the future. 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 values for the parameters and lookup functions in the model are based on different statistical databases obtained from the Swiss Federal Statistical Office and on expert knowledge about regional rural development.

Model formulation follows the same logic as the development of the conceptual framework in section 3. The following sections focus on the formulation of the quantitative model. In order to capture the dynamic complexity implicitly stated in the regional economics and rural studies literature, generic structures from related disciplines have to be added to the analysis. Model equations are listed in the appendix.

4.1 Basic mechanisms of a regional economy

The basic mechanisms of a regional economy follow the same rules in rural and urban areas. Their formulation is therefore related to existing work on urban dynamics (e.g. FORRESTER 1969, ALFELD AND GRAHAM 1976). With respect to the problem under study the following points deserve attention:

- In order to analyze to which extent the decline in agriculture is paralleled by non-agricultural employment growth, we distinguish two employment stocks.
- Population is also 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.

Figure 9: Basic scheme of the regional economy in stock-flow forma

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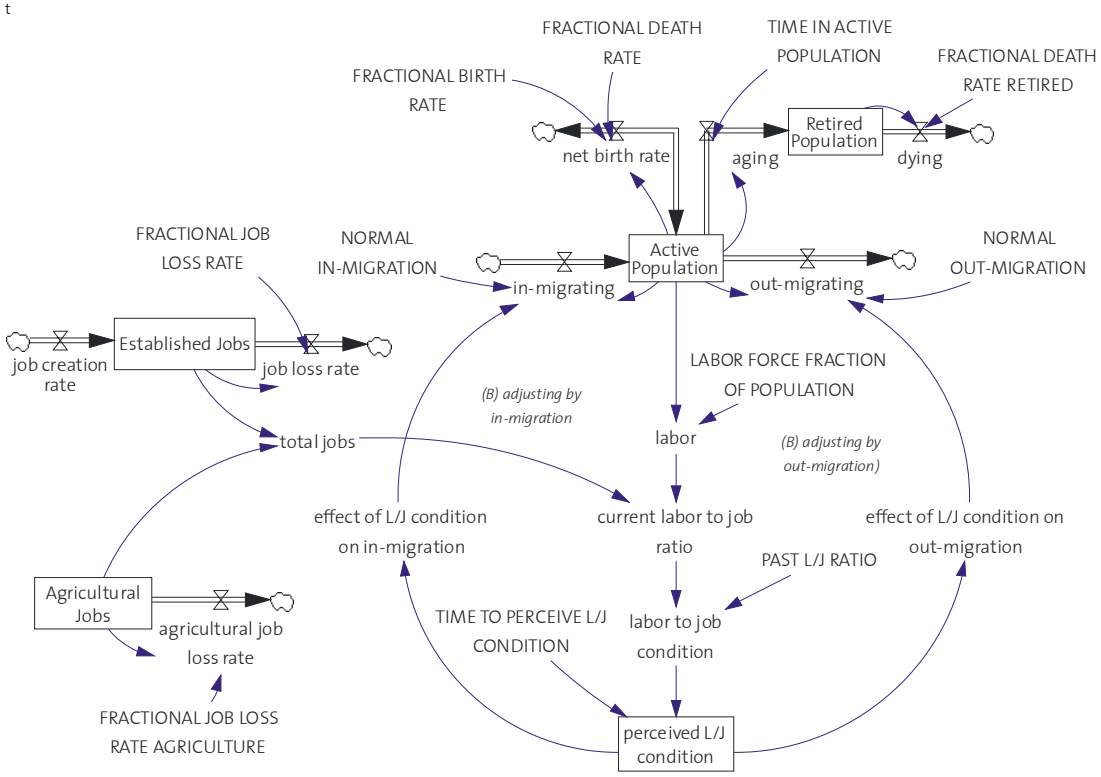
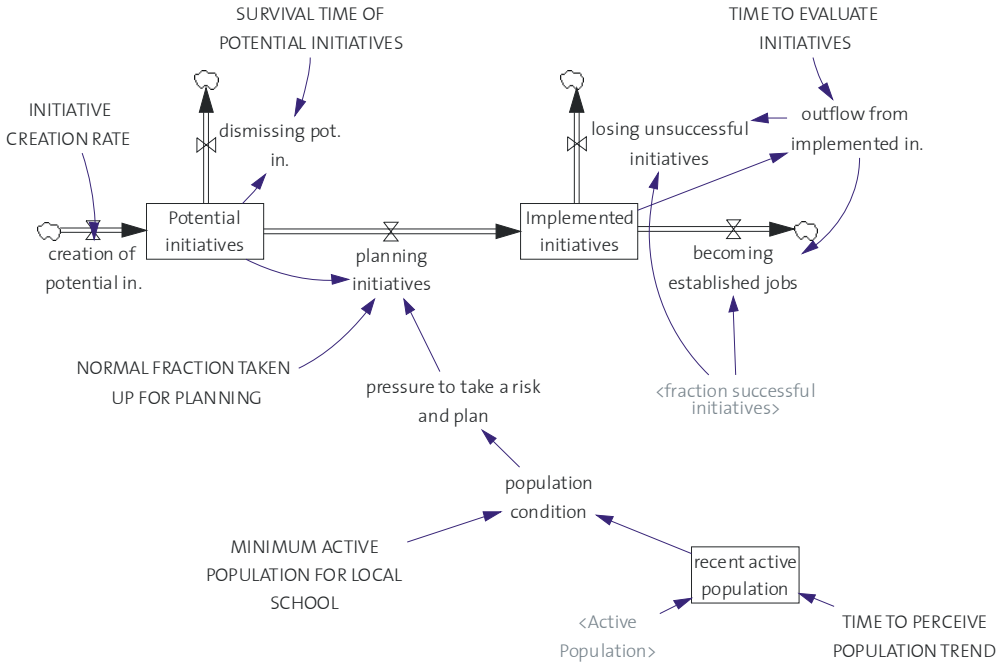


