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# When and how does commuting to cities influence rural employment growth?

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# When and how does commuting to cities influence rural employment growth?

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**Abstract**
Urban areas tend to grow in population and employment while most rural areas face decline. Earlier research suggests that well-growing rural areas benefit from urban proximity and more specifically from rural-to-urban commuting. Studies on local labor markets suggest that highly educated individuals earn more than other commuters and that they tend to travel over longer distances to work. This suggests that the impacts on growth differ for different parts of commuting labor. The aim of this paper is to combine these literatures and explore how rural employment growth is influenced by commuting and how far across space these effects reach.

**JEL codes:** R0

**Keywords: U**rban spread effects, rural-urban integration, commuting

## 1. INTRODUCTION

The general urbanization trend in Europe is that cities grow in population, employment and in other economically important variables, while most but not all rural areas face decline (OECD 2013, 2014). There are however exceptions to this pattern and in the case of Sweden, which is the focus of this paper, data show that parts of the countryside have experienced impressive growth rates in population and employment of 25-30 percent during 1995-2009. Clearly there is a large heterogeneity in rural Sweden, and parts of the countryside are growing at the same pace as cities, and sometimes even excelling urban growth rates. What is the reason behind these significant differences in rural growth? Earlier research suggests that the degree of rural integration with urban areas is a key determinant in rural growth processes (Partridge and Rickman 2008; Renkow and Hoover 2000). One type of such integration involves commuting from rural residence to urban places of work and studies from Canada and the United States confirm that commuting is a key determinant to consider when explaining rural growth (Ali et al., 2011; Partridge et al., 2010; Renkow and Hoover 2000; Renkow 2003). Moreover, decades of research within commuting and local labor market studies emphasize that the propensity to commute and individuals' traveling distances to work vary between different segments of the labor force (Johansson et al., 2002; Johansson et al., 2003). The aim of this paper is therefore to combine these views and explore how local (rural) employment growth is influenced by rural-to-urban commuting but separating between commuters' levels of education. This task has not been performed previously and it is therefore an unexplored issue whether commuters' level of education influences local employment growth differently.

Policymakers in Sweden disagree on the role of rural-to-urban commuting for the future of rural Sweden. On the one hand, rural-to-urban commuting is perceived in a positive light, as a way of providing access to urban labor markets for rural residents, while at the same time allowing individuals to enjoy a rural lifestyle. Besides from functioning as a strategy to counteract rural unemployment, the local economy benefits from these type of commuting flows. As commuters enjoy increased earnings due to the higher urban wage levels, this potentially spurs local services and retail, subsequently creating rural employment opportunities (Tacoli 1998; Gaile 1980). On the other hand, there are concerns that commuting is harmful for rural growth and that it eventually leads to rural out-migration and contribute to rural depopulation. In addition, even though potentially enjoying (higher) urban wages, there is nothing that prevents rural-to-urban commuters to spend most of their incomes in the urban regions where they work. Although contributing to the local tax base, none of the

spatial spillovers from commuting are realized on the rural labor market in that case. Intuitively, these opposing views on the role of commuting in rural growth processes seem equally plausible and also raise the question of what development strategies different rural areas should adopt. At the time this paper is written, there is little research on these issues, and policymakers are left with minor guidance on these questions.

This paper explores whether rural-to-urban commuting is productive or harmful for rural growth and also where the spatial reach of labor market commuting ends for different parts of the labor force. Such knowledge provides indications of what growth strategies rural areas in Sweden potentially can benefit from. But it is however not obvious where, when and how this occurs and in what settings. For instance, studies on labor market commuting find that highly educated commuters have higher wages than less educated commuters (see e.g. Mulalic et al., 2013). This suggests that highly educated commuters potentially can spend more locally and contribute stronger to the local economy than those with less education. In addition, Johansson et al., 2002/2003 find that that highly educated individuals travel longer distances to work than their less educated counterparts due to stronger incentives of commuting; for instance due to higher urban wage levels and more complex labor-market matching problems to solve. Intuitively, the spatial reach of rural-to-urban commuting should be larger for highly educated commuters than for other labor. A potential growth strategy for rural regions located outside the spatial reaches of commuting could then be to attract highly educated workers to 'get the best value for money' in terms of stronger local employment growth. For instance, improvements in infrastructure such as better roads and train connections could reduce traveling times to work for individuals and thereby attract these workers. Through such improvements, rural-to-urban commuting could function as a viable policy instrument to void the gap of declining rural employment rates and existing urban jobs. When and where this is possible is expressed in sheer numbers in this paper.

The main contributions of the paper are threefold. First, and foremost, the analysis is performed for different segments of the labor force. This has not been done earlier and numbers of where the spatial reach of commuting ends for different types of labor are provided in the paper. Second, it is distinguished between 'pure' commuter effects and distance related effects in the analysis. Earlier studies often fail to disentangle effects on employment growth from pure commuting flows from the ones related to distance alone.

Distance is often treated as a residual that comprise everything related to the spatial effects on e.g. local growth (e.g. commuting flows, accessibility and so on); see e.g. Henry et al., (1997) for an example and Partridge et al., (2010) for an exception. In this paper, rural-to-urban commuting is not part of the 'distance residual' but explicitly measured and distinguished from other distance related effects. Third, it is by no means obvious that the findings from Canada and the United States could be transferred to sparsely populated countries as in the European context. The findings in this paper contribute with knowledge in how commuting may work as a policy instrument in more sparsely populated areas.

This paper is organized as follows. In section 2, the conceptual framework and the stipulated hypotheses are presented. Following this, in section 3, the research design is found. Here, the regressions models used in the analysis are discussed in relation to the hypotheses. In section 4, the rural countryside in Sweden is depicted while the empirical analysis is performed in section 5. The analysis is performed in two steps. The first step involves examination of spread effects from rural-to-urban commuting on local employment in different sectors in rural municipalities. The second step involves establishing how far across space spread effects from commuting reach. Lastly, in section 6, concluding remarks and policy implications are debated.

## 2. CONCEPTUAL FRAMEWORK

*The effects on local employment growth from rural-to-urban commuting*

Research shows that places close to urban areas experience higher growth rates in population, incomes and employment (Ali et al., 2011; Barkley et al., 1996; Fallah et al., 2011; Goetz et al., 2010; Henry et al., 1997; Partridge et al., 2007a-b, 2010; Shaffer et al., 2004; Renkow and Hoover 2000). The literature offers a variety of explanations of such growth patterns that in essence boils down to the existence of interdependencies between places. In the context of this paper such (rural-urban) interdependencies involve flows of people (in terms of labor market commuting) between rural places of residence and urban places of work and how local (rural) employment growth is influenced by these.

With reference to work by Myrdal (1957) and Hirschman (1958) spatial spillovers from core areas (urban) to its peripheries (rural) are referred to as spread effects. Commuting ties are often considered as the most obvious forms of rural-urban interdependencies and function as a way for peripheral areas to experience spread effects. For instance, commuting can work as a

way for rural inhabitants to access urban labor markets and work as a way to backfilling the loss of jobs in rural areas (Ali et al., 2011; Goetz et al., 2010; Henry et al., 1997; Partridge et al., 2010; Renkow and Hoover 2000). This access to urban labor markets enables a better job-match for rural individuals in comparison to the alternative of working locally (rurally) and also to enhance local incomes (Partridge et al., 2010).

Rural-to-urban commuting has at least two implications on the economic base in rural areas, Firstly, the tax base expands as people who potentially would have been unemployed in absence of access to urban labor markets contribute to the local economy through tax payments. In addition, higher urban wages (vis-à-vis rural wage levels) augments the tax revenues for rural authorities. Secondly, besides from contributing to the local tax base, earlier research suggests that rural-to-urban commuters also increase the local demand for goods and services (Goetz et al., 2010; Partridge et al., 2010; Stockdale 2006). As rural-to-urban commuters drive up the demand for rural goods and services, rural firms must employ labor. Thus, in absence of commuting possibilities to urban areas, some individuals had likely been unemployed, either by not accessing an urban place of work through commuting, or by not achieving local (rural) employment that stems from an increased local consumption of commuters.

