

**A SYSTEM DYNAMICS ANALYSIS OF THE DEVELOPMENT IN NORWEGIAN
RURAL COMMUNITIES**

A Preliminary Model with Emphasis on Migration

by

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ABSTRACT

The purpose of this paper is to explain the expansion and contraction of the population in Norwegian rural communities. A preliminary system dynamics simulation model with emphasis on migration have been developed portraying a population sector, and sectors for kindergarten, education, housing, business, resources and regional policy. The results of our simulations is being compared to actual development in eight communities for the period 1976 to 1988 with respect to the total number of employed in the private sectors as well as the number of unemployed and the number of migrants.

Historically and in our simulations the communities are relatively attractive in total up until 1982. During the last part of the seventies there was relatively low unemployment and the population increased due to immigration. The local labour market, however, was not sufficiently large to absorb increases in the supply of labour in the early eighties. Consequently unemployment increased, leading first to emigration and reduced unemployment and thereafter to higher unemployment due to the smaller local market.

On the basis of the model, we have suggested four strategies for stabilization of the population in the communities. In a period of declining population, a strategy that seeks to compensate for declining local markets by producing for external markets may reduce the negative effects and lead to a stabilization of the population.

1. THE PROBLEM

The starting-point for this paper has been the research project "Development and Opportunities in Norwegian Rural Areas". This project has been financed by The Agricultural Research Council of Norway. The purpose of the project was:

"to gain insight into and knowledge about the factors promoting or restraining development in rural areas, changes in the population and maintenance of the cultural, social and other welfare qualities".

The project has been split into two parts:

- Analysis of the business development and the job creation processes in Norwegian rural areas.
- System dynamics analysis of the population and the business development in rural areas.

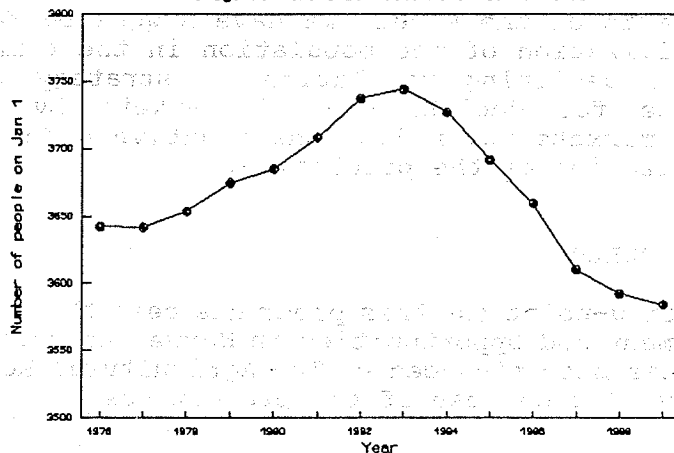
Here we shall deal with the second part which could be of interest for government policy makers. We also hope it will be of interest for researchers within the system dynamics community working with rural development problems in industrial countries.

The data have been collected from 8 Norwegian rural communities¹. When selecting these communities considerable thought was given to choosing communities outside the area of day commuting to regional centers, that the communities should belong to the least central ones (group 0 according to CBS-classification), and that a relatively large part of the population should live in areas with low population density when compared to county average. Also relatively large structural changes in business structure should have taken place during the eighties, and agriculture or fishing should have had a traditional strong position in the communities.