4.2 Dynamics of initiatives

The literature on the dynamics of innovation is abundant (e.g. ABRAHAMSON AND ROSENKOPF 1997, MILLING 2002, STERMAN 2000). It differentiates between several stages in the innovation process. For the purpose of this paper that is concerned with how and under which circumstances actors in a municipality start an employment-related initiative, two stages are distinguished (see Figure 10). Different socio-political processes influence the decision whether an initiative moves one stage further ahead or is dismissed.

Push- and pull-factors determine whether a potential initiative is taken up for planning (normal fraction; pressure to plan resulting from population development). The success of an initiative depends on the commitment of the actors involved in the initiative and on the support these actors experience. How these processes relate with each other is investigated in section 4.3.

Figure 10: Dynamics of initiatives in stock-flow format



4.3 Self-help capacity linking population, economy and initiatives

Self-help 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 (TERLUIN 2003: 335). It determines whether the growth-generating effects of initiatives can be developed or whether they are inhibited by unfavorable combinations of socio-political processes.

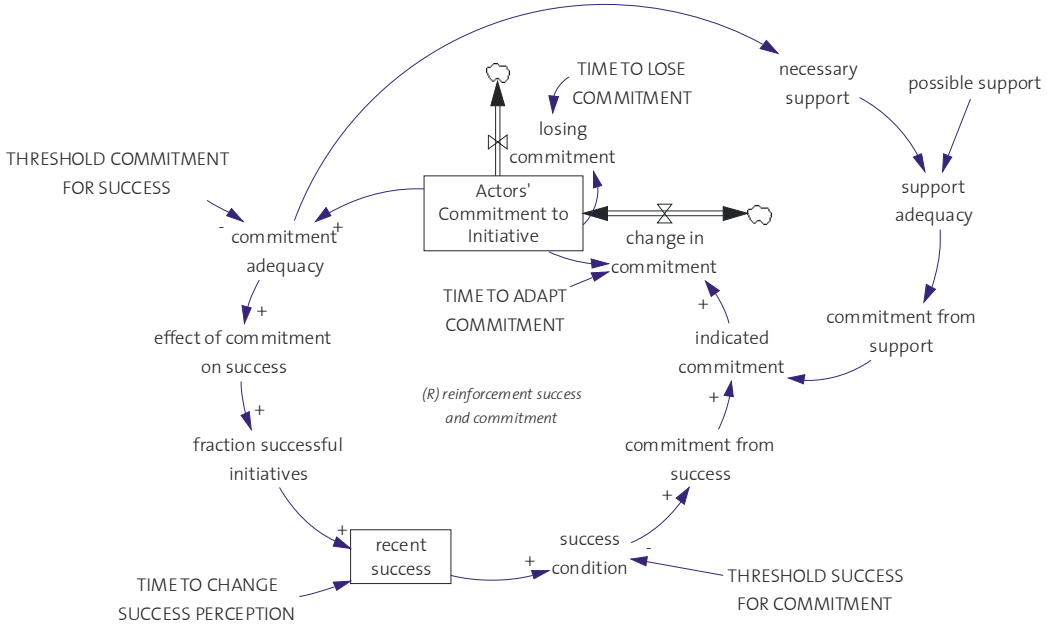
The formulations for this part of the model are based on the literature about innovation implementation (see REPENNING 2002). The key concept in innovation implementation is the commitment of the involved actors. This commitment is part of a reinforcing feedback loop (*reinforcement success and commitment*) containing the success resulting from commitment and feeding back into commitment. It is also part of a balancing feedback loop (*commitment through motivation*) that determines the direction of the reinforcing loop. The idea of the balancing loop is that the gap in commitment is closed by entrepreneurs' effort to motivate actors. These ideas are sketched in Figure 11.

Repenning's paper refers to the situation in private enterprises. The logic described there consequently has to be adapted to local economies as a whole, especially to the fact that there are no such actors as a company's managers that have the competence to induce the necessary commitment. We therefore add a decision structure that determines whether the necessary effort to motivate can at all be made by the entrepreneurs, given their capacity to inspire and mobilize (possible support or support adequacy, respectively). Possible support arises from entrepreneurial capacity. It is determined by a variety of factors and can be encouraged by structural changes in industrial composition and organization, shifts in the labor

market, or socio-demographic changes (BAUMOL 1990). These are all related to the population development with its consequences for the average skills and networks of entrepreneurs.

In addition to Repenning's paper, a drain on commitment is added. The drain reflects the fact that commitment has a limited half-life and needs constant and active renewal.

Figure 11: Self-help capacity and initiatives in stock-flow format



5 Model analysis

Model analysis is divided in two parts. Section 5.1 analyzes model sectors initialized to equilibrium and their reactions to step inputs. Section 5.2 sets the agenda for backcasting and forecasting experiments.

5.1 Model sectors initialized to equilibrium

The main symptoms of the problems in lagging rural areas are population and employment. Figure 12 and Figure 13 show the reactions of these two variables to parameter changes. The parameters varied for the simulations refer to the main influencing factors of population and employment development. Changes in in-migration, job loss rate, initiative creation rate and the fraction of initiatives taken up for planning are analyzed. The simulations apply to the two model sectors basic mechanisms of a regional economy and dynamics of initiatives. The dynamics of the self-help capacity sector are not integrated in these analyses but are investigated separately in Figure 14 and Figure 15.

Figure 12: Reaction of active population to changes in basic mechanisms in the economy and to changes in the dynamics of initiatives

