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Rural Population Growth in Sweden in the 1990s: Unexpected Reality or Spatial–Statistical Chimera

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Sammanfattning
Att mäta befolkningsutveckling på landsbygden kan verka oproblematiskt, men inbegriper i själva verket både svårigheter av metodologisk karaktär och att landsbygden har definierats på ett otvetydigt sätt. I denna uppsats undersöks problemet med urban ”spillover” i landsbygdens befolkningsutveckling. Enkelt uttryckt innebär det att tätorter tenderar att skjuta en ring av embryonisk tätortstillväxt utanför sina gränser allteftersom de växer. Med en statisk tätortsavgränsning kommer denna urbana expansion att framstå som en cyklisk tillväxt av landsbygdsbefolkningen. I denna rapport beräknas effekten av urban spillover i Sverige under 1990-talet. Förutan denna effekt minskade landsbygdebefolkningen i Sverige under 1990-talet. Undersökningen visar också hur effekten varierar geografiskt beroende på vilken mätmetod som används

Abstract
Though estimating rural population change at first glance seems simple, it in fact involves methodological difficulties and requires the accommodation of definitional ambiguities. This article addresses the matter of urban spillover in rural population development. Simply stated, “urban spillover” here refers to how urban localities tend to push a ring of diffuse urban growth outwards as they expand in area. If constant delimitations of urban localities and rural areas are employed, their definitions will *de facto* change, and what is actually diffuse *urban* growth will be treated as *rural*. If the spatial areas used are constructed from predefined areas (e.g. census enumeration areas), the effect of arbitrary geographical subdivision is added. These effects of urban spillover in different methods of estimating rural population change are illustrated here using Swedish data, which are suitable for this purpose given their high spatial resolution. The data do not support the existence of any actual rural population growth in Sweden in the 1990s, apart from the effects of urban spillover. We also show that urban spillover varies geographically depending on the measurement method used.

Keywords: urban spillover, urban localities, counterurbanisation, reclassification, rural population

Introduction

In the mid 1970s, unexpected rural population growth was reported in the U.S.A. and several other countries, including Sweden (Stahre and Wretblad, 1972; Alexandersson and Falk, 1974). Berry (1976) coined the term “counterurbanization” to describe this new phenomenon, and declared that a “turning point has been reached in the American urban experience”, arguing that urbanisation had ended and been replaced by its opposite. Soon similar trends were being reported in many other countries. Urban–rural population redistribution has been monitored ever since, and in some countries and regions the tendency towards counterurbanisation has been reported to have both ended and restarted over the years since it was first discovered.

However, for rural–urban population development to be reliably measured, a few methodological problems must first be resolved. One of these is addressed more particularly here: the fact that urban localities tend to contract, or more often, expand in area over time. This means that urban growth spills over the urban boundaries into rural areas (or vice versa). Consequently, the delimitations of rural versus urban areas must periodically be adjusted to keep the definitions of rural and urban areas, and with them rural (and urban) populations, consistent over time. The alternative, using the same delimitations at different times, means *de facto* that different definitions are employed at different times. However, the extent of the resulting urban spillover effect is unclear.

The phenomenon has been commented on repeatedly, but a lack of suitable data has so far restrained researchers from analysing it in any great detail. Yet, the appearance of grid data in more and more countries has changed this situation while bringing the problem to the fore, since grid data allows anyone – academics or policy makers – to monitor urban–rural population redistribution, irrespective of when the urban delimitations are adjusted. Reflecting this new situation, a method to avoid the problem of urban spillover, but without necessitating the adjustment of urban delimitations, has recently been suggested and used. The idea is to supply existing urban localities with buffer zones intended to catch the urban spillover (Westlund, 2002).

The general aim of this article is to determine the degree of urban spillover in rural population growth as measured employing constant areas (supplied with buffer zones or not). This is done by separately estimating the population development from 1990 to 2000 in Swedish areas either continuously urban, rural or in a buffer zone, or with some kind of changed status. Attention is also drawn to the fact that the urban spillover component in a measuring method varies between regions depending on geographical variation in the urban structure. From these results, different methods for measuring urban–rural population redistribution can be evaluated, and the rural and urban population development in Sweden 1960–2000 calculated.

The first section of this paper touches on general methodological problems in measuring urban–rural population redistribution and outlines the background of the problem in focus. The second section presents several methods for statistically distinguishing between urban and rural areas; the Swedish method is emphasized, as the empirical data employed in this study are Swedish. The third section presents recent research into rural population development in Sweden. The data and method applied in the empirical part are presented in the fourth section. Following that, I demonstrate how the results obtained from measuring urban and rural population development vary depending on how one defines and applies the concepts “urban” and “rural”; then, in the sixth section I examine how this variation in turn varies geographically after which the urban and rural population development in Sweden from 1960 to 2000 is estimated, employing constant criteria of urban and rural. The main points are summarized in the last section.

The problem of urban spillover in rural population development

From the counterurbanisation literature following on Berry’s (1976) often-cited article it is clear that the “turning point” or “clean break” with past urbanisation has not been unambiguous. As has been pointed out, seemingly contradictory results can often be explained by differing definitions of crucial underlying concepts. In this case, Berry is not particularly clear as to what exactly the term “counterurbanization” refers to (Champion, 1998), and the availability of data imposes restrictions as well. Consequently, the term has come to refer to several phenomena. Mitchell (2004) has recently suggested the adoption of three related concepts – counterurban, counterurbanising, and counterurbanisation – and a framework integrating them to sort out the conceptual mishmash.

One issue concerns whether only migration is to be considered (e.g. Bergström and Wiberg, 2003), or whether births and deaths should be considered as well (e.g. Champion, 1998); if all these factors are taken into account, they might well balance each other. This leads us to the second matter: whether the phenomenon necessarily involves a growing (in absolute or relative terms) rural population (e.g. Champion, 1998), or whether the in-flow of new people as such qualifies as well (e.g. Lindgren, 2003). The spatial resolution of the phenomenon is a third point of concern: at one extreme, large regions have been compared (e.g. Kontuly, 1998), while at the other, 1-km^2 grid squares have also been used in studying rural population development (e.g. Muilu and Rusanen, 2004). In the case of Sweden, Borgegård *et al*. (1995) have shown that for the last 200 years it has been the rule, rather than the exception, for growing population concentrations to be considered at one geographic level of analysis while de-concentration is considered at another. They also noted how different kinds of population development occurred in different parts of the country at the same time.

However, these problems will not be elaborated on here, as this article focuses on another type of measurement problem. Simply stated, as an urban locality is delimited according to certain criteria, it pushes a ring of embryonic expansion outside its delimitations as its area expands. If the same delimitation is kept throughout the time-span studied, as long as the urban areas keep expanding, their surrounding *rural* areas will be credited with this embryonic *urban* population growth. Thus, under such circumstances an urban spillover component appears in the rural population development.