A key hypothesis in Partridge et al., (2010) is that rural out-commuters enhance local incomes which support local (rural) retail and service. Thus, the effects on rural employment growth from commuting operate through an increased demand in local retail and services sectors (see also Goetz et al., 2010 and Stockdale 2006). This may also suggest that sectors that do not primarily rely on local demand should be less or not influenced by increased commuting between rural and urban places. Thus, the first hypothesis examined in this paper is

**H1** Rural-to-urban commuting has a positive impact on local employment growth in rural areas and these effects are mainly materialized through increased employment opportunities in (rural) service and retail sectors.

With reference to papers in regional studies, it can certainly be argued that a functioning commuting system is important for the vitality of rural communities since rural dwellers get access to urban labor markets and potentially bring urban spread effects to the rural countryside (Partridge et al., 2010). However, at some distance, people no longer commute

for one reason or another and consequently spread effects from commuting ends. By studying migration and population growth rates it is possible to assess where this occurs (see e.g. Partridge et al., 2010; Renkow and Hoover 2000). As people move to the countryside, commuting is necessary in order to access jobs in nearby cities. The distance where population growth no longer drives rural-to-urban commuting clearly indicates where people stop migrating to reach urban labor markets. The second hypothesis examined in the paper is therefore

**H2** There is a critical distance where spread effects on employment from rural-to-urban commuting ends. This distance corresponds to the spatial reach of rural-to-urban labor market commuting.

Earlier studies on integration between rural and urban areas have calculated distances where the population no longer drives rural-to-urban commuting and thus where the spread effects end. For example, using Canadian data, Partridge et al., (2010) find that spread effects from rural-to-urban commuting reach over 118-153 kilometers. At the same time, other strands of literature on individuals' commuter patterns and their preferences show that the time sensitivity of commuting decreases with the level of education (Johansson et al., 2003). This implies that highly educated workers tend to commute longer distances (in minutes) than their lower educated counterparts (Johansson et al., 2003: Dahl et al., 2003). Explanations given in the literature is that highly educated individuals face more specialized labor-market matching problems than individuals with a lower education. Moreover, occupations where a higher education is necessary are often more geographically dispersed than occupations that have no requirements on education (Johansson et al., 2003). In essence, some highly educated individuals need to commute. Additionally, more specialized work often goes hand in hand with higher earnings as well, which suggest that there are stronger incentives for highly educated labor to engage in commuting (Johansson et al., 2002; Rietveld and Van Woudenberg 2003). It is also reasonable to believe that highly educated individuals have more freedom at work which for instance involves working from home one or more days during the week. Thus, even though commuting for a longer distance to work, the aggregate commuting time is surmountable and less burdensome for such individuals. Bridging these two strands of literatures suggests that there is more to add to the picture and makes it reasonable to assume that spread effects on local employment through commuting likely

differ for different parts of the labor force. This leads to the third and final hypothesis tested in this paper

**H3** The spatial reach from rural-to-urban commuting occurs over longer distances for individuals with a higher education.

## 3. RESEARCH DESIGN

*Test of hypothesis 1*

To test hypothesis 1 it is examined whether rural-to-urban commuting influences rural employment growth on a municipal level. This is done by modeling employment growth in rural municipalities (divided upon service and retail sectors as well as remaining sectors excluding services and retail) as a function of rural-to-urban commuting and distance related variables. In addition, spatially lagged variables are included in the regression models to account for spatial dependencies between municipalities (such as spatial autocorrelation, i.e. that locations in proximity are dependent and correlated). Some control variables are included in the model to account for local (rural) characteristics as well. The spatially lagged regression models are defined as

Regression (1a)

$$\mathrm{EmpGr}_{\text{service\&retail},1995-2009,\mathrm{i}} = \alpha + \beta_1 RUC_{1995,i} + \beta_2 \mathrm{DNUC}_{\mathrm{i,j}} + \beta_3 \mathrm{SqDNUC}_{\mathrm{i,j}} + (\ldots)$$
$$\beta_4 \mathrm{AddDist}_{\mathrm{i,j}} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_{\mathrm{i}}$$

Regression (1b)

$$\mathrm{EmpGr}_{\text{other sectors},1995-2009,\mathrm{i}} = \alpha + \beta_1 RUC_{1995,i} + \beta_2 \mathrm{DNUC}_{\mathrm{i,j}} + \beta_3 \mathrm{SqDNUC}_{\mathrm{i,j}} + (\ldots)$$
$$\beta_4 \mathrm{AddDist}_{\mathrm{i,j}} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_{\mathrm{i}}$$

The subscripts in the regression models correspond to rural municipality i and urban area j. When a variable is subscripted with both i and j, it makes a variable that measures the relationship between rural area i and urban area j. **W** is a weighting matrix in which the cells comprise the squared inverse of the distance in minutes between rural municipalities. Using the square of distance in the denominator incorporates a declining impact of distance on neighboring municipalities (the impact of municipalities beyond 45 minutes traveling time has been set to have zero impact)[1]. Moreover, to mitigate bias from direct endogeneity (e.g. Y and

X are simultaneously determined), lagged values of the explanatory variables are used in the regression models (see e.g. Ali et al., 2011; Fallah et al., 2011; Veneri and Ruiz 2013).

The dependent variables $\mathrm{EmpGr}_{\mathrm{service\&retail,1995-2009,i}}$ and $\mathrm{EmpGr}_{\mathrm{other\ sectors,1995-2009,i}}$ comprise the employment growth rates in service and retail sectors and in other sectors (excluding services and retail). To precisely gauge the local labor market, employment growth is measured as the working day population (i.e. where employed people work). A rural-to-urban commuter is defined as an individual that lives rural and works urban (on a municipal level)[2] and RUC1995 comprise the number of rural-to-urban commuters divided by the number of rural-living workers (i.e. employment based on where individuals reside). The reason for dividing with working individuals is to capture commuter effects as "pure" as possible. For instance, normalizing by the number of rural dwellers instead will introduce noise by the inclusion of non-potential commuters (since not all rural dwellers are of working age). RUC1995 is calculated for all individuals and also divided upon education[3]. Regression (1a) and (1b) are run for all commuters and for those with a low respectively high education (in total 3+3 regressions), i.e. the dependent variable is the same in 1a and 1b but the RUC change in the different regressions. The reason for running separate regressions for each type of commuting labor is to conclude if the effects from RUC on local employment growth differ for different parts of the commuting labor (depending on their level of education) [4].

It is expected that $RUC_{1995,i}$ has a positive impact on employment growth in service and retail sectors in regression (1a) (irrespective of workers' educational levels). This is consistent with hypothesis 1 that commuters' higher wages vis-à-vis rural workers spur local demand in service and retail sectors, and as the demand increases, so does the demand for labor, resulting in local employment growth. In addition, it is expected that the local employment growth effects are stronger for highly educated commuters than for less educated (due to higher wage levels for commuters with higher education). The main argument is that highly educated individuals can potentially spend more locally on services and retail than their less paid and lower educated counterparts. There should be weak or no significant effect from $RUC_{1995,i}$ on employment growth in sectors not primarily relying on local demand (in regression specification 1b). There is no obvious link between increased local spending and increased job opportunities in such industries. Thus, spread effects from rural-to-urban commuting is

not expected when employment growth in these sectors are examined. This result is expected to hold regardless of the commuters' length of education.

The set of distance variables (DNUC, SqDNUC and AddDist) reflects the role of distance and urban proximity on rural employment growth in regression (1a) and (1b). Distance to the nearest urban center (DNUC) is measured as the driving time in minutes from the population centroid in each rural municipality to the population weighted centroid of the nearest urban classified municipality[5]. There are at least two key motivations of including distance related variables in the models. Firstly, these capture the spatial heterogeneity of different rural areas w.r.t urban accessibility. DNUC captures effects related to rural households and firms' access to urban centers for markets and services (following Partridge et al., 2007a-b; Partridge et al., 2010). For instance, local employment growth may be hampered by urban remoteness in terms of poorer market potential (e.g. due to lower urban-led demand). Secondly, the inclusion of distance related variables in regression (1a) and (1b) makes it possible to disentangle spread effects stemming from rural-to-urban commuting (measured by $RUC_{1995,i}$) from those that purely relate to distance. RUC measures the actual commuting flows while for instance commuting costs are assumed to be captured by the distance measures[6].