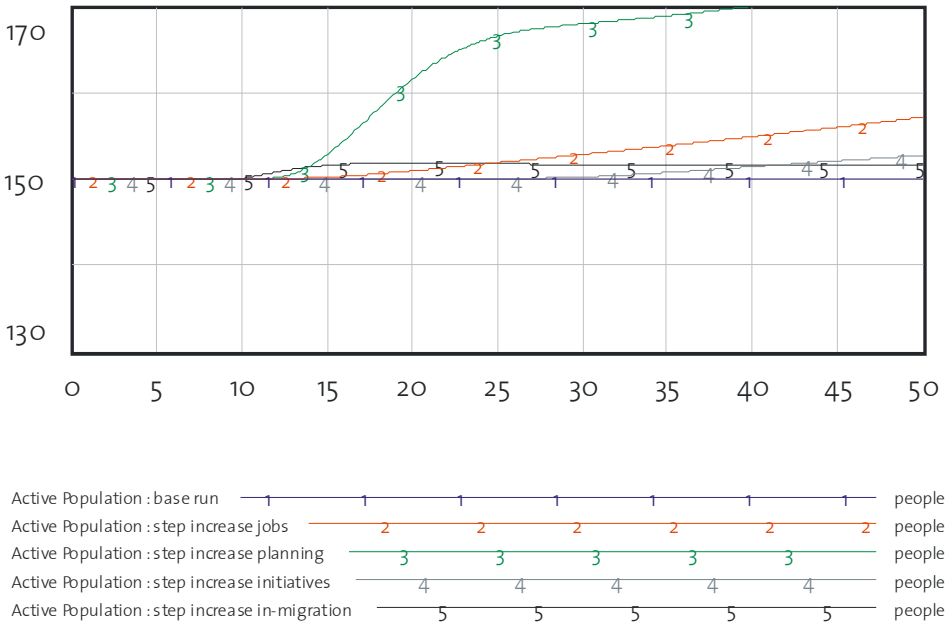
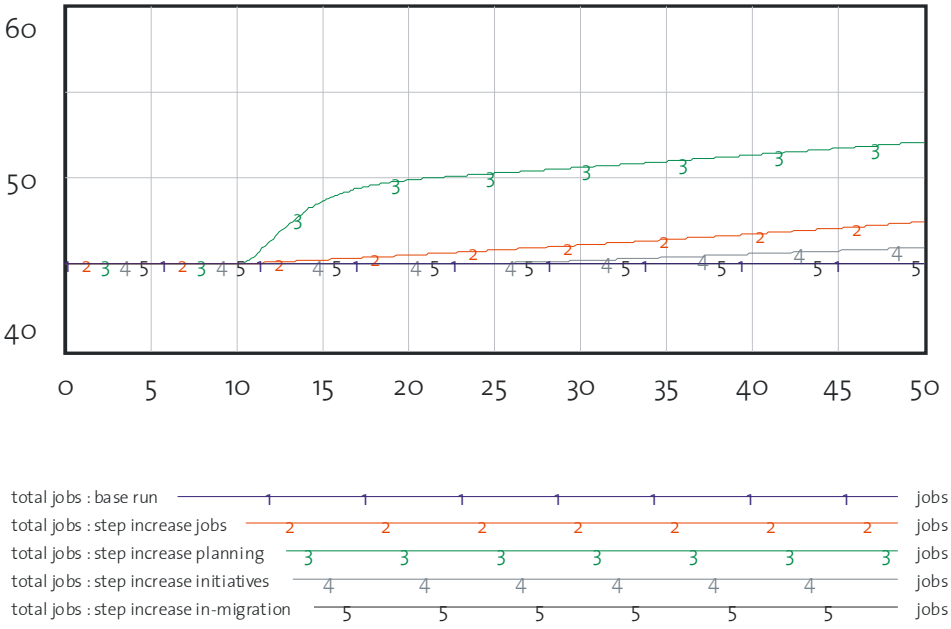


Figure 13: Reaction of total employment to changes in basic mechanisms in the economy and to changes in the dynamics of initiatives



Changes in exogenous forces clearly affect employment and population development. From a policy point of view it is interesting to note that the reactions to a change in the fractions that govern the flows in the initiatives aging chain are much bigger than the reactions to

changes in variables at the boundary of the model. This effect even exceeds changes in the overall economy (job creation or job loss rate).

Without the self-help capacity sector, model behavior is restricted to first or higher order delays. The system is driven by a series of balancing feedback loops that lead to goal-seeking behavior as a reaction to parameter changes. Figure 14 and Figure 15 therefore show some behavioral patterns for the self-help capacity sector.

The self-help capacity sector is driven by a reinforcing and a balancing feedback loop. The simulations show that this model sector shows 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 full commitment or zero commitment. The drivers for these changes are changes in the threshold values that actors apply for their decisions and that determine the direction of the positive feedback loop.