At a regional scale this problem has long been noted. American researchers have figured prominently in studies of *metropolitan* versus *non-metropolitan* population growth, though they have focused more often on empirical results than on methodology. Even as far back as 1964, a group of researchers at the University of Michigan drew attention to two different ways of handling the fact that metropolitan areas grew physically with time. Thus a given county (the smallest geographical building block of metropolitan areas) might lie outside a metropolitan area at the beginning of a study period, but inside it by the end. One way to handle this is to pick a certain point in time and apply the status a county holds at this time throughout the study period – the “constant area” case; in the alternative, “constant criteria” case, the counties considered metropolitan vary with time (Hawley *et al*., 1964).

Two details from this American study are of particular interest here. First, the latter, constant-criteria method reduces non-metropolitan growth considerably compared to the first one. Second, although only commented on in passing by Hawley *et al*. (1964), is the observation that non-metropolitan counties adjacent to metropolitan areas grew considerably towards the end of the studied period (1950–1960); farther out, the growth rate decreased and finally became negative with sufficient distance.

Later studies of metropolitan versus non-metropolitan population growth in the U.S.A. have produced similar results, in terms of detecting fast-growing counties adjacent to metropolitan areas (Tucker, 1976; Fuguitt *et al*., 1988; Nucci and Long, 1995). Nonetheless, the meaning of these observations has been given more attention because it was soon suggested that there might (at least partly) be a spatio–statistical explanation for the non-metropolitan population growth reported in the 1970s. This line of thought refers to the fact that new metropolitan areas tend to arise and previously established ones tend to expand geographically as a consequence of economic restructuring, and of the spatial extension of the economic and social links (e.g. commuting) in metropolises, respectively (Wardwell, 1977). Thus, metropolitan growth might spill over metropolitan borders into the adjacent parts of non-metropolitan counties and embryonic future metropolitan centres might appear in the midst of non-metropolitan counties.

Fuguitt *et al*. (1988) compared metropolitan to non-metropolitan population development employing different definitions. Their conclusion was that the population turnaround of the 1970s was real: the use of different definitions or measurement methods was found to influence only the *degree* of the process rather than its kind. Long and Nucci (1995) took the analysis a step further by separating counties into different groups depending on when they obtained metropolitan status – if they had it. They drew attention to a new period of migration gain in continuously non-metropolitan counties.

However, as should be clear from the above presentation of the problem, and as was already pointed out in the 1970s, U.S. data regarding metropolitan versus non-metropolitan population development were not really suitable for estimating the importance of the urban spillover effect (Wardwell, 1977; Gordon, 1979). As counties – the building blocks of metropolitan areas – are rather large units, the measured expansion of the metropolitan areas will involve threshold effects. The expansion, which is continuous in reality, will appear in data as a step-wise process, as new counties fulfil the criteria and – as wholes – are suddenly joined to the metropolitan area. From this it is clear that not only the criteria of a metropolitan county, but also the design of the subdivision of states into counties, influences whether or not a county attains metropolitan status at a certain point in time. Hence, in these data a possible urban spillover effect (e.g. increased rate of commuting in non-metropolitan counties) cannot be distinguished from the effect of the arbitrary subdivision of states into counties. Besides that, the U.S. definition of metropolitan areas has also changed repeatedly with time.

To analyse these matters more closely, Zelinsky (1978) analysed population data from 1940 to 1970 for approximately 2 000 minor civil divisions in non-metropolitan Pennsylvania in the U.S.A. He concluded that although certain peripheral places grew, the dominant trend was for the areas surrounding metropolitan areas to dominate the non-metropolitan population growth. Gordon (1979) supplemented the U.S. findings by analysing European and Japanese data, which made other geographical subdivisions possible. He sought indirect support for the urban spillover effect (or “wave theory”, as he called it) by calculating Hoover indices for urban core areas, their hinterlands, and rural areas, respectively.

Thus, the problem of urban spillover has attracted most attention at the regional level, certainly in the U.S. setting. However, the problem has also been identified at a more detailed, smaller scale, a level of inquiry that is in fact more suitable for studying the problem. Compared to the regional level, the threshold effects can be expected to be smaller, although not absent, at a more detailed scale. The delineation of urban versus rural areas is usually based on population and/or building density rather than on socio–economic links (e.g. commuting between arbitrarily delineated administrative regions), and is thus less ambiguous too. Besides, a more detailed geographical scale agrees more with our everyday understanding of urban versus rural and allows the separate monitoring of urban areas too small to attain metropolitan status (cf. Wardwell, 1977).

At the more detailed scale some Canadian geographers drew attention to a peculiarity similar to what Hawley *et al*. (1964) had noticed in the case of non-metropolitan growth back in the 1960s. They found an interesting cyclical pattern in rural (non-farm) population development in Canada in the 1931–1981 period. Every second decade of this period was characterised by a dramatic rural population increase, while growth was very modest in the intervening decades (Joseph, Keddie and Smit, 1988). A few years later they focused explicitly on the spillover effect which could explain this peculiarity. (Keddie and Joseph, 1991). Hugo (1994) had noticed the same phenomenon at a detailed scale in Australian data too, and this is the scale at which the problem is addressed in the empirical part of this article.

The geography underlying urban localities – some examples

The question as to which areas is to be considered urban and which rural, has many suggested answers. Countless definitions have been proposed over the years (Muilu and Rusanen, 2004). However, in studies based on statistical data the choice is usually limited to what national statistical bureaus have to offer. In this study, the spatial resolution and design of the geographical building blocks is of crucial importance, while the statistical criteria of rural versus urban area (e.g. density of population or dwellings, proportion of agriculturalists, land use, etc) are in fact less significant. In terms of geographical subdivisions, three ways to handle the matter can be identified.

In Canada, the smallest geographical unit used to compile statistics had been the census enumeration area (EA); however, this was replaced by a smaller unit, the block, in the census carried out in 2001. The EA is described as a “small area composed of one or more neighbouring blocks” containing between 125 and 650 dwellings. An enumeration area (or nowadays a “block”) is considered urban if it has a density of at least 400 inhabitants per km^2 and if it, either in itself or together with adjacent areas fulfilling the density criterion, has a minimum population of 1000 people (Statistics Canada, 2005). Consequently, a threshold effect appears when urban localities expand and new EAs are added to them, although this effect is much smaller than when counties are added to metropolitan areas in the U.S.A. Similar statistical definitions of “urban” versus “rural” can be found in, for example, the U.S.A., Australia, and New Zealand.