2. THE POPULATION DEVELOPMENT IN THE RURAL COMMUNITIES

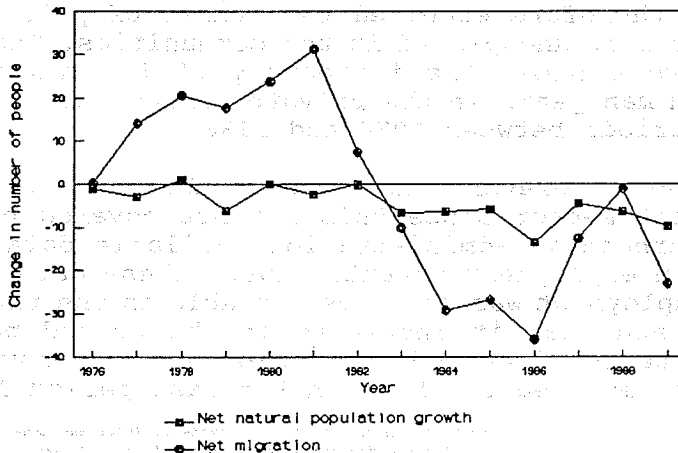
Figure 1 shows development of average number of people in the communities for the period from 1976 and up until 1989.

Figure 1. The Norwegian rural population development
Average for the 8 selected rural communities



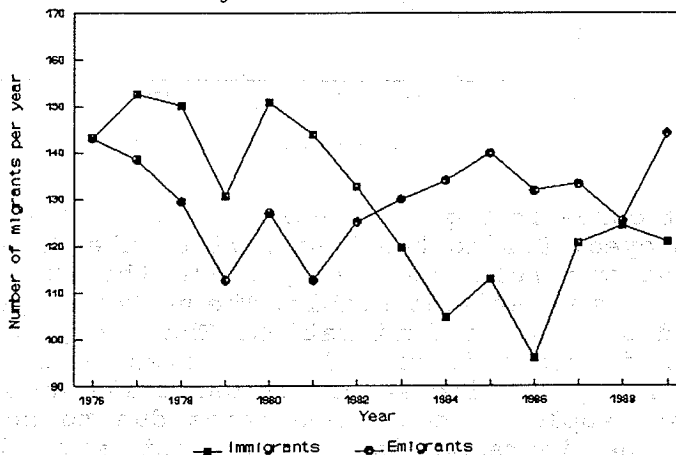
From 1976 to 1983 the population increased with around 100 persons. However during the following 6 years it was reduced with around 200 persons i.e. a reduction of 4,9%. In order to study changes in the population size we will first compare net migration with net natural population change, that is changes due to deaths and births. Figure 2 shows that the natural population change is not much different from zero in the beginning and that it falls slightly during the period.

Figure 2. Net natural population growth and net migration
Average for the 8 selected rural communities



The second curve in figure 2 shows that the net migration is positive up until 1982 and thereafter negative. A small and unstable improvement can be noted for the latest years. We have considered the natural population change exogenous, and concentrated the further work on changes in migration. In figure 3 the net migration has been decomposed into immigration and emigration.

Figure 3. Number of immigrants and emigrants
Average for the 8 selected rural communities

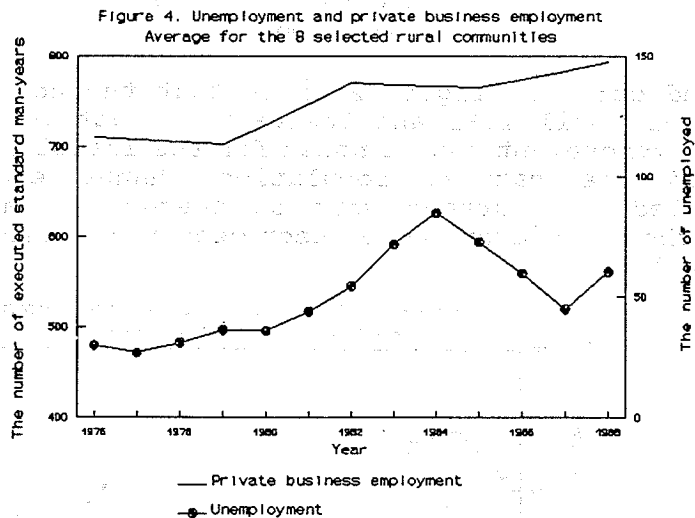


The pattern of development seems to be that when immigration is high emigration is low, and opposite. This suggests that the communities are experienced as more or less attractive in different parts of the period.