Figure 14: Reaction of actors' commitment to changes in the self-help capacity sector

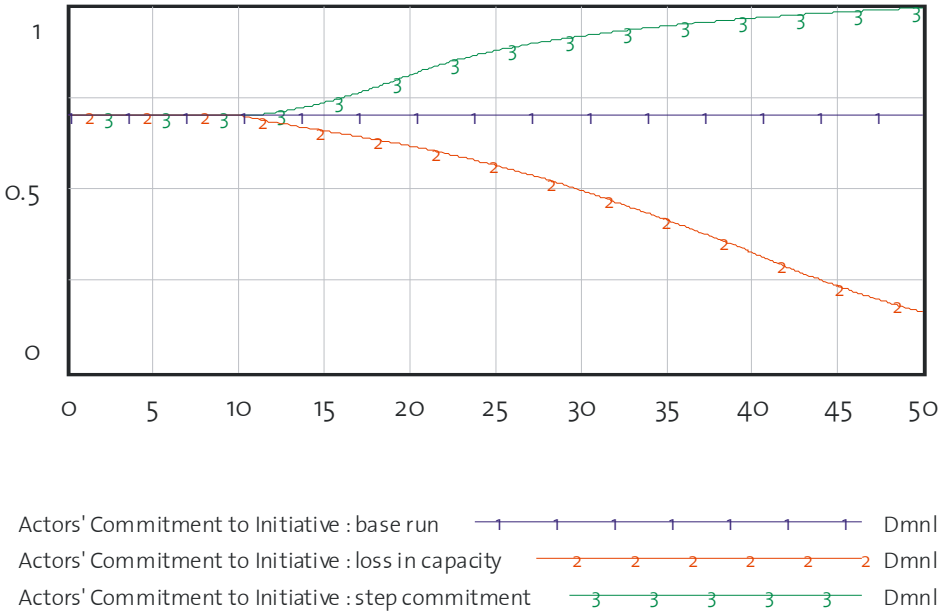
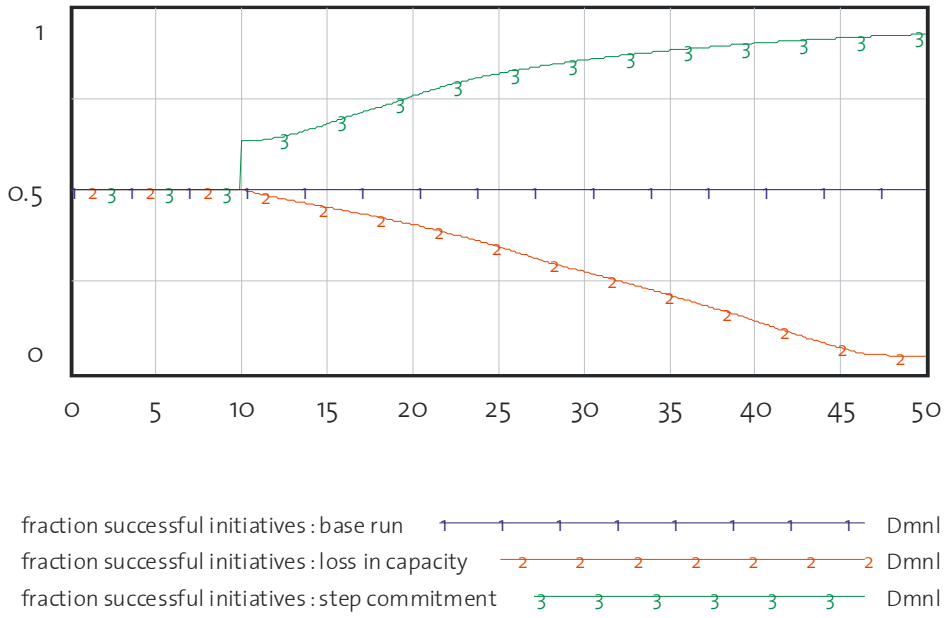


Figure 15: Reaction of the fraction of successful initiatives to changes in the self-help capacity sector



5.2 Planned policy analysis

Based on the understanding of model behavior from the previous section, model analyses will be conducted with parameters and initial values that represent the situation in the municipalities as captured by statistical data or estimated by expert knowledge. Backcasting experiments evaluate the ability of the model to reproduce the reference modes shown in section 2 and will be complemented by additional model validation tests. Forecasting experiments test a series of policies that address either current discussions in regional policy and the regional science literature or issues that proved to be insightful in model analyses in the previous section.