A second way to delimit urban localities uses communes as the smallest geographical unit and their administrative status (urban or rural) as a criterion, a system still used in many central and eastern European countries. In Germany, for example, regional governments decide whether a commune (*gemeinde* or *kreis*) fulfils the criteria to be declared a *stadt* (town or city). In Baden-Württemberg, for example, population, built-up form, and cultural and economic features are what define an area as urban (Gemeindeordnung für Baden-Württemberg §5, 2003). As Germany is a federal state, the criteria vary slightly between member states.

Following the international statistical congress of 1860, 2000 inhabitants became the criterion employed to distinguish a town from a rural locality; indeed, this criterion is still applied in many countries. A variant of the commune-based delimitation of urban localities is found in France, where communes are classified as urban if they include an agglomeration of buildings of a certain density and at least 2000 inhabitants (Julien, 2000). With commune-based delimitation follow the well-known problems of under- or overbounding. Besides that, threshold problems grow with the size of the smallest geographical building blocks. Although the general size of communes varies considerably both between and within countries, they are usually larger than the census enumeration areas used in Canada as the building blocks of the Keddie and Joseph study.

A third way to define urban localities takes as its starting point the co-ordinates of dwellings and knowledge of their inhabitants. This method, which recalls the first step in the French model, is employed in the Nordic countries. As it is more precise, the threshold effect disappears and the urban spillover effect can be revealed.

The Nordic countries have all applied similar definitions of urban localities since 1960 in their official statistics, although how they transform this definition in practice differs slightly between them. In Sweden, a group of dwellings is considered to comprise an urban locality if the gaps between the dwellings are less than 200 metres and if the group contains at least 200 inhabitants. Nowadays, the criteria can be examined using GIS, as the geographical co-ordinates of all dwellings are registered and every inhabitant and dwelling is registered for a given property. Since 1960, nearly 2000 localities have been thus identified every fifth or tenth year. This number of additional localities has remained rather constant over time, while the precise set of urban localities has changed.

Cyclical reclassification of population in Sweden in the late 1900s

The question of an urban spillover effect in rural population development as measured in Sweden might seem superfluous, as a new delimitation of the localities is worked out in connection with the advent of every new dataset regarding urban and rural population presented by Statistics Sweden. Thus, the criteria, not the delimitation, remain static and consequently there is no urban spillover component. However, with the appearance of register-based grid data approximately a decade ago, population development in urban localities and their surrounding rural areas has been monitored continuously, even between occasions when new locality delimitations are presented (Westlund and Pichler, 2000; Westlund, 2002). The Swedish National Rural Development Agency, Glesbygdsverket, has contributed to and made use of these studies. Thus, the issues raised in this study are not just of academic interest; rather, they are also of significance in supplying policy makers with correct bases for their decisions.

Westlund and Pichler (2000) and Westlund (2002) are aware of the problem of urban spillover, but rather than attempting to get to the bottom of the problem, they attempt to marginalise it by employing buffer zones around the polygons representing the delimitations of urban localities, in hopes of capturing urban expansion in these zones.[1] Thus, this method presupposes the availability of grid data – or at least data with high spatial resolution – and the areas considered to be rural initially lie outside these buffer zones. Even employing this method, Westlund still

[1] This method recalls that of Gordon (1979), who separately analysed population development in counties adjacent to metropolitan areas with and without the stipulated amount of commuting. However, his aim was to demonstrate the possibility of an urban spillover effect. In fact, Hawley *et al.* (1964) had already noticed that in the U.S.A. the ring of counties immediately surrounding a metropolitan area grew faster than a second outer ring, which in turn had a more positive population development than the remaining counties did.

finds evidence of an “unplanned green wave” in Sweden between 1990 and 1997: metropolitan regions excluded, the population is reported to have grown 2.3% outside urban localities – and their buffer zones – in this period.

This is somewhat surprising, given that this was generally a period of rapid population concentration and that Statistics Sweden actually reported a population *decrease* outside urban localities just a few years later. According to the locality statistics from Statistics Sweden, the population considered to be urban grew 4.2% in the 1990s while the rural population decreased by –0.7% (Statistics Sweden, 2002). Statistics Sweden reported a considerably worse situation for rural Sweden than Westlund did, despite the fact that their figures included the rather rapidly growing rural parts of metropolitan regions.

These seemingly contradictory results can partly be explained by the different time spans studied: it is possible and even probable that the rural population decrease was worse in the second half of the 1990s than in the first. As well, Statistics Sweden takes account of the fact that the set of urban localities is changing. Seventy-seven places, home to 13 703 inhabitants, lost their urban status in the 1990s; on the other hand, 150 new urban localities were identified over the decade, localities home to 47 538 inhabitants as of 2000 (Statistics Sweden, 2002). These changes were not considered by Westlund, and as the buffer zones of few localities overlap those of other localities, the populations of *new* urban localities are considered to be rural, and vice versa, in his study. Besides the changing set of urban localities in the 1990s, many existing urban localities expanded in area. The total area considered to be urban grew by almost 16 000 hectares to 521 038 hectares by the year 2000: this total area represented just 1.3% of the area of Sweden, but held 84% of the population – 7 465 000 inhabitants[2] (Statistics Sweden, 2002). This establishment of entirely new urban areas comprises the third part of the explanation of the contradictory results obtained thus far, and is the part of the explanation explicitly addressed here.

Data and method

The geographical data used in analyzing the cyclical reclassification of population in the Swedish setting are (1) the polygons corresponding to the delimitations of urban localities from the years 1990 and 2000 and (2) point objects (geographical co-ordinates) corresponding to the residential registration of each inhabitant in the country in those years. All these data originate from Statistics Sweden, but are unpublished. For reasons of personal privacy (but to the detriment of research), the spatial resolution of the points representing inhabitants is rounded to 100 metres of precision. This means that the sizes of the urban and rural populations differ slightly from the official data presented by Statistics Sweden. It also means that a few inhabitants (127 in 1990 and 144 in 2000) reside at the co-ordinates of borders between areas, and have been split between the abutting areas. Besides this, a few minor errors have been detected in the datasets. Nine inhabitants in 1990 and 1 in 2000 have co-ordinates lying outside the borders of the country and have been excluded. Moreover, 12 537 inhabitants lack geographical co-ordinates in the 1990 dataset; this figure equals just 0.15% of the population, but as these inhabitants were excluded, all ensuing calculations will exaggerate population growth somewhat. Should all these omitted inhabitants in fact be domiciled in the same place this would be problematic and would interfere

[2] For the purposes of international comparison, it should be added that localities with at least 2000 inhabitants contained a total of 6 514 000 inhabitants, corresponding to 73% of the population of Sweden.

with the results; this cannot, however, be determined due to the spatial resolution of the data. However, comparison with official population data for NUTS3 (Nomenclature des Unités Territoriales Statistiques – statistical regions used in the EU, corresponding to the administrative division of Sweden into *län)* suggests that these inhabitants are in fact widely distributed: of the 21 Swedish NUTS3 regions, more than 500 people are missing in each of 9 of them. In addition to this it can be noted that further 88 persons are missing in the 1990 dataset compared to published data from Statistics Sweden. The explanation for this minor difference is unknown.