The effect of DNUC on rural employment growth is anticipated to be negative in regression (1a) and (1b): i.e. remoteness from urban centers is likely penalizing for rural employment growth. In regression (1a) when employment growth in service and retail sectors is considered, remoteness from urban centers may weaken the positive effects from urban market demand. Increased distance to urban centers makes rural service and retail less accessible for urban inhabitants. Furthermore, closeness to urban markets facilitates rural retail and recreational venues, making such areas attractive places of employment (Glaeser 1997; Krugman 1993) and may work as a way for urban adjacent places to experience spread effects. In regression (1b) the expected sign of DNUC is negative, but due to different motivations than for firms in services and retail. For instance, manufacturing firms may benefit from relatively lower land costs and cheap rural labor and still have access to urban consumer markets. Thus, these firms can keep distance-related costs low; for instance, transportation and transaction costs decrease with closeness to cities (Glaeser 1997; Krugman 1993). Remote rural areas cannot offer these benefits. New and relocating firms are therefore hampered with increased distance to urban places and as a consequence, urban-led employment growth is lower in remote rural places. The argument of including a squared

DNUC term in the models is to account for attenuating effects of urban proximity. A positive sign of the squared DNUC is expected and indicates that gains of urban proximity diminish when moving farther into the rural countryside.

DNUC is constructed as the distance to the nearest urban center irrespective of its size. However, the size of the nearest urban center plays an important role for rural areas following the rationale of Central Place Theory (CPT) of Christaller (1933) and Lösch (1940). According to CPT, large urban centers provide rural inhabitants the highest-ordered goods, services and urban amenities and represent the highest-tier in urban hierarchy (i.e. the highest level in an ordering of urban places with respect to the goods and services provided). Some of these goods cannot be found in urban centers lower in the urban hierarchy. In essence, negative and penalizing effects of urban remoteness are expected to be greater from large urban centers than it is from smaller urban centers (for instance in terms of increased costs for households and firms to access higher-ordered goods, services and markets ) [7]. The variable AddDist is therefore included in the regression models[8]. AddDist accounts for the additional distance it takes for rural inhabitants to reach (the closest) large urban center instead of going to any of the ones found lower in the urban system. This makes it possible to distinguish distance effect from urban areas of different sizes. By creation, AddDist equals zero if the nearest urban center is large. However, if going to a large urban center is done with less (or the same) effort as going to a smaller urban center, the former is assumed to be preferred due to the larger supply of higher-ordered goods and services. Thus, if significant, the coefficient of AddDist is expected to be negative (and larger in absolute terms than DNUC).

Conceptually, it makes sense considering factors in surrounding municipalities that may influence local job growth locally. Thus spatial lags are included in the regression models. In regression 1a-1b, *employment growth in surrounding rural areas* (in services and retail as well as in other sectors, respectively) and *the distance to nearest urban center for neighboring municipalities* are spatially lagged. It is likely that local employment growth is influenced by the growth performance in employment in adjacent municipalities. Whether the effect of such surrounding employment growth is positive or negative for local employment growth is of subordinate importance for the purpose of this paper. For instance, a positive effect from surrounding growth on local employment growth could indicate that other rural areas' growth performances are beneficial for a municipality in terms of employment growth. There could also be reverse effects, a negative effect would be a sign of that rural surrounding economies'

deprive the local economy for instance by drawing resources away (e.g. human capital). It is however important to control for this in the models in order to get unbiased parameter estimates. This also holds for the spatially lagged variable on neighboring municipalities' distance to nearest urban center. If being surrounded by neighboring municipalities that more easily access urban areas, this could negatively influence the growth prospect in employment locally. For instance, labor rather reside in municipalities where it is easier to access urban labor markets, thus these potential workers are foregone in more remote areas if the city is more easily accessed from a rural neighbor.

The control variables are included in the regressions to control for local (rural) conditions. The initial population size, the share of population in working age (20-64 years), the share of higher educated individuals and employment growth in nearest urban center intend to account for the influence of (local and surrounding) agglomeration economies as well as human capital migration effects. When control variables are included in the analysis, it is accounted for the possibility that the regression result is driven by local economic and demographic conditions in rural areas. The initial population size intends to capture effects related to the size and scale of the rural municipality. For instance, large rural municipalities in terms of population are likely more self-sufficient in terms of employment opportunities et cetera. The share of individuals of working age 20-64 intends to measure how "saturated" the local (rural) labor market is. A large share of individuals of working age means that there is a higher need for rural out-commuting (not necessarily to an urban center) since local economies are not likely to provide all dwellers employment. The same argument holds for the share of workers in a rural municipality with secondary or higher education but captures the "saturation" of labor markets for higher educated individuals in rural places. Finally, employment growth in the nearest urban center exposes employment growth effects in surrounding urban agglomerations and its potential effect on rural municipalities.

*Test of hypothesis 2 and hypothesis 3*

To test hypothesis 2 and 3, the key determinants of rural-to-urban commuting are examined. A regression model is set up to explain rural-to-urban commuting as a function of rural population and local employment growth, time distance related variables, control variables of local rural conditions and spatial lags to account for potential impact of rural neighbors. In regression form, this is spatially modelled as

Regression (2)

$$RUC_{2009,i} = \alpha + \theta_1 \mathrm{PopGr}_{1995-2001,\mathrm{i}} + \theta_2 \mathrm{EmpGr}_{1995-2001,\mathrm{i}} + \theta_3 \mathrm{DNUC}_{\mathrm{i,j}} + (\ldots)$$
$$\theta_4 \mathrm{SqDNUC}_{\mathrm{i,j}} + \theta_5 \mathrm{DNUC}_{\mathrm{i,j}} * \mathrm{PopGr}_{1995-2001,\mathrm{i}} + \theta_6 \mathrm{AddDist}_{\mathrm{i,j}} + \mathrm{Controls} + (\ldots)$$
$$+\mathbf{W} * \mathrm{Spatial\ lags} + \omega_{\mathrm{i}}$$

In regression specification 2, the variables are measured in the same way as earlier but the share of rural-to-urban commuters in the rural workforce is the dependent variable (for all individuals and by education, in total 3 regressions; see Appendix 1). The key aim is to explain rural-to-urban commuting shares in 2009 with population and employment growth as well as of an interaction term between population growth and distance to nearest urban center (DNUC). Both population and employment growth are conceptually important when explaining determinants of rural-to-urban commuting (in regression 2). Only considering rural population growth when explaining rural-to-urban commuting could possibly cover employment related effects. Employment growth is therefore included in the models to disentangle population and employment effects on rural-to-urban commuting. In addition, by including both population and employment growth as explanatory factors of rural-to-urban commuting, it is possible to determine what drives the local economy. If the rate of out-commuting is negatively influenced by local employment growth this indicates that the area is self-sufficient in terms of employment opportunities. On the other hand, if population growth drives rural-to-urban commuting, this is consistent with the idea that rural areas participate in urban growth through the process where people move to rural areas to commute to an urban workplace.

To find support for hypothesis 2 and 3, the sign of population growth on rural-to-urban commuting is expected to be positive and significant. This is an indication that people migrate to the rural-urban fringe with access to urban employment through commuting. If no such effects exist, population growth is expected to be insignificant when employment growth is added to the regression. It is also possible that both population and employment drive rural-to-urban commuting (see e.g. Partridge et al., 2010). In that case employment growth is anticipated to have a negative impact on rural-to-urban commuting since municipalities with strong local employment growth are less reliant on commuting to urban areas. People choose to work locally instead to avoid the inconveniences that commuting entails (Partridge et al., 2010). The employment growth variables on the right hand side of regression 2 are also

divided after commuters' length of education to isolate labor market effects for each separate group in the different regressions. For instance, if employment opportunities exist for work that requires higher education (at rural home), fewer highly educated workers is expected to commute to the city for work, or even less, migrate to such rural areas in order to access urban employment.

The effects of the distance related variables DNUC and AddDist are expected to have a negative impact on rural out-commuting rates. In regression 2, DNUC captures the effects of commuting possibilities to jobs, urban amenities and reflects access to public services such as larger hospitals, police stations or universities. Rural-to-urban commuting is likely to be negatively influenced as the distance to urban centers increase. For instance, long commuting distances hamper rural-to-urban commuting and access to urban labor markets and the probability of getting an urban employment. The interaction term in regression (2) reveals how rural population growth effects (on rural-to-urban commuting) declines with distance and is included in the model to find the distance where the spatial reach of commuting ends. The expected result from regression specification 2 is that population growth has a positive impact on rural-to-urban commuting with a declining rate of distance and thus the estimate of the interaction term is expected to be negative. More practically this means that the phenomena of people moving to rural areas to access urban work is less pronounced with increased efforts to access an urban place of work.