3. THE LABOUR MARKET AND THE MOTIVES OF MIGRATION

Out of the different factors motivating migration, the possibilities for employment and income seems most important. We have therefore examined the number of potential employees and number of unemployed in the communities. One of the curves in figure 4 shows the trajectory of the number of executed standard man-years in the private businesses in the four three years periods between 1976 and 1988.

We do not, however, have the number of employees in the government sector since this was not covered by the project. For governmental administration available data show a strong growth in employment up until 1982. These data indicates that total employment was relatively stable in the first three years period, and that it increased in the second period 1979-82. During the third period the employment may have stagnated while it improved slightly in the last period 1985-88.



The other curve in figure 4 shows the development of the number of unemployed. During the last part of the 70's the number of unemployed was relatively low, while the number of executed man-years was relatively stable. The number of people, however, increased due to net immigration. The first part of the 80's showed an increase in unemployment even though the number of executed man-years increased. It was still an increase in the number of people in the communities due to net immigration. Some of the increase in unemployment may also be due to increased labour force participation of women.

From the beginning of the 80's the immigration was reduced while the emigration increased. During 1982 the net migration became negative and during 1986 the population became smaller than in 1976. From 1984 to 1987 we can register a reduction in the number of unemployed, together with a decrease in the number of people. Emigration was rather high during these years. As emigration is reduced while immigration increases slightly so that the curves are approaching each other in 1988, unemployment again is increasing.

The figures considered together suggest the existence of some basic reasons for shifts that determine the population development in the rural communities. Changes in the labour market seems to explain the changes in the population. The possibilities for a job must be considered an important migration motivating factor. We have also identified and modeled other migration motivating factors such as the availability of housing, kindergarten and education. Together with job opportunities these factors determine the total attractiveness of the rural area.

4. FORCES IN THE RURAL DEVELOPMENT

Figure 5 illustrates how some actual factors in the rural development are assumed to interact.

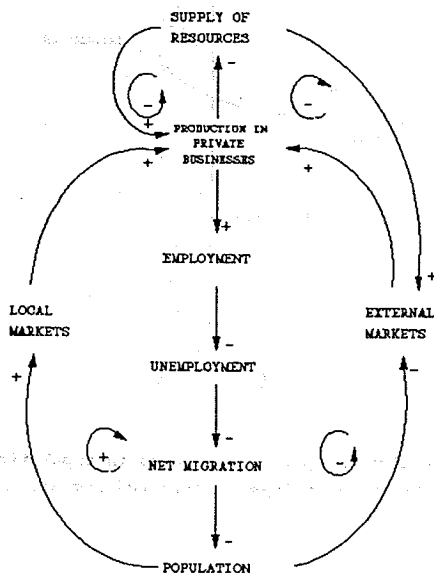


Figure 5. Illustration of central feedback-loops determining the development of private business production in Norwegian Rural Communities

Feedback-loops may be a tool to understand the forces of rural

development. The figure contains four loops, one positive with a plus sign in the centre and three negative with a minus sign in the centre of the loops.

An increase in the population in these communities will lead to a strengthened local customer base that will open up a larger local market with possibilities for increased employment. An increase in employment thus leads to reduced unemployment and reduced emigration and increased immigration. Thus a self re-enforcing or positive, feedback-loop.

The increase in production may, however, be so large that the supply of resources will become a limiting factor for further production increases. This is illustrated with the negative feedback-loop in the upper left corner in figure 5.

The feedback-loop diagram in figure 5 has been used as a starting-point for the system dynamics model, a part of which is illustrated in the flow-diagram in figure 6.