We identified all the 1-km squares intersected by the 1990 and 2000 sets of urban polygons; then, each urban polygon in each dataset (1990 and 2000) was provided with a 1-km buffer zone, and the 1-km squares intersecting these buffers were identified. The resulting four sets of polygons (two for each year) based on the 1 km × 1 km grid were added to the four original sets of polygons (two for each year). Each set of polygons was then used to split up the others. After these operations, we end up with one set of polygons of 2 × 2 × 2 × 2 = 16 types.

Of these types, six consist of areas that were officially changed from rural to urban status, or vice versa. These were subdivided into completely newly arisen (or ceased) urban localities, on the one hand, and newly incorporated (or parcelled-off) areas on the outskirts of previously established urban localities, on the other. In one type, i.e. 1-km squares intersecting urban polygons considered to be rural in 1990 but urban in 2000, this is just a theoretical possibility. This adds 5 variants to the 16 types. Finally, the NUTS3 regions have been used to split up all the polygons extending over the NUTS3 region borders. This enables us to compare development in different parts of the country. The result is a division of Swedish territory into 7513 polygons of 21 types, as presented in Table 1.

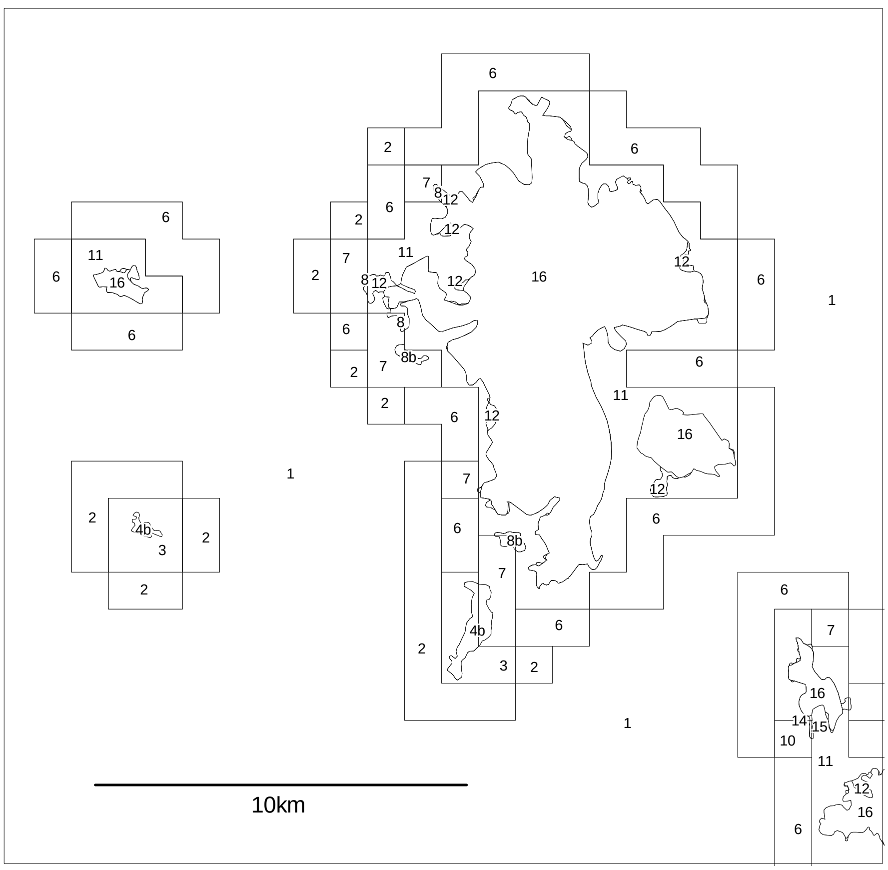
Table 1 Types of polygons

	1990	2000
1	Rural	Rural
2	Rural	1-km squares intersected by buffers
3	Rural	1-km squares intersected by urban polygons
4	Rural	Urban polygons
4b	Rural	Urban (new locality)
5	1-km squares intersected by buffers	Rural
6	1-km squares intersected by buffers	1-km squares intersected by buffers
7	1-km squares intersected by buffers	1-km squares intersected by urban polygons
8	1-km squares intersected by buffers	Urban polygons
8b	1-km squares intersected by buffers	Urban (new locality)
9	1-km squares intersected by urban polygons	Rural
10	1-km squares intersected by urban polygons	1-km squares intersected by buffers
11	1-km squares intersected by urban polygons	1-km squares intersected by urban polygons
12	1-km squares intersected by urban polygons	Urban polygons
13	Urban polygons	Rural
13b	Urban polygons (ceased locality)	Rural
14	Urban polygons	1-km squares intersected by buffers
14b	Urban polygons (ceased locality)	1-km squares intersected by buffers
15	Urban polygons	1-km squares intersected by urban polygons
15b	Urban polygons (ceased locality)	1-km squares intersected by urban polygons
16	Urban polygons	Urban polygons

These GIS operations allow us to compare differences in results that occur when measuring urban versus rural population development, differences that depend on how urban and rural areas are themselves classified.

Figure 1 depicts the division of the country into polygons, taking the area around the city of Uppsala (124 000 inhabitants, 70 km north of Stockholm) as an example. The numbers correspond to the first column in Table 1. Note that not all of the types of polygons are represented in this small sample of the country, and that a few (small) polygons in the figure lack numbers.

Figure 1 Types of polygons in the region surrounding the city of Uppsala



Most of the polygons represent parts of urban localities or their outskirts. Many are very small, but a few rural ones are huge. The populations of each of the 7 513 polygons were established by a GIS-supported examination of the number of point objects in each polygon in 1990 and 2000. Then the polygons were aggregated to the types presented above. By combining these types of areas in different ways, the outcomes in terms of population growth of different definitions of "rural" and "urban" can be examined.

Results

Monitoring rural population change employing constant areas as of 1990 and 2000

The population development in several different types of area, classified with respect to the 1990 delimitation, according to the data employed in this study, is presented in Table 2.