6 Discussion

In this paper an integrated dynamic theory of employment and population dynamics in lagging rural areas in Switzerland was developed. The conceptual framework was based on literature in the fields of regional economics and rural studies. The resulting dynamic hypothesis was translated into a formal simulation model by recurring to the literature in related fields such as urban dynamics and innovation implementation and management.

One major reason for the interest in employment and population dynamics stems from the current reform in regional policy in Switzerland. While there is consensus about a shift from top-down to bottom-up development approaches little is know about how to effectively support the latter. Partial model analysis confirmed the vulnerable nature of these small economies to trends in national and international market forces. However, it also showed that internal mechanisms have higher leverage potential. Local policy makers and entrepreneurs are

the main actors in designing and implementing development strategies to counteract exogenous forces. This does, however, not imply that regional policy as a public policy loses its significance. In many cases, local actors will not or only partially manage to bring about these new developing routines. Therefore, encouragement from upper administrative levels or other external actors will be required. It is only by these policies that the leverage points identified in partial model analysis can effectively be influenced. Partial model analysis so far suggests that special attention be paid to policies that affect the threshold values in the self-help capacity sector.

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Appendix: Model equations

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."population & labor market"

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(02) Active Population= INTEG (net birth rate+"in-migrating"-"out-migrating"-aging, 282)
Units: people
(03) aging=
Active Population/TIME IN ACTIVE POPULATION
Units: people/Year
(04) agricultural job loss rate=
Agricultural Jobs*FRACTIONAL JOB LOSS RATE AGRICULTURE
Units: jobs/Year
(05) Agricultural Jobs= INTEG (-agricultural job loss rate, 5)
Units: jobs
(06) becoming established jobs=
"outflow from implemented in."*fraction successful initiatives
Units: initiatives/Year
(07) births step=
0
Units: Dmnl/Year
(08) CARRYING CAPACITY POPULATION=
600
Units: people
(09) current labor to job ratio=
labor/total jobs
Units: people/jobs
(10) deaths step=
0
Units: Dmnl/Year
(11) dying=
Retired Population*FRACTIONAL DEATH RATE RETIRED
Units: people/Year
(12) "effect of L/J condition on in-migration"= WITH LOOKUP (
"perceived L/J condition",
([(0,0)-(2,2)],(0,2),(0.2,1.95),(0.4,1.8),(0.6,1.6),(0.8,1.35),(1,1),(1.2,0.5),(1.4,0.3),(1.6,0.2),(1.8,0.15),(2,0.1)))
Units: Dmnl
(13) "effect of L/J condition on out-migration"= WITH LOOKUP (
"perceived L/J condition",
([(0,0)-(2,2)],(0,0.1),(0.2,0.15),(0.4,0.2),(0.6,0.3),(0.8,0.5),(1,1),(1.2
,1.35),(1.4,1.6),(1.6,1.8),(1.8,1.95),(2,2)))
Units: Dmnl
(14) "effect of population density on in-migration"= WITH LOOKUP (
population density,
([(0,0)-(1,1)],(0,1),(0.1,1),(0.2,1),(0.3,1),(0.4,1),(0.5,1),(0.6,1),(0.7
,0.95),(0.8,0.8),(0.9,0.5),(1,0.1)))
Units: Dmnl
(15) Established jobs= INTEG (job creation rate-job loss rate,
job creation rate/FRACTIONAL JOB LOSS)
Units: jobs
(16) FRACTIONAL BIRTH RATE=
0.03*(1+STEP(births step,10))
Units: Dmnl/Year
(17) FRACTIONAL DEATH RATE=
0.03*(1+STEP(deaths step, 10))
Units: Dmnl/Year
(18) FRACTIONAL DEATH RATE RETIRED=
0.03
Units: Dmnl/Year
(19) FRACTIONAL JOB LOSS=
0.01+STEP(job step,10)
Units: Dmnl/Year
(20) FRACTIONAL JOB LOSS RATE AGRICULTURE=
0+STEP(step loss agriculture,10)
Units: Dmnl/Year
(21) Implemented initiatives= INTEG (+planning initiatives-becoming established jobs-

losing unsuccessful initiatives,planning initiatives*TIME TO EVALUATE INITIATIVES)
Units: initiatives