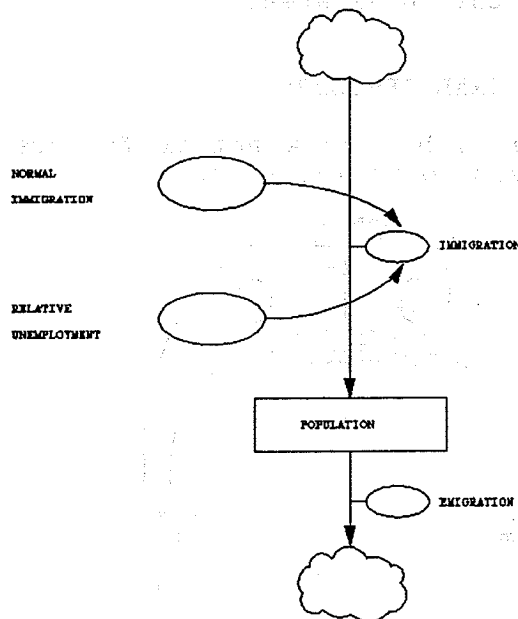


Figure 6. Flow-diagram for changes in population due to unemployment affected migration

The migration in figure 6 is assumed to be determined by the relative unemployment in the rural community which is expressed as the actual unemployment relative to the unemployment in reference periods. Since the unemployment was low and stable during the first three years, the unemployment in 1976 are assumed to indicate a reference condition on the labour market, i.e. relative unemployment equal to 1.

In periods with unemployment corresponding to the reference unemployment the actual immigration and emigration will be equal with the reference immigration and emigration. If the actual unemployment in the communities is larger than this reference, the immigration is reduced, while emigration increases.

In many situations linear relations may not give a realistic picture of the reality. It can be assumed that small changes in unemployment have a slight effect on migration and it will only be affected when changes in unemployment are large. Thus figure 7 illustrates such a non-linear relationship between relative unemployment and subsequent effect upon migration.

EFFECT OF RELATIVE UNEMPLOYMENT ON MIGRATION

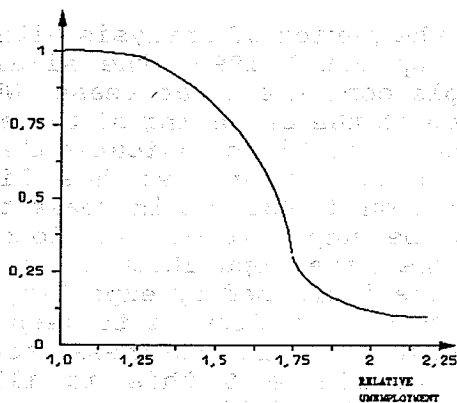


Figure 7. A non-linear relation between relative unemployment and migration

The figure indicates that when unemployment increases with 25% compared with the reference periode, the migration will change with only 2%. With 75% change in unemployment, however, the migration will change with around 70%.

5. RURAL DEVELOPMENT AND MODEL TEST OF STRATEGIES

The simulations indicated that we had a self re-enforcing development in the first three years period. The unemployment was relatively low at the end of the 1970's. At the same time there was net immigration into the rural communities a development that lead to a larger local customer base. This caused increased production in the local businesses. The increase lead to a reduced unemployment and the motivation for immigration increased further. The positive feedback loop in figure 5 seems to be dominating the development from 1976 and

up until 1982.

The capacity limit for production, however, was then reached. At this point the negative feedback-loops were strengthened and dominated the development (the feedback-loop in the upper left corner of figure 5). This development led to reduced business investments, increased unemployment and the number of people started to decrease after 1983.

It seems, however, that the positive feedback-loop again takes over the dominance after 1984, but now with a self re-enforcing decreasing development in the number of people. From 1984 there is a stagnation in production, increased unemployment and increased emigration reduced population and local customer base.

By increasing the period of analysis with two extra three years periods, i.e. up until 1995, the simulations show that the number of people continue to decrease. What efforts could have been undertaken at the beginning of the eighties to reverse the emigration? The simulations indicate that the reduced resource base in the rural communities has limited the production increment from around 1982. To increase the import of resources can, however, be unprofitable as long as it is primarily produced for the base population of the communities. If the customer base are increased by exporting goods and services it may, however, become profitable to keep production at a level preventing stagnation in business activity and increased unemployment. In figure 5 this is illustrated by the two feedback-loops on the right side.