The spatial lags in regression (2) comprise *the share of rural-to-urban commuters in surrounding rural areas* as well as *the employment growth in neighboring municipalities*. As in the case with regression 1a-1b, the primary interest is not in the direction of parameter estimates but rather to account for what happens in surrounding rural areas and how local rural-to-urban commuting rates are influenced by this. Substantial shares of rural-to-urban commuters in adjacent rural municipalities may well indicate that a municipality is part of a strong out-commuter region. This could of course have both positive and negative effects on rural-to-urban commuting locally. For instance, many out-commuters in the region may work as a hinder of getting urban employment (due to higher competition of urban jobs). Concerning employment growth in neighboring rural municipalities, it is likely that this could influence the out-commuting rate to urban municipalities. For instance, being close to a well-growing municipality (in terms of employment opportunities) could have a negative effects on the rural-to-urban out-commuting rate. People may rather commute to the rural surroundings

than getting an urban job where the efforts of traveling to work may be larger for the individual.

To examine hypothesis 3 more specifically and how far across space (in minutes driving time) population growth drives rural-to-urban commuting the estimates from regression 2 is utilized. Thus, how far across space spread effects from commuting reach is calculated (for all workers and divided upon educational levels) by setting regression(s) (2) to zero and take partial derivatives with respect to rural population growth. The moments (in minutes) where population growth no longer drives rural-to-urban commuting are found and can be expressed as calculation (3):

$$DNUC_{Spatial\ reach} = -\left(\frac{\theta_1}{\theta_5}\right)$$

In the calculations of the spatial reach of commuting, the expected result (to find support for hypothesis 3) is that the spread effects related to higher educated individuals reach for longer distance than for their less educated counterparts. This occurs because commuters with higher levels of education travel over longer distances, have higher wages and thus stronger incentives to move and commute to urban places of work.

*Data and descriptive statistics of the regression variables*

The data material used in this paper stems from Statistics Sweden's LISA database (Integrated database for labor market research for the years 1995-2009) and consists of 196 rural municipalities in Sweden. In Table 1, descriptive statistics on growth rates in employment, population and commuting related variables are found. Descriptive statistics for all variables used in the regression models is Appendix 2.

According to Table 1, the employment growth in service and retail during 1995-2009 has been stronger than employment growth in other sectors (when excluding services and retail). This reflects that rural areas are following the urban trend and moving towards becoming service economies. Suggestively, the large decline employment growth in other sectors reflects the closure of farming industries and manufacturing firms. Considering employment growth in rural areas in broad show that there is a large heterogeneity in performance between municipalities. Some rural municipalities have performed well (showing growth rates of 30-

50% depending on the labors' educational levels) while others have been worse off (up to 70% decline in employment). Employment growth based on individuals' education length comprises growth rates in employment of working individuals that have high and low education, respectively. There is a similar pattern in rural population growth. The worst performing municipality regarding population growth has experienced negative growth rates of 22% during 1995-2009 while the best has experienced a 14% growth. In all, these large differences in growth rates in rural areas show a large variability which reflects the fact that there are difference among rural areas and their performance.

**TABLE 1: Descriptive statistics of rural municipalities in Sweden**

| Variable | Average | Std. Dev | Min | Max |
|---|---|---|---|---|
| Employment growth in service/retail (1995-2009) | 4.36 | 13.38 | -27.50 | 67.66 |
| Employment growth in other sectors (excl service/retail) (1995-2009) | -20.29 | 16.58 | -71.47 | 23.45 |
| Employment growth - all individuals (1995-2009) | -0.98 | 7.60 | -17.56 | 31.89 |
| Employment growth - individuals with higher education (1995-2009) | 12.17 | 10.94 | -22.39 | 53.40 |
| Employment growth - individuals with low education (1995-2009) | -3.91 | 7.34 | -20.52 | 29.57 |
| Population growth (1995-2009) | -4.87 | 3.60 | -11.58 | 6.78 |
| Share of rural-to-urban commuters in the workforce (2009) | 16.52 | 11.72 | 2.55 | 51.50 |
| Share of rural-to-urban commuters in the workforce (2009) (Individuals with higher education only) | 21.61 | 13.91 | 3.83 | 58.37 |
| Share of rural-to-urban commuters in the workforce (2009) (Individuals with low education only) | 20.86 | 13.55 | 3.94 | 65.34 |
| Dist. to nearest urban center (DNUC) - in minutes | 53.93 | 33.39 | 17.59 | 234.27 |
| Additional dist. to a large urban center - in minutes | 148.84 | 147.44 | 0.00 | 594.90 |

**Source:** Statistics Sweden (LISA database 1995-2009) and own calculations.
**Note:** The calculations is based on all years possible from the data material (1995-2009), see Appendix 2 for the corresponding descriptive statistics for variables used in the regression models. The statistics in Table 1 represent the 196 rural municipalities included in the analysis.

The share of rural-to-urban commuters of the rural working population (RUC) is 16.52%. The standard deviation and minimum and maximum values suggest that there is a large heterogeneity between rural areas. This result is also true when commuters are considered according to their level of education. The share of rural-to-urban commuters by education length is created by dividing rural-to-urban commuters with high (low) education with the share of rural working population with high (low) education. The distance related variables show that the average traveling time to an urban center of any size (DNUC) is 54 minutes while the additional distance to a large urban centers is 149 minutes. The minimum traveling distance in minutes to an urban center is 18 minutes while the most remote rural municipality in Sweden is located 234 minutes away from an urban center. Following the hypotheses in the conceptual framework it is expected that a large rural variability in terms of employment growth is exposed in the subsequent analysis.

## 4. A DEPICTION OF RURAL SWEDEN 1995-2009

Growth rates in population and employment between 1995 and 2009 are shown in Figure 1. Three conclusions can be drawn from the figure. One, closeness to an urban center may be advantageous for municipalities in terms of population and employment growth. Indisputably other factors exist to explain the rural heterogeneity as well: this is indicated by the low $R^2$ values in Figure 1 and by the substantial variations in population and employment growth (even at the same distances). This suggests that both conditions in the rural municipality as well as the characteristics of the nearest urban center matters in order for urban growth to spill over to its surroundings. This calls for the inclusion of control variables (to account for local conditions) as well as considering the size of the nearest urban center (disentangling distance effect from small and large urban centers) in the subsequent analysis. The second conclusion is that remote rural municipalities often perform poorer than their counterparts in urban proximity. This corroborates that there are penalizing effects of urban remoteness, both on employment and population growth. Third and finally, Figure 1 drives home the point that population growth not necessarily is strongly related to local employment growth which suggest that commuting may be used as a tool to cancel the resulting gap in unemployment.