(22) "in-migrating"=
Active Population*"NORMAL IN-MIGRATION"*"effect of L/J condition on in-migration"*"effect of population density on in-migration"
Units: people/Year

(23) "in-migration step"=
0
Units: Dmnl/Year

(24) job creation rate=
JOBS PER INITIATIVE*becoming established jobs
Units: jobs/Year

(25) job loss rate=
Established jobs*FRACTIONAL JOB LOSS
Units: jobs/Year

(26) job step=
0
Units: Dmnl/Year

(27) JOBS PER INITIATIVE=
2
Units: jobs/initiative

(28) labor=
Active Population*LABOR FORCE FRACTION OF POPULATION
Units: people

(29) LABOR FORCE FRACTION OF POPULATION=
0.3
Units: Dmnl

(30) labor to job condition=
current labor to job ratio/"PAST L/J RATIO"
Units: Dmnl

(31) net birth rate=
Active Population*(1/65+FRACTIONAL BIRTH RATE-FRACTIONAL DEATH RATE)
Units: people/Year

(32) "NORMAL IN-MIGRATION"=
0.056*(1+STEP("in-migration step", 10))
Units: Dmnl/Year

(33) "NORMAL OUT-MIGRATION"=
0.056*(1+STEP("out-migration step", 10))
Units: Dmnl/Year

(34) "out-migrating"=
Active Population*"NORMAL OUT-MIGRATION"*"effect of L/J condition on out-migration"
Units: people/Year

(35) "out-migration step"=
0
Units: Dmnl/Year

(36) "PAST L/J RATIO"=
1.025
Units: people/jobs

(37) "perceived L/J condition"=
SMOOTH (labor to job condition,"TIME TO PERCEIVE L/J CONDITION")
Units: Dmnl

(38) population density=
total population/CARRYING CAPACITY POPULATION
Units: Dmnl

(39) Retired Population= INTEG (aging-dying, Active Population/(TIME IN ACTIVE POPULATION*FRACTIONAL DEATH RATE))
Units: people

(40) step loss agriculture=
0
Units: Dmnl/Year

(41) TIME IN ACTIVE POPULATION=
65
Units: Year

(42) "TIME TO PERCEIVE L/J CONDITION"=
2
Units: Year

(43) total jobs=
Agricultural Jobs+Established jobs+(Implemented initiatives*JOBS PER INITIATIVE)
Units: jobs