Table 2 Population change in urban localities/rural areas according to the 1990 delimitation

Type of Area, 1990 (see Table 1 for explanation)	Population, 1990	Population, 2000	Population growth	
① Urban (13, 13b, 14, 14b, 15b, 15, 16)	7 064 040	7 217 890	153 850	2.2%
② Rural (1, 2, 3, 4, 4b, 5, 6, 7, 8, 8b, 9, 10, 11, 12)	1 513 956	1 664 901	150 945	10.0%
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

Source: Data computed from Statistics Sweden

From this point of view the rural population growth (row ②, 10.0%) initially seems to have been much faster than its urban counterpart (row ①, 2.2%) in the 1990s. However, such a conclusion would be very premature for obvious reasons. It does not consider that a number of new urban localities arose in the midst of rural areas in the 1990s, or that a number of others ceased to exist. Nor does it consider that the demarcation lines changed as new dwellings were built, or as older dwellings were deserted or even demolished, in the outskirts of urban localities. When the delimitation of 1990 is employed – as it is in Table 2 – parts of or entire localities of diminishing population considered urban in 1990, but not in 2000, are considered to be urban, while growth connected to urban expansion is entered into the table as rural growth. This is also reflected in the population densities, which – given that the areas are left unchanged – will change to the same degree as the size of the population. The implications of this approach are clear from Table 3.

Table 3 Population change in (parts of) urban localities/rural areas according to the 1990 delimitation

Type of Area, 1990 (see Table 1 for explanation)	Population, 1990	Population, 2000	Population growth	
① Urban	7 064 040	7 217 890	153 850	2.2%
② in continuing localities (13, 14, 15, 16)	7 051 399	7 207 275	155 876	2.2%
③ in continuing urban areas (16)	7 048 837	7 204 814	155 977	2.2%
④ redefined as rural (13, 14, 15)	2 562	2 461	–101	–3.9%
⑤ in ceased localities (13b, 14b, 15b)	12 641	10 615	–2 026	–16.0%
⑥ Rural (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)	1 513 956	1 664 901	150 945	10.0%
⑦ in continuing rural areas (1–3, 5–7, 9–11)	1 449 918	1 483 906	33 988	2.3%
⑧ in rural areas redefined as urban (4, 4b, 8, 8b, 12)	64 038	180 995	116 957	182.6%
⑨ expansion of existing localities (4, 8, 12)	33 198	137 237	104 039	313.4%
⑩ in newly arisen localities (4b, 8b)	30 840	43 758	12 918	41.9%
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

Source: Data computed from Statistics Sweden

The table shows first that the population decreased in areas which had lost their urban status in 2000 (rows ④ and ⑤). However, the error effect of entering them into the table as “urban” is marginal. The subgrouping of the rural part of the table is of greater importance. As expected, it turns out that most of the rural population increase presented in Table 2 is in fact urban expansion that happened outside the delimitations established in 1990 (row ⑨). These newly arisen urban localities represent an additional, smaller part of the growth (row ⑩).

Against this background it could be argued that we are simply rearranging the table, moving the rows representing ceased localities and areas considered urban in 1990 but not in 2000 from the urban to the rural part of the table, and the rows representing rural areas redefined as urban to the urban part of the table. This would mean that the point of view had changed from 1990 to 2000, and we would end up with the following results:

Table 4 Population change in urban localities/rural areas according to the 2000 delimitation

Type of Area, 2000 (see Table 1 for explanation)	Population, 1990	Population, 2000	Population growth	
① Urban (4, 4b, 8, 8b, 12, 16)	7 112 876	7 385 809	272 933	3.8%
② Rural (1–3, 5–7, 9–11, 13, 13b, 14, 14b, 15, 15b	1 465 120	1 496 982	31 862	2.2%
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

Source: Data computed from Statistics Sweden

Compared to the situation presented in Table 2, urban population growth now seems faster (row ①) while rural growth seems slower (row ②). However, besides the fact that the problem of urban spillover is still being ignored, this way of measuring the urban–rural population development presupposes that the 2000 delimitation of urban localities was actually carried out and reported on, and thus cannot be employed in the interim, between the delimitation years.

Urban spillover – a concrete example

In a growing locality new dwellings are constructed both inside and outside the formal delimitations, although such construction is sparser the farther out one goes. What we see is that when the building density in an area outside urban boundaries becomes great enough, the area will be included in the *urban* locality the next time urban localities are delimited. However, this increasing density of buildings in the outskirts of an urban locality might start long before the area finally qualifies for incorporation into the urban locality. Under such circumstances, this area will continue to be recorded as rural. This is not problematic at any one point in time, but over a period it means that an expanding urban locality is pushing a ring of embryonic growth outside its expanding territory. For example, between 1990 and 2000 this ring of growth moves outwards. If the 2000 delimitation is employed in examining both 1990 and 2000, this ring of growth will lie inside the delimitation in 1990 but will have moved outside it by 2000, and its population growth will thus be counted as rural. Then history will be repeated when 2010 is compared with 2000, and so on. Note that this is not a question of how to *define* urban or rural, but of a systematic cyclic error in the measuring process – the urban spillover effect.

The two following maps illustrate what happens, taking the city of Linköping (94 000 inhabitants, 210 km south of Stockholm) as an example. Figure 2a illustrates where dwellings were constructed in the 1990s.