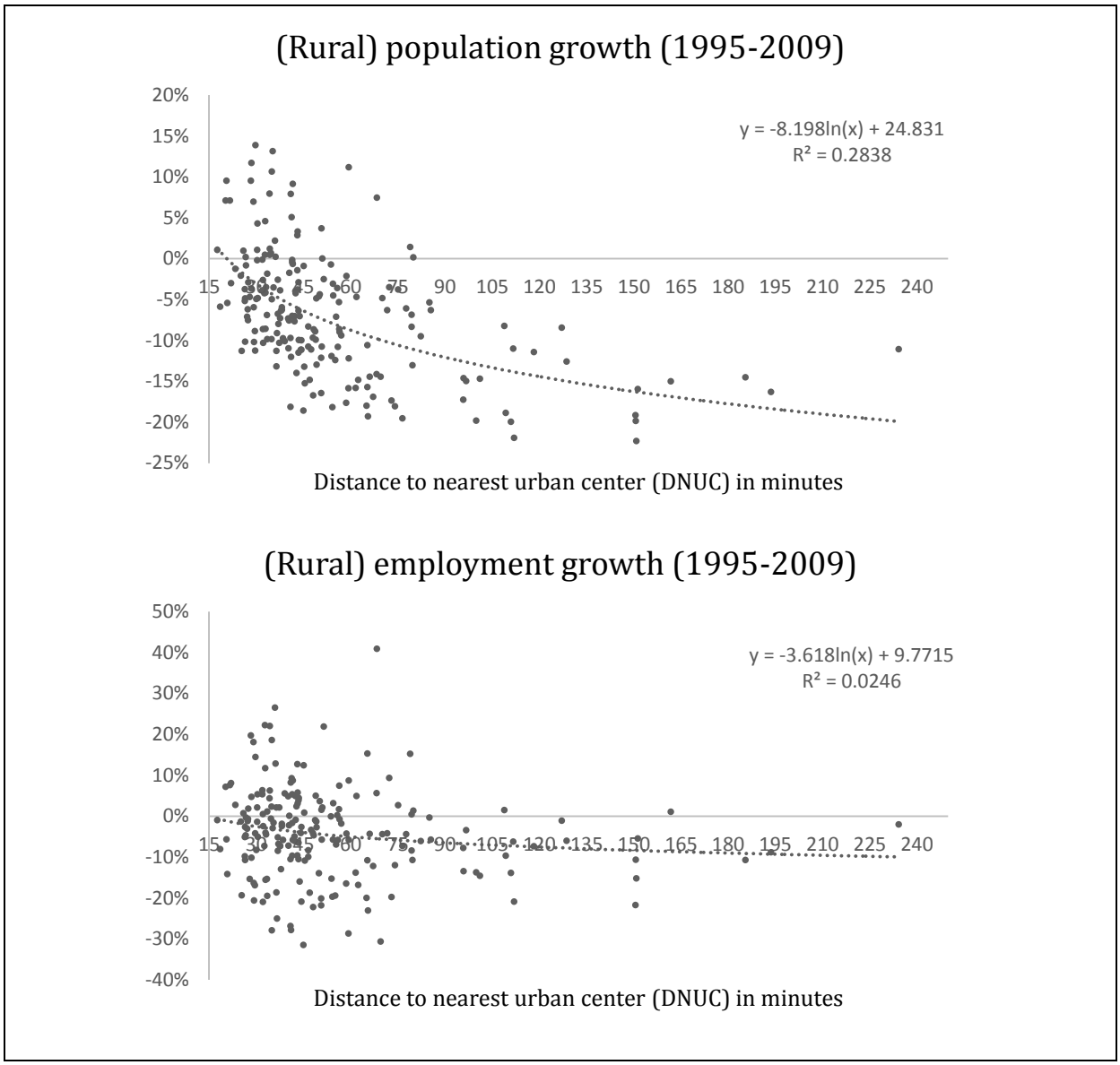


**FIGURE 1:** Population growth (upper panel) and employment growth (lower panel) in rural municipalities 1995-2009. Each dot corresponds to a rural municipality (196 in total).

Figure 2 presents the percentage share of rural-to-urban commuters by DNUC. As expected, commuting from rural municipalities close to cities is more frequent the closer these are located to an urban center. The tendency to commute to urban areas start to decline at 60-90 minutes. The rural-to-urban commuting share is relatively low and constant for areas located 90 minutes and beyond. However, there is a substantial variability in rural-to-urban commuting rates, suggesting that commuting may not be an alternative in some parts of the Swedish countryside (for instance due to lacking infrastructure or poor commuting possibilities). The increasing decline in commuting with distance again support that there exist a distance penalty of urban remoteness. As people do not commute, spread effects from commuting do not reach parts of the remote countryside in Sweden.

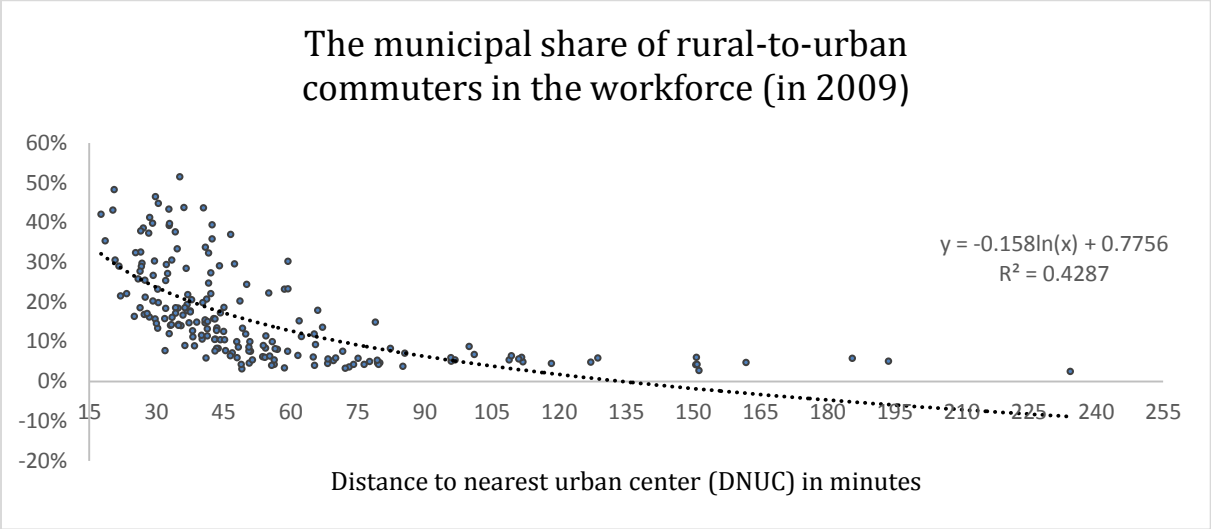


**FIGURE 2**: The share of rural workers commuting to urban areas in 2009. Each dot in the diagram corresponds to a Swedish rural municipality (196 in total).

In the upper panel in Figure 3, the disposable income of rural-to-urban commuters is depicted for individuals' by their level of education. Figure 3 shows that rural-to-urban commuters with higher education consistently earn more than less educated commuters. In the lower panel of Figure 3 the income differential (in percentage) between rural-to-urban commuters and local rural workers is presented. Accordingly, rural-to-urban commuters with higher education earn more than their local working neighbors that also have higher education (this results also holds for individuals with lower education). Higher educated individuals earn on average 12.5% more than their local working peers during 1995-2009, while the same number for the less educated is 8.9% (not reported). As hypothesized and in accordance with earlier studies, commuters earn more than local workers (see e.g. Brownstone and Small 2005 and Mulalic et al., 2013). This may have implications on local employment growth as suggested by hypothesis 1. Thus, commuters can potentially spend more and contribute stronger to the local economy in terms of increased demand and subsequent employment growth.