The simulations indicate that the high unemployment leads to the strong emigration from 1983 and throughout the eighties. We must, in other words, ensure a certain employment level in order to avoid net emigration. With this starting-point the model has been used to compare 4 strategies for changing an unwanted development.

One of the strategies has been called "Small scale business development strategy" (Kvarv 1992). It consists of, among other things, expansion to different external markets. If the decrease in local population is compensated with stronger emphasis on external markets the effect of an insufficient local customer base could be counteracted. Thus the number of employed could be stabilized. The simulations indicated that the total customer base in our rural communities has to be increased with around 40% in order to maintain a production level sufficiently large to consolidate the employment. With this level the net emigration is around zero and the population stabilizes at 1983 level.

The model may also form a basis of studying what motivates establishment of new business activities in the rural communities. A strategy for influencing this has been called

a "Job-creation strategy". Also a specification of the different sectors of production may give a possibility for studying the relationship between the sectors and uncover where the different efforts to increase employment most efficiently could be put into action. This strategy is called "Business sector strategy". The fourth strategy is called a "General strategy for business development". It consists of, among other things, changes in the level of taxation, governmental practical advice and extension concerning the establishment of new businesses and different infrastructure investments in the rural area.

6. CONCLUDING REMARKS

It is difficult to prove what is the right relationship between a set of factors, and simulation can only indicate what feedback-loops that dominates in the different periods. The simulations only result in a pattern of development for the modeled factors. Simulations, based upon the hypothesis about the structural relationships assumed to be central in the Norwegian rural communities, have been compared with the pattern of behaviour of the actual data. This way we have studied the relationship between structure and behaviour and can indicate what factors, and the relationship between them, that may explain the population development in Norwegian rural communities.

The simulations make it possible to study delays in the system. The effects of such delays are often difficult to predict, but they can prove to have an immense important influence upon the behaviour. For instance when a need for more houses arises, there has to be a certain delay before decisions are made, permissions are given and houses are built. It will also take some time before potential migrants will perceive the changes in supply of houses. How attractive it will be to live in a rural community is therefore a number that will be changed with a certain sluggishness compared with the real attractiveness. The relationship between the attractiveness of the rural area and migration will also be affected by commuting into and out of the communities⁴.

A certain understanding of this kind of dynamics is a necessary precondition for studying effects of certain state financed labour market efforts. The simulation model can also contain a larger set of inter-related factors than we are able to deal with mentally in an efficient way. Thus it may be possible to undertake a coordinated analysis of all factors thought important for the population development in Norwegian rural communities.

Implementing employment promoting efforts in rural Norwegian communities are expensive, and it is not easy to measure the outcome. Here simulation models may be a tool where strategies

and efforts may be designed and tested. This could be of interest for training government policy makers. To build and apply such models imply an alternative to studies based upon "Action Research" that more aims to change parts of the development without first having tested the underlying theories.

Simulations may often uncover causes and effects that one were not aware of in the beginning. Our preliminary model simulations indicates that the market and the demand for the goods and services produced in the rural communities will determine the long run population development there. Recommendations for governmental engagement and strategies and efforts to change the development, should take this as a starting-point.

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Kvarv, S. (1992): Næringsutvikling og jobbskaping i norske bygder. Studier i 8 kommuner. (Economic development and new employment opportunities in rural areas of Norway. Studies in eight municipalities). Norsk institutt for landbruksøkonomisk forskning. Melding A-019-92.

NOTES:

1. The following communities were selected: Asnes and Os in Hedmark County, Ernedal and Nord-Fron in Oppland County, Leksvik and Høylandet in Nord-Trøndelag County and Nesna and Steigen in Nordland County.

2. The curve in figure 7 only indicates the main tendencies in the relationship between unemployment and the subsequent effect on migration. The form of the curve is in other words not a result of model tuning.

3. This stagnation is only indicated in the simulation results and not documented in the data. In accordance with the development of other factors (e.g. stagnation in executed standard man years) during the same period such a developments seems likely.

4. Based on a somewhat limited material we have in this preliminary model assumed that the commuting is constant during the period of analysis.