(44) total population=
Retired Population+Active Population
Units: people

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********************************
  ."self-help capacity"
********************************
(46)    Actors' Commitment to Initiative= INTEG (change in commitment-losing commitment, 0.5)
        Units: Dmnl
(47)    change in commitment=
        (indicated commitment-Actors' Commitment to Initiative)/TIME TO ADAPT COMMITMENT
        Units: Dmnl/Year
(48)    commitment adequacy=
        Actors' Commitment to Initiative/THRESHOLD COMMITMENT FOR SUCCESS
        Units: Dmnl
(49)    commitment from success= WITH LOOKUP (
        success condition,
        ([(0,0)-(1,2)],(0,0.1),(0.2,0.2),(0.4,0.3),(0.6,0.5),(0.8,0.9),(1,1) ))
        Units: Dmnl
(50)    commitment from support= WITH LOOKUP (
        support adequacy,
        ([(-1,0)-(1,0.5)],(-1,0),(0,0),(0.2,0.1),(0.4,0.2),(0.6,0.3),(0.8,0.4),(1,0.5) ))
        Units: Dmnl
(51)    effect of commitment on success= WITH LOOKUP (
        commitment adequacy,
        ([(0,0)-(2,1)],(0,0.025),(0.3,0.05),(0.75,0.3),(1,0.5),(1.25,0.7),(1.7,0.95
        ),(2,1) ))
        Units: Dmnl
(52)    indicated commitment=
        commitment from success+commitment from support
        Units: Dmnl
(53)    losing commitment=
        Actors' Commitment to Initiative/TIME TO LOSE COMMITMENT
        Units: Dmnl/Year
(54)    necessary support=
        1-commitment adequacy
        Units: Dmnl
(55)    possible support=
        1+STEP(step support,10)
        Units: Dmnl
(56)    recent success=
        SMOOTH(fraction successful initiatives, TIME TO CHANGE SUCCESS PERCEPTION)
        Units: Dmnl
(57)    step commitment=
        0
        Units: Dmnl
(58)    step support=
        0
        Units: Dmnl
(59)    step threshold success=
        0
        Units: Dmnl
(60)    success condition=
        recent success/THRESHOLD SUCCESS FOR COMMITMENT
        Units: Dmnl
(61)    support adequacy=
        necessary support*possible support
        Units: Dmnl
(62)    THRESHOLD COMMITMENT FOR SUCCESS=
        0.5+STEP(step commitment, 10)
        Units: Dmnl
(63)    THRESHOLD SUCCESS FOR COMMITMENT=
        0.5+STEP(step threshold success,10)
        Units: Dmnl
(64)    TIME TO ADAPT COMMITMENT=
        5
        Units: Year
(65)    TIME TO CHANGE SUCCESS PERCEPTION=
        10
        Units: Year
(66)    TIME TO LOSE COMMITMENT=  5
        Units: Year
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****
.Control
****
(69) FINAL TIME = 50
Units: Year
(70) INITIAL TIME = 0
Units: Year
(71) SAVEPER =
TIME STEP
Units: Year [0,?]
(72) TIME STEP = 0.125
Units: Year [0,?]
****
.initiatives aging chain
****
(74) "creation of potential in."=
INITIATIVE CREATION RATE
Units: initiatives/Year
(75) "dismissing pot. in."=
Potential initiatives/SURVIVAL TIME OF POTENTIAL INITIATIVES
Units: initiatives/Year
(76) fraction successful initiatives=
effect of commitment on success
Units: Dmnl
(77) INITIATIVE CREATION RATE=
1+STEP(step initiatives, 20)
Units: initiatives/Year
(78) losing unsuccessful initiatives=
"outflow from implemented in."*(1-fraction successful initiatives)
Units: initiatives/Year
(79) MINIMUM ACTIVE POPULATION FOR LOCAL SCHOOL=
65
Units: people
(80) NORMAL FRACTION TAKEN UP FOR PLANNING=
0.2
Units: Dmnl/Year
(81) "outflow from implemented in."=
Implemented initiatives/TIME TO EVALUATE INITIATIVES
Units: initiatives/Year
(82) planning initiatives=
Potential initiatives*NORMAL FRACTION TAKEN UP FOR PLANNING*pressure to take a risk and plan
Units: initiatives/Year
(83) population condition=
recent active population/MINIMUM ACTIVE POPULATION FOR LOCAL SCHOOL
Units: Dmnl
(84) Potential initiatives= INTEG ("creation of potential in."-"dismissing pot. in."-planning initiatives, "creation of potential in."/((1/SURVIVAL TIME OF POTENTIAL INITIATIVES)+
(NORMAL FRACTION TAKEN UP FOR PLANNING*pressure to take a risk and plan)))
Units: initiatives
(85) pressure to take a risk and plan= WITH LOOKUP (population condition,
([(0,0)-(2,2)],(0,2),(0.5,1.8),(1,1),(1.5,0.6),(2,0.5)
))
Units: Dmnl
(86) recent active population=
SMOOTH(Active Population,TIME TO PERCEIVE POPULATION TREND)
Units: people
(87) step initiatives=
0
Units: initiatives/Year
(88) SURVIVAL TIME OF POTENTIAL INITIATIVES=
20
Units: Year
(89) TIME TO EVALUATE INITIATIVES=
10
Units: Year
(90) TIME TO PERCEIVE POPULATION TREND=
5
Units: Year

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