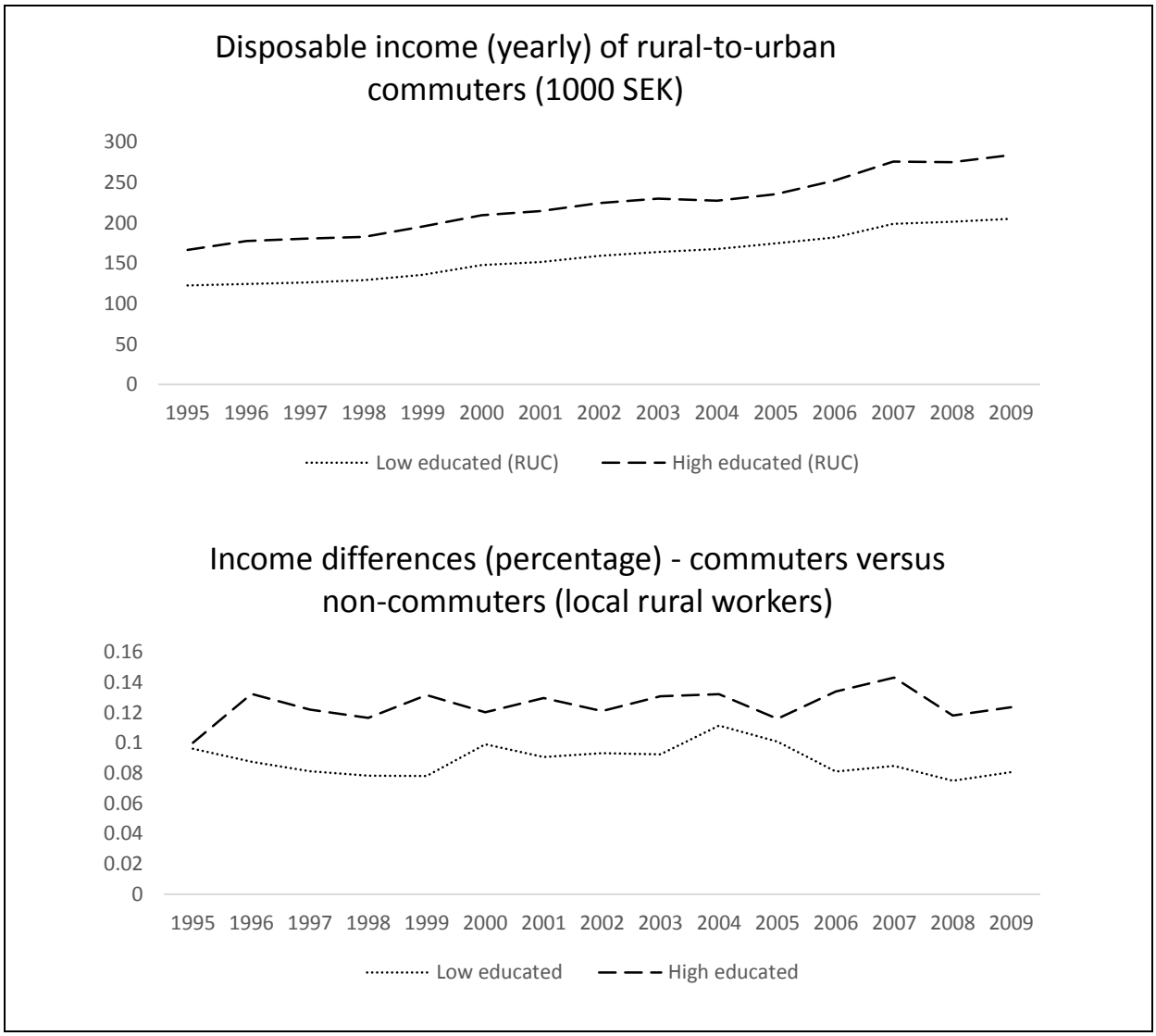


**FIGURE 3***:* Upper panel shows the disposable income for rural-to-urban commuters (in 1000 SEK). The lower panel shows income differences (in percentage) of rural-to-urban commuters in comparison to local workers (employment measured as working day population).

## 5. EMPIRICAL ANALYSIS

*Does rural-to-urban commuting influence employment growth?*

Table 2 presents the estimated parameters of the spatial lag models in regression specification (1a) and (1b). Accordingly, there is a significant and positive impact of rural-to-urban commuting (of any type of education) on employment growth in rural service and retail sectors. There is thus support for hypothesis 1 that there are positive impacts of rural-to-urban commuting on rural employment growth in these sectors. This is also consistent with the idea that commuters earn (higher) urban incomes and spend them on local services and retail products. Thus, commuting may stimulate rural development in terms of increased employment opportunities. When studying other sector employment growth (excluding

services and retail), no positive effects from commuting exist. As expected, firms in sectors that primarily not depend on local demand are not influenced by increased commuting rates. It is also worth remarking that there seems to be no negative restructuring effects of rural-to-urban commuting. A plausible scenario is that people change from employment in other sectors to service and retail (as this part of the economy grows). In that case, the positive effects on local employment in services and retail would potentially be offset by reducing the labor supply in other sectors. This seems not to be the case.

According to Table 2, a 10% increase in the share of rural-to-urban commuters of the working population increases the local employment growth in services and retail sectors with 1.59 – 2.92 % depending on what level of education of the commuting labor. These employment growth effects seem to be stronger when highly educated individuals are considered. This is also consistent with the fact (with reference to Figure 3) that highly educated commuters have higher incomes than less educated commuters and thus can spend more locally on local services and retail products. This suggests that a development strategy for rural areas is to attract highly educated commuters since these contribute to increases in local employment growth. However, an inspection of the confidence intervals of the RUC-estimates shows that the difference between low and high educated individuals is insignificant. Due to its insignificance such result should be interpreted with caution.

Concerning the distance parameter estimates, the effect of increased remoteness from urban areas only operates through the large urban centers. Urban spread effects accruing to distance alone decrease with urban remoteness. Areas located 10 minutes farther away from large urban centers experience approximately a 0.36 percentage decrease in local service and retail employment growth.

## TABLE 2: Employment regressions

**Dependent variable**
**Employment growth 1995-2009 in rural municipalities in (i) service and retail and (ii) other sectors (excl service and retail).**

| | *(i) SERVICE AND RETAIL* | | | *(ii) OTHER SECTORS* | | |
|---|---|---|---|---|---|---|
| | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| | *ALL* | *High ED* | *Low ED* | *ALL* | *High ED* | *Low ED* |
| Rural-to-urban commuting share in 1995 (RUC) | 0.215** | 0.292*** | 0.159* | -0.217 | -0.177 | -0.175 |
| | (0.101) | (0.0826) | (0.0883) | (0.210) | (0.173) | (0.179) |
| Distance to nearest UC (DNUC) | 0.248* | 0.348** | 0.228* | -0.218 | -0.226 | -0.207 |
| | (0.127) | (0.138) | (0.127) | (0.210) | (0.221) | (0.207) |
| Squared distance to nearest UC (SqDNUC) | -0.000845 | -0.00121** | -0.000771 | 0.000525 | 0.000562 | 0.000483 |
| | (0.000513) | (0.000556) | (0.000511) | (0.000861) | (0.000900) | (0.000853) |
| Additional distance to a large UC (AddDist) | -0.0293*** | -0.0292*** | -0.0294*** | 0.00720 | 0.00694 | 0.00740 |
| | (0.00911) | (0.00902) | (0.00909) | (0.0110) | (0.0110) | (0.0110) |
| Share of population in age 20-64 in 1995 | 0.721 | 0.909 | 0.695 | -0.488 | -0.584 | -0.464 |
| | (0.612) | (0.617) | (0.611) | (0.962) | (1.006) | (0.953) |
| Population (1995) | -0.0168 | 0.00296 | -0.0198 | -0.136 | -0.131 | -0.137 |
| | (0.116) | (0.111) | (0.117) | (0.147) | (0.147) | (0.147) |
| Share of higher educated individuals (1995) | 1.024 | 0.962 | 1.052* | 0.360 | 0.381 | 0.331 |
| | (0.626) | (0.618) | (0.625) | (0.861) | (0.868) | (0.856) |
| Employment growth in nearest UC (1995-2001) | 0.193 | 0.172 | 0.204 | 0.478 | 0.463 | 0.471 |
| | (0.173) | (0.172) | (0.173) | (0.359) | (0.361) | (0.359) |
| Share of workers in sector(s) (1995) | 0.0354 | 0.00992 | 0.0396 | -0.145 | -0.129 | -0.148 |
| | (0.137) | (0.130) | (0.138) | (0.175) | (0.173) | (0.178) |
| *(Spatial lag)*: Employment growth in surrounding rural areas | 0.391*** | 0.370*** | 0.395*** | 0.0769 | 0.0759 | 0.0750 |
| | (0.0981) | (0.0968) | (0.0983) | (0.108) | (0.108) | (0.108) |
| *(Spatial lag)*: DNUC for surrounding rural areas | -0.179** | -0.181** | -0.177** | 0.0205 | 0.0132 | 0.0204 |
| | (0.0813) | (0.0812) | (0.0816) | (0.171) | (0.170) | (0.170) |
| Constant | -50.33 | -64.58* | -48.63 | 19.14 | 24.58 | 17.82 |
| | (34.14) | (34.67) | (34.04) | (55.14) | (58.29) | (54.71) |
| R-squared | 0.316 | 0.335 | 0.313 | 0.045 | 0.044 | 0.044 |
| Moran's I (p-value) | 0.076 | 0.115 | 0.067 | 0.740 | 0.742 | 0.743 |
| Moran's I (p-value), without spatial lags | 0.006 | 0.007 | 0.006 | 0.610 | 0.620 | 0.623 |
| Observations | 196 | 196 | 196 | 196 | 196 | 196 |

*** p<0.01, ** p<0.05, * p<0.10

**Note:** For full models specifications see Appendix 1. Clustered standard errors (on municipal level) are found within the parentheses. R-square is a goodness of fit measure and indicates how well the variation of the predicted values conform the observed data. Moran's I is a specification test for spatial autocorrelatio

Somewhat surprising, the estimated effects of DNUC on rural-to-urban commuting are positive in Table 2. Municipalities located farther away from large cities are not penalized by that, rather the opposite. One explanation given in the literature is that there is a distance protection from spatial competition (partly in accordance with some models in New Economic Geography, these reflects 'growth shadows'; see e.g. Krugman 1993). For instance, urban remoteness protects rural firms from urban competition in the production of retail goods and provision of services. One plausible explanation is that higher-end retail products may be bought locally to avoid waiting and traveling times for consumers. The argument would be that it is more convenient to get a certain product instantly by buying it locally instead of taking the time and effort buying it in a larger urban area. As hypothesized, the effect of additional distance to larger urban centers is negative.