Figure 2a Dwellings constructed in the environs of Linköping, 1990–2000

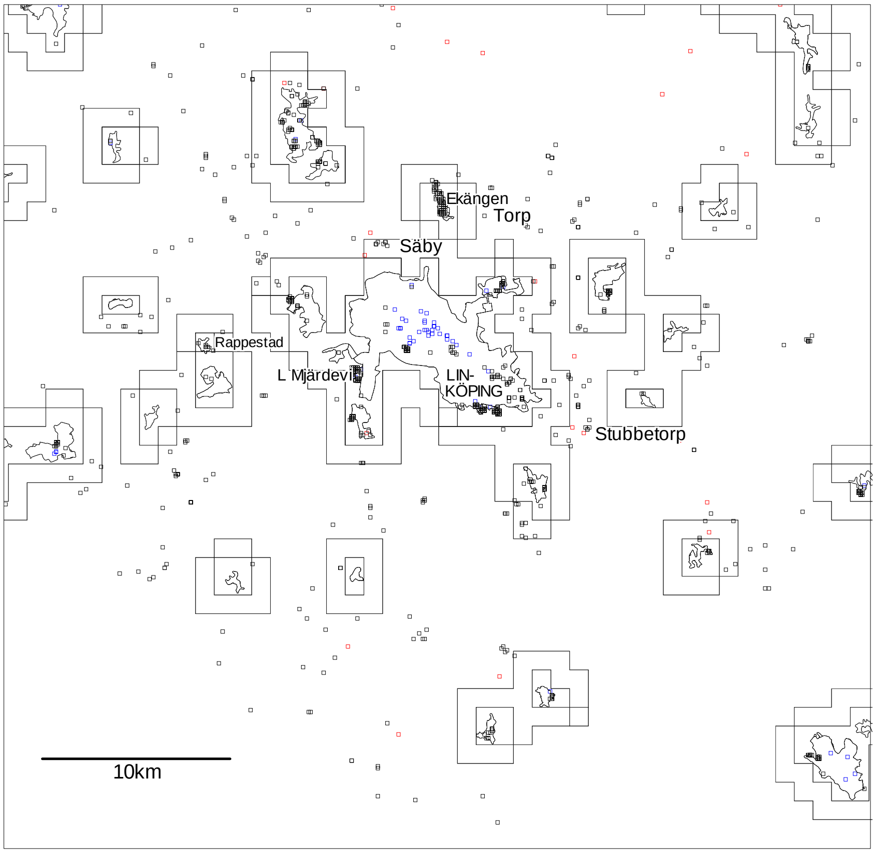
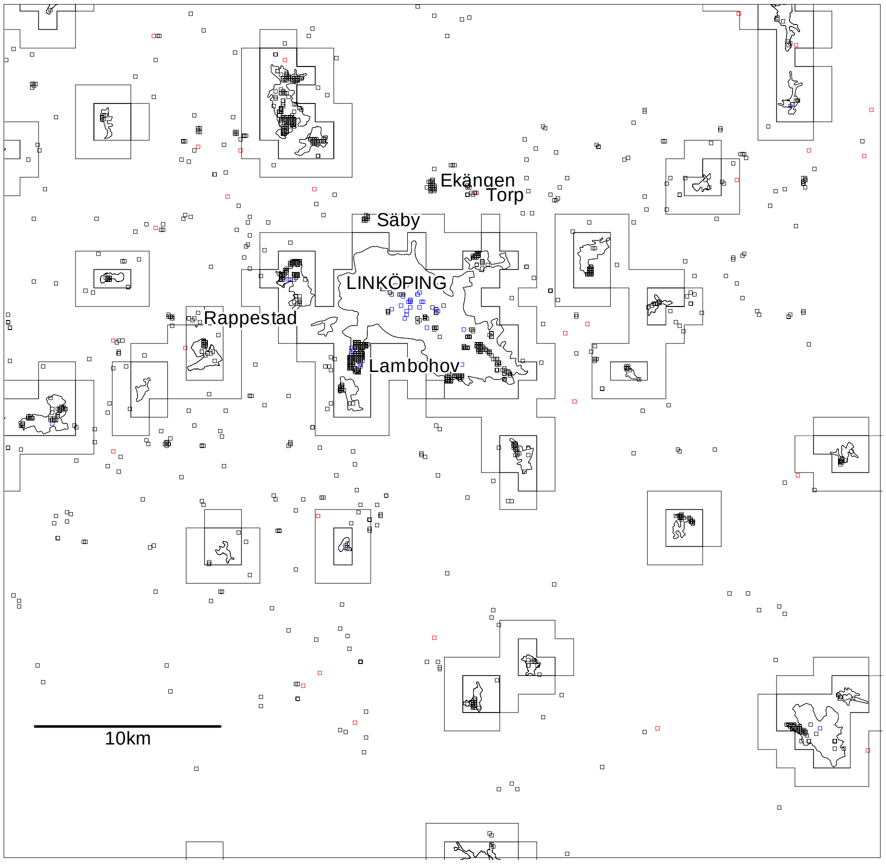


Figure 2a depicts how many of the new dwellings are situated well inside the urban localities, though most are found in a few areas in the urban outskirts (such as Lilla Mjärdevi in the south-western part of Linköping) or in newly arisen urban localities (such as Ekängen, north of the city, or Rappestad to the west). Figure 2b depicts where dwellings were constructed in the 1980s.

Figure 2b Dwellings constructed in the environs of Linköping, 1980–1990



A glance at Figure 2b shows that there was already considerable construction activity in the outskirts of Linköping even in the 1980s. What I would like to draw attention to is that residential development already begun in, for example, what would later become the new urban localities of Ekängen and Rappestad.

Many dwellings were already constructed outside the urban delimitations in the 1980–1990 period. The new construction of *rural* dwellings is denser in the immediate environs of the *urban* locality of Linköping in both the 1980s and 1990s. Some of these houses most likely constitute embryonic urban expansion, and will probably become part of an urban locality in coming decades (just as Lambohov did in the 1980s or Ekängen in the 1990s). In the 2000 delimitation of urban localities, no fewer than 16 potential localities (fulfilling the first, but not the second criterion) were identified within the commune of Linköping. When a constant area delimitation is applied, however, these potential localities are considered to be rural during their earliest period of growth.

With the geographic subdivision employed here, what happens around the urban localities can be investigated in detail. By subdividing the rural area, as delimited in 2000, into parts surrounding the urban localities and other parts, respectively, the different types of rural areas can be systematically compared. This is accounted for in Table 5.

Table 5 Population change in urban localities/(parts of) rural areas according to the 2000 delimitation

Type of Area 2000 (see Table 1 for explanation)	Population, 1990	Population, 2000	Population growth	
① Urban (4, 4b, 8, 8b, 12, 16)	7 112 876	7 385 809	272 933	3.8%
② Rural (1–3, 5–7, 9–11, 13, 13b, 14, 14b, 15, 15b)	1 465 120	1 496 982	31 862	2.2%
③ in the 1-km squares intersected by urban polygons (3, 7, 11, 15, 15b)	195 449	210 675	15 226	7.8%
④ in the 1-km squares intersected by urban buffers (2, 6, 10, 14, 14b)	262 549	277 389	14 840	5.7%
⑤ outside the buffers (1, 5, 9, 13, 13b)	1 007 122	1 008 918	1 796	0.2%
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

Source: Data computed from Statistics Sweden

Table 5 confirms that rural population growth is much faster in the immediate vicinity of urban localities (rows ③ and ④) than outside the buffers representing these fringe areas (row ⑤).

Monitoring rural population change employing constant areas with buffer zones

The purpose of Table 3 to 5, all of which presupposes that the 2000 delimitation has been implemented, and of Figure 2, a and b, is to illustrate some of the problems connected with measuring urban versus rural population growth. Anyone interested in measuring this before the 2000 delimitation was implemented had to devise a method that did not depend on the results of the 2000 delimitation. One possibility was to add buffer zones to the polygons representing the urban localities as delimited in 1990. This method might include the generalisation of these zones to a 1 km × 1 km grid if the data have this spatial resolution (Westlund and Pichler, 2000; Westlund, 2002). Here the types of polygons representing the 1990 buffer zones (polygons of types 5–12, as explasined in Table 1) are used to replicate this method. The results are presented in Table 6, which is similar to Table 5, but works from the 1990 rather than the 2000 delimitation of urban localities.