Most of the control variables are insignificant in Table 2 which suggests that local rural conditions are not as important for local employment growth as external conditions and a region's accessibility to urban areas. For instance, the spatial lag variables are significant in the regression where employment growth in service and retail are considered. Employment growth in surrounding rural areas has a positive effect on local employment growth in service and retail. Moreover, the spatial lag of the DNUC for adjacent rural regions is negatively significant. This suggests that the easier rural neighboring municipalities access urban areas, the less is the local employment growth in service and retail locally. Finally, Moran's I test statistics are insignificant (after adding the spatial lags), strengthening that the adjustment for spatial autocorrelation is successful; i.e. no spatial autocorrelation prevails in the residuals

*What is the spatial reach of rural-to-urban commuting?*

According to Table 3 and consistent with hypothesis 2, there is a certain distance where rural-to-urban commuting is no longer driven by population growth and as a result spread effects end. First, population growth is positively significant; a 1% increase in population growth yield between 1.9-2.5 % increases in the rural-to-urban commuting rate (dependent on the commuters' length of education). Second, this effect persists even when employment growth is added to the regression model. Third, the pace of which migration to urban surroundings occurs is negative and has explanatory power (since the interaction terms are negatively significant). These results hold for all individuals and also when the educational level of the labor force is taken into account.

**TABLE 3: Rural-to-urban commuting regressions**

| **Dependent variable(s)**<br>**Share of rural-to-urban commuters in 2009 (RUC)**<br>***(All individuals and by education levels)*** | (1)<br>*ALL* | (2)<br>*High ED* | (3)<br>*Low ED* |
|---|---|---|---|
| Population growth in 1995-2001 (PopGr) | 1.880*** | 2.499*** | 1.902*** |
| | (0.542) | (0.552) | (0.655) |
| Employment growth 1995-2001 (EmpGr) | -0.123 | -0.224*** | -0.0828 |
| | (0.0962) | (0.0648) | (0.117) |
| Interaction term (PopGr*DNUC) | -0.0192*** | -0.0208*** | -0.0213** |
| | (0.00712) | (0.00760) | (0.00877) |
| Distance to nearest UC (DNUC) | -0.612*** | -0.796*** | -0.678*** |
| | (0.0670) | (0.0739) | (0.0814) |
| Squared distance to nearest UC (SqDNUC) | 0.00155*** | 0.00216*** | 0.00170*** |
| | (0.000308) | (0.000304) | (0.000382) |
| Additional distance to a large UC (AddDist) | 0.0122** | 0.0129** | 0.0139** |
| | (0.00496) | (0.00559) | (0.00583) |
| Share of population in age 20-64 in 1995 | -0.696* | -1.296*** | -0.721 |
| | (0.399) | (0.406) | (0.491) |
| Population (1995) | -0.148* | -0.194** | -0.170* |
| | (0.0792) | (0.0820) | (0.0976) |
| Share of higher educated individuals (1995) | 0.646 | 0.536 | 0.770 |
| | (0.396) | (0.404) | (0.485) |
| Employment growth in nearest UC (1995-2001) | 0.191 | 0.0438 | 0.290 |
| | (0.168) | (0.163) | (0.218) |
| *(Spatial lag)*: Rural-to-urban commuting share from | 0.380*** | 0.332*** | 0.386*** |
| surrounding rural areas in 1995 | (0.0817) | (0.0795) | (0.0842) |
| *(Spatial lag):* Employment growth in surrounding rural areas | -0.203 | -0.179* | -0.224 |
| | (0.144) | (0.104) | (0.174) |
| Constant | 71.14*** | 125.8*** | 74.98*** |
| | (22.33) | (23.76) | (27.12) |
| R-squared | 0.619 | 0.691 | 0.577 |
| Moran's I (p-value) | 0.341 | 0.192 | 0.415 |
| Moran's I (p-value), without spatial lags | 0.000 | 0.000 | 0.000 |
| Observations | 196 | 196 | 196 |

*** p<0.01, ** p<0.05, * p<0.10

**Note:** Estimates in 1-3 are from OLS regressions with spatial lags. For full models specifications see Appendix 1. Clustered standard errors (on municipal level) are found within the parentheses. R-squared is a goodness of fit measure and indicates how well the variation of the predicted values conform the observed data. Moran's I is a specification test for spatial autocorrelation.

DNUC is negatively significant in all regressions in Table 3, indicating that distance hampers rural-to-urban commuting (e.g. through increasing commuting costs with distance or due to increased efforts associated with commuting). The squared DNUC indicates that the negative effect of distance is attenuating with remoteness which is also consistent with literature on commuting (see e.g. Johansson et al., 2003) and earlier studies on rural-to-urban commuting (see e.g. Partridge et al., 2010). Unexpected, however, is the finding that the additional distance to large urban centers is positively significant. One explanation of this is that there

exist substitution effects in where commuting occurs. The idea is that substitution occurs when distance to a large urban center becomes 'too far away' for commuting from some rural areas. Individuals that face commuting options to a large urban center may reconsider and instead commute to another but smaller urban place. It is, simply put, not an option to travel to work in larger urban centers after a certain distance. This is however only parts of the explanation. Another one is that increased urban remoteness is associated with increased lack of local employment opportunities, thus remoteness from large urban centers generate a need for commuting.

**TABLE 4: Spatial reaches of rural-to-urban labor market commuting**

| | |
|---|---|
| All workers | 97.92 min |
| High educated workers | 120.14 min |
| Low education workers | 89.30 min |

**Note:** Based on partial derivatives of estimates from 1-3 in Table 3.

The estimates that are needed to calculate the spatial reach of commuting are significant and therefore it is possible to use calculation (3). The critical distances of where population growth no longer drives commuting are found in Table 4. The distances in Table 4 reveal that there are different types of countryside in Sweden that highly depend on the decomposition of the labor force (in terms of the labors' length of education). Urban spread effects related to commuting reach on average 97.92 minutes from the population centroid of rural municipalities. It is evident that municipalities with highly educated individuals have the potential to experience spread effects over longer distances in comparison with those characterized by less educated labor (120.14 versus 89.30 minutes). This is in line with hypothesis 3 that the spatial reach from commuting spans over longer distances for individuals with higher education.

## 6. CONCLUDING REMARKS AND POLICY IMPLICATIONS

The result from this paper shows that rural-to-urban commuting has a positive and significant impact on local rural employment growth. These growth effects operate through employment growth in rural service and retail sectors, consistent with the hypothesis that increased spending of commuters (who have higher salaries than their local working peers) generates local labor demand. Subsequently, this leads to employment growth. An additional and important finding in the paper is that rural-to-urban commuting is not harmful for employment growth in other sectors. Certainly there is a risk that labor in other sectors is

reduced as individuals seek employment in the growing service and retail sectors. However, there seems to be no negative effects on the labor supply in sectors that are not dependent on local demand. Further, the analysis shows that spread effects from highly educated individuals are stronger than for their less educated neighbors. This indicates that a potential rural growth strategy could be to attract highly educated individuals to urban adjacent areas and offer access to urban labor markets. This result should however be interpreted cautiously, since the differences in magnitude of spread effects between different types of labor are insignificant.