Table 6 Population change in urban localities and (parts of) buffer zones/rural areas, according to the 1990 delimitation

Type of Area, 1990 (see Table 1 for explanation)	Population, 1990	Population, 2000	Population growth	
① Urban + buffer zones	7 548 408	7 840 425	292 017	3.9%
② Urban (13, 13b, 14, 14b, 15, 15b, 16)	7 064 040	7 217 890	153 850	2.2%
③ Buffer zones	484 368	622 535	138 167	28.5%
④ in outer parts of 1-km squares intersecting urban polygons (9, 10, 11, 12)	213 400	320 669	107 269	50.3%
⑤ in 1-km squares intersecting buffer zones (5, 6, 7, 8, 8b)	270 968	301 866	30 898	11.4%
⑥ Rural (1, 2, 3, 4, 4b)	1 029 588	1 042 366	12 778	1.2%
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

Source: Data computed from Statistics Sweden

As can be seen, the buffer zones work as intended, capturing considerable “rural” population increase that in fact comprises urban population growth (rows ③, ④ and ⑤). However, the remaining rural growth (row ⑥) seems much faster (1.2%) than is apparent from Table 5, row ⑤

(0.2%). The difference is that here "rural" includes many of the fast-growing areas redefined from rural to urban in 2000, but not the areas of negative population growth redefined from urban to rural. The opposite is true for the urban areas presented in the first row of the table (compare, for example, the newly arisen urban locality of Ekängen in Figure 2.)

So far we have seen that rural population growth varies greatly depending on the delimitations and/or buffer zones employed. Even more problematic is that none of these measurement methods really handles the problem of urban spillover. The changes in population densities are still equivalent to the population changes presented in Table 6. Thus, the problem is not simply that of capturing urban expansion in terms of a certain (arbitrary) definition; rather, the delimitation is constant while the reality is changing, a fact which gives rise to cyclical effects. What must be done to handle this problem is to employ similar *criteria* in delimiting urban areas in 1990 and 2000, rather than using the same geographical areas.

Monitoring rural population change by employing constant criteria

In Table 5 the 2000 *population* of urban localities is employed in both 1990 and 2000, but the 1990 extension of these localities is governed by the 1990 delimitation and the 2000 extension by the 2000 delimitation. Table 7 also allows us to uncover the contributions of a) redefinition of areas from rural to urban (or vice versa) and b) of population redistribution.

Table 7 Population in (parts of) urban localities/rural areas as of 2000, in 1990 according to the 1990 delimitation, and in 2000 according to the 2000 delimitation, and population change

Type of Area ([a-h]: see Table 1 for explanation)	Population, 1990, according to 1990 delimitation	Population, 2000, according to 2000 delimitation	Population growth	
① Urban [a]	7 051 399	7 385 808	334 409	4.7%
② net population redistribution [b]	7 048 837	7 321 770	272 933	3.9%
③ redefined population [c]	*2 562	**64 038	61 476	
④ of which in newly arisen localities [d]		***30 840	30 840	
⑤ Rural [e]	1 526 597	1 496 982	–29 615	–1.9%
⑥ net population redistribution [f]	1 462 559	1 494 420	31 861	2.2%
⑦ redefined population [g]	**64 038	*2 562	–61 476	
⑧ of which in newly arisen localities [h]	***30 840		–30 840	
Missing population	12 546	1		
Sweden	8 590 542	8 882 792	304 795	3.4%

[a] (13, 14, 15, 16 / 4, 4b, 8, 8b, 12, 16)
[b] (16/ 4, 4b, 8, 8b, 12, 16– 4 [90] – 4b [90] – 8 [90] – 8b [90] – 12 [90]))
[c] (13, 14, 15, / 4 [90], 4b [90], 8 [90], 8b [90], 12 [90])
[d] (/4b, 8b)
[e] (1–12, 13b, 14b, 15b / 1–3, 5–7, 9–11, 13, 13b, 14, 14b, 15, 15b)
[f] (1–3, 5–7, 9–11, 13b, 14b, 15b / 1–3, 5–7, 9–11, 13, 13b, 14, 14b, 15, 15b – 13 [90] – 14 [90] – 15 [90])
[g] (4, 4b, 8, 8b, 12 / 13 [90], 14 [90], 15 [90])
[h] (4b , 8b /)
* I.e. population 1990 in areas urban 1990 but rural 2000
** I.e. population 1990 in areas rural 1990 but urban 2000
*** I.e. population 1990 in areas rural 1990 but urban 2000 in localities arisen 1990-2000

Source: Data computed from Statistics Sweden

The urban population increase now appears to be 4.7% (row ①) while the rural areas display a decrease of 1.9% (row ⑤); both population redistribution (rows ② and ⑥) and the redefinition of areas (rows ③ and ⑦) contribute to this development. The latter effect means that people have been effectively urbanised (or "ruralised") without changing their place of residence. Instead, the classification of their environs has changed as new buildings have been constructed (or demolished/abandoned in the case of ruralisation) in their immediate neighbourhoods. More areas have been redefined from rural to urban than the reverse. The net number of people affected amounts to 61 476. New urban localities account for almost half of the affected people (rows ④ and ⑧), while the remainder are assigned to the expansion of existing urban localities. This accounts for only a minor part of the urban population increase, but the rural population decrease is entirely dependent on this factor: the rural population would have increased, were it not for the redefinitions. However, as pointed out, the redefined population largely consisted of embryonic *urban* expansion in past decades. Therefore, it would be wrong to accept this apparent growth at face value, and proclaim the existence of rural population growth in Sweden in the 1990s.

Regional aspects and rural–urban population development 1960–2000

As the cause of urban spillover is the appearance and expansion of urban localities over time, spillover will also vary geographically with the extent of this phenomenon. This can be shown by subdividing the data into suitable geographical subgroups. Here the NUTS3 regions centred on the three largest cities in Sweden – Stockholm, Gothenburg, and Malmo: StoGoMa – have been distinguished from the rest of the country. Half of the Swedish population of approximately 9 million people live in this composite entity. The population in these regions grew more than 7%, double the national average, in the 1990s. Of the 150 new localities that arose in the 1990s, 79 are located in StoGoMa. Comparison between these regions and the rest of the country (other regions) is summarised in Table 8.

Table 8 Population development in urban localities/rural areas in different parts of Sweden according to 3 measuring methods (in parentheses: difference – in absolute population – from the results of the "Constant criteria – different areas" method)

Method	Population development (difference from method 2, in absolute population)					
	Urban			Rural		
	StoGoMa	other rgns.	Total	StoGoMa	other rgns.	Total
1a) Urban localities, delimited	7.3%	0.3%	3.9%	5.7%	–0.7%	1.2%
1990 + Buffer zones	(–17 839)	(–24 541)	(–42 380)	(17 839)	(24 541)	(42 380)
1b) Urban localities, delimited	7.3%	0.2%	3.8%	6.6%	–0.0%	2.2%
2000	(–31 941)	(–29 535)	(–61 476)	(31 941)	(29 535)	(61 476)
2) Constant criteria – different	8.2%	1.0%	4.6%	0.0%	–2.9%	–1.9%
areas	(0)	(0)	(0)	(0)	(0)	(0)

Source: Data computed from Statistics Sweden

From Table 8 it is clear that the two methods employing a constant area (methods 1, a and b) underestimate the urban, but exaggerate the rural, population growth in both StoGoMa and the rest of Sweden. But while the 2000 delimitation method (1b) is worse in this regard for the large city regions (i.e. StoGoMa), the buffer method (1a) is worse for the rest of the country (other regions). This is because in the "other regions", a larger proportion of the population changes (according to method 2) has to do with redefinitions, and these redefinitions are not taken into consideration. This affects method 1a the most, as neither newly arisen urban localities are counted as urban nor ceased localities as rural when it is employed. As method 1b works the other way around, it is not as sensitive to the proportion of the population change accounted for by redefinitions.

As mentioned, the data used above are somewhat lacking in precision, and about 12 000 of the 1990 inhabitants lack co-ordinates. Consequently, our results differ slightly from the data *published* by Statistics Sweden (their data, however, cannot be subgrouped in the way presented above). Next, the population change according to the data published by Statistics Sweden is focused. The method employed is "Constant criteria – different areas" (method 2). As indicated, this means that the delimitation implemented at the end of a period determines the populations of the urban localities, but that different delimitations are employed at different times. Using this method and the data compiled by Statistics Sweden to estimate rural/urban population development, we end up with the results presented in Table 9.

Table 9 Population change in urban localities/rural areas according to Statistics Sweden when the "Constant criteria – different areas" method is employed

Period	Category*	Population, start	Population, end	Population growth	
1960–1970	Urban	5 415 977	6 574 247	1 158 270	21.4%
	Rural	2 079 152	1 502 656	–576 496	–27.7%
1970–1980	Urban	6 555 229	6 913 491	358 262	5.5%
	Rural	1 521 574	1 406 948	–114 626	–7.5%
1980–1990	Urban	6 903 373	7 162 615	259 242	3.8%
	Rural	1 417 036	1 428 015	10 979	0.8%
1990–2000	Urban	7 14 8912	7 464 861	315 949	4.4%
	Rural	1 441 718	1 417 931	–23 787	–1.6%

*The delimitation at the end of the period determines the *set* of localities considered urban, but their *extents* are determined independently at each point in time and thus differ between the beginning and end of a period.

Source: Falk (1976) Table 6.2, Statistics Sweden (1975, 1984, 1992, 1996, 2002a)

Swedish urbanisation peaked in the 1960s, and by the early 1970s the rural population was rather aged and characterised by low birth and high death rates, consequently the rural population loss continued into the 1970s. In the 1980s, urban population increase slowed while rural population stopped decreasing and began increasing, and by 1990 the rural population was younger than its urban counterpart. In the 1990s, urban population growth continued and even increased somewhat; the rural population, on the other hand, began to decrease again.

Conclusion

The existence of the urban spillover effect in estimating rural population change is essentially very simple and completely logical, and researchers have long been aware of it. It has been a subject of debate, certainly in connection with how 1970s non-metropolitan population growth in the U.S.A. is to be interpreted. In the decades since its identification, attention has occasionally also been drawn to a similar effect occurring at a more detailed level of scale: rural and urban areas constructed of thousands of census enumeration areas certainly give better opportunities than do metropolitan areas, constructed of counties, to estimate this effect. However, threshold effects will still appear, meaning that the effects of urban spillover cannot be separated from those emanating from the arbitrary shaping of the subdivision of a country into census enumeration areas or counties. This means that the urban spillover effect has hitherto only been hinted at or indirectly shown.

As the Swedish delimitation of urban versus rural areas starts from point objects (the geographical co-ordinates of buildings) instead of pre-defined areas, with the appearance of grid data, the effect of arbitrary shapes can be eliminated and the urban spillover effect can be revealed. Table 8 recapitulates the various results we end up with, depending on the measurement method employed.

Table 10 Population change in urban localities/rural areas according to different measuring methods

Method	Population development	
	Urban	Rural
1) Different criteria – constant area		
a) Urban localities, delimited 1990 + Buffer zones (Table 4)	3.9%	1.2%
b) Urban localities, delimited 2000 (Table 6)	3.8%	2.2%
2) Constant criteria – different areas (Table 7)	4.6%	–1.9%

Source: Data computed from Statistics Sweden

When attention is paid to the urban spillover effect in this way, we end up with results rather different from those of the alternatives. Employing constant criteria, but different areas (method 2), the urban population appears to have increased 4.7% in the 1990s while the rural population decreased 1.9%. The two methods that apply constant areas (methods 1, a and b) systematically underestimate the urban growth while exaggerating the rural. The use of the 2000 delimitation in both 1990 and 2000 (method 1b) is the worst in this regard. The employment of buffer zones (method 1a) means that the areas considered urban are enlarged and consequently capture more of the urban spillover effect.

The explanation for these underestimations is that an expanding urban locality tends to push a ring of embryonic expansion before it, outwards from the edge of its formal delimitation. In any given period this growth ring is pushed a little farther out, while its innermost parts are formally incorporated into the urban locality. At the same time, new population concentrations are growing in the rural areas until they one day meet the criteria to be stipulated urban; other urban localities, meanwhile, that undergo population loss may lose their urban status. Employing a constant area, no matter what the stipulated criteria are, means that this embryonic urban expansion is formally registered as rural growth. The phenomenon is cyclical, and the fictitious rural growth will appear again in the next period. In this way a rural population which is diminishing between two points in time at which urban delimitations are adjusted might seem to grow in every sub-period (if measured using a constant area approach). It has also been demonstrated how the urban spillover component varies between metropolitan and non-metropolitan regions, depending on the measurement method employed.

The lesson to be learned is that urban versus rural population development cannot be measured properly unless the process is accompanied by renewed delimitation of urban localities from rural areas. Drawing on these findings, the rural (and urban) population development in the four decades between 1960 and 2000 can be calculated for Sweden. Ignoring growth assigned to urban spillover, the population decline in rural Sweden slowed in the 1970s and reversed in the 1980s; however, in the 1990s the rural population declined once again.

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