The results also show that the spatial reach of rural-to-urban commuting is different for different types of rural municipalities. Some municipalities experience urban-based growth, but a prerequisite is that commuting from rural place of living to urban places of work is possible. In this paper, the spatial reach of commuting is defined as the moment where population growth (or migration to rural municipalities) no longer drives rural-to-urban commuting. The idea is that people move to the rural-urban fringe to commute to an urban place of work. These distances differ for parts of the labor force with respect to their length of education. In fact, there is almost a 30 minutes difference between highly and less educated individuals (120.14 and 89.30 minutes) in terms of the spatial reach of commuting. There are potential determinants given in the literature of why labor with a higher education will travel over longer distances. Among those determinants are wage differentials and that highly educated individuals have challenging labor-matching problems to solve (i.e. they need to commute over longer distance due to labor specialization and to achieve a good labor match; see e.g. Johansson et al., 2002, 2003). In any case, this means that two municipalities located at the same distance from an urban center do not necessarily experience urban based growth since it depends largely on the nature of the workforce. Rural municipalities located beyond 89.30 minutes need to attract a well-educated labor pool to experience positive spread effects from urban growth. While rural municipalities beyond 120.14 minutes of traveling time to cities will not experience positive impacts of urban spread through commuting, irrespective of how the labor force is composed. This is likely due to the fact that at these distances commuting is not a realistic alternative for most workers. The fraction of workers traveling longer distances is probably small and also exerts a small impact on local employment in their dwelling municipality.

By studying demographic flows in terms of population growth (migration) and commuting in the same framework, it is possible to gain some valuable insights in policy design. The result

in this paper strongly suggests that migration and commuting are complements rather than substitutes within the suggested distances (up to approximately 120 minutes). One type of complementarities exists when people move and choose a rural living and at the same time begin to commute to urban work (in the models in this paper, this corresponds to a positive association between population growth and rural-to-urban commuting shares). From a policy perspective, a growth strategy would then be to increase commuting to urban places from rural residential areas by various actions (e.g. improving infrastructure or subsidizing commuting) and attract individuals that are willing to commute to an urban place of work while at the same time prefer a rural lifestyle.

Finally, the analysis also shows that regions are spatially dependent, for instance, the labor market performance in neighboring municipalities influences the growth prospects for a municipality. The analysis is however performed at the municipal level but need to be put in a broader context to be accurately apprehended. Jointly efforts of municipalities on investments in building better roads and increasing the accessibility to urban regions are needed. Individual efforts of municipalities to increase the urban accessibility are likely to fail; increasing the accessibility to the municipal border not necessarily increases the access to urban regions. A further depth-in exploration of the interdependencies between rural areas is however left as a suggestion for future research.

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**APPENDIX 1 - Regression specifications**

In the following, **RUC_HED** and **RUC_LED** comprise the share of rural-to-urban commuters with low (high) education divided by the working population based on where they live (working night population) by educational levels. EmpGr_HED and EmpGr_LED correspond to the employment growth (working day population) for low and high educated individuals, respectively. The variables that change between the different model specifications are marked in italics in the specifications below.

**TABLE 2 in paper– column (1)-(3): Based on regression model 1a**

$$\mathrm{EmpGr}_{\mathrm{service\&retail,1995-2009,i}} = \alpha + \beta_1 RUC_{1995,i} + \beta_2 \mathrm{DNUC}_{\mathrm{i,j}} + \beta_3 \mathrm{SqDNUC}_{\mathrm{i,j}} + \beta_4 \mathrm{AddDist}_{\mathrm{i,j}} + \mathrm{Controls} + \mathbf{W} * \mathrm{Spatial\ lags} + \varepsilon_{\mathrm{i}}$$

$$\mathrm{EmpGr}_{\mathrm{service\&retail,1995-2009,i}} = \alpha + \beta_1 RUC\_HED_{1995,i} + \beta_2 \mathrm{DNUC}_{\mathrm{i,j}} + \beta_3 \mathrm{SqDNUC}_{\mathrm{i,j}} +$$

$$\beta_4 \text{AddDist}_{i,j} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_i$$

$$\text{EmpGr}_{\text{service\&retail},1995-2009,i} = \alpha + \beta_1 RUC\_LED_{1995,i} + \beta_2 \text{DNUC}_{i,j} + \beta_3 \text{SqDNUC}_{i,j} + \beta_4 \text{AddDist}_{i,j} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_i$$

**TABLE 2 in paper– column (4)-(6): Based on regression model 1b**

$$\text{EmpGr}_{\text{other sectors},1995-2009,i} = \alpha + \beta_1 RUC_{1995,i} + \beta_2 \text{DNUC}_{i,j} + \beta_3 \text{SqDNUC}_{i,j} + \beta_4 \text{AddDist}_{i,j} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_i$$

$$\text{EmpGr}_{\text{other sectors},1995-2009,i} = \alpha + \beta_1 RUC\_HED_{1995,i} + \beta_2 \text{DNUC}_{i,j} + \beta_3 \text{SqDNUC}_{i,j} + \beta_4 \text{AddDist}_{i,j} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_i$$

$$\text{EmpGr}_{\text{other sectors},1995-2009,i} = \alpha + \beta_1 RUC\_LED_{1995,i} + \beta_2 \text{DNUC}_{i,j} + \beta_3 \text{SqDNUC}_{i,j} + \beta_4 \text{AddDist}_{i,j} + \text{Controls} + \mathbf{W} * \text{Spatial lags} + \varepsilon_i$$

**TABLE 3 in paper– column (1)-(3): Based on regression model 2**

$$\boldsymbol{RUC_{2009,i}} = \alpha + \theta_1 \text{PopGr}_{1995-2001,i} + \theta_2 EmpGr_{1995-2001,i} + \theta_3 \text{DNUC}_{i,j} + \theta_4 \text{SqDNUC}_{i,j} + \theta_5 \text{DNUC}_{i,j} * \text{PopGr}_{1995-2001,i} + \theta_6 \text{AddDist}_{i,j} + \text{Controls} + + \mathbf{W} * \text{Spatial lags} + \omega_i$$

$$\boldsymbol{RUC\_HED_{2009,i}} = \alpha + \theta_1 \text{PopGr}_{1995-2001,i} + \theta_2 EmpGr\_HED_{1995-2001,i} + \theta_3 \text{DNUC}_{i,j} + \theta_4 \text{SqDNUC}_{i,j} + \theta_5 \text{DNUC}_{i,j} * \text{PopGr}_{1995-2001,i} + \theta_6 \text{AddDist}_{i,j} + \text{Controls} + + \mathbf{W} * \text{Spatial lags} + \omega_i$$

$$\boldsymbol{RUC\_LED_{2009,i}} = \alpha + \theta_1 \text{PopGr}_{1995-2001,i} + \theta_2 EmpGr\_LED_{1995-2001,i} + \theta_3 \text{DNUC}_{i,j} + \theta_4 \text{SqDNUC}_{i,j} + \theta_5 \text{DNUC}_{i,j} * \text{PopGr}_{1995-2001,i} + \theta_6 \text{AddDist}_{i,j} + \text{Controls} + + \mathbf{W} * \text{Spatial lags} + \omega_i$$

## APPENDIX 2 - Descriptive statistics - regression variables

| Variable | Type | Average | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| ***Specific to models in 1a-1b*** | | | | | |
| Employment growth in service/retail (1995-2009) | DV | 4.36 | 13.38 | -27.50 | 67.66 |
| Employment growth in other sectors (excl service/retail) (1995-2009) | DV | -20.29 | 16.58 | -71.47 | 23.45 |
| Share of rural-to-urban commuters in the workforce (1995) | IV | 12.40 | 9.90 | 1.43 | 44.08 |
| Share of rural-to-urban commuters in the workforce (1995) (Individuals with higher education only) | IV | 17.01 | 12.37 | 2.70 | 52.34 |
| Share of rural-to-urban commuters in the workforce (1995) (Individuals with low education only) | IV | 15.66 | 11.35 | 2.00 | 51.97 |
| Share of workers in retail/services (1995) | IV | 34.71 | 10.17 | 7.95 | 68.70 |
| Share of workers in other sectors (excl retail/services) (1995) | IV | 65.29 | 10.17 | 31.30 | 92.05 |
| ***Specific to models in 2*** | | | | | |
| Share of rural-to-urban commuters in the workforce (2009) | DV | 16.52 | 11.72 | 2.55 | 51.50 |
| Share of rural-to-urban commuters in the workforce (2009) (Individuals with higher education only) | DV | 21.61 | 13.91 | 3.83 | 58.37 |
| Share of rural-to-urban commuters in the workforce (2009) (Individuals with low education only) | DV | 20.86 | 13.55 | 3.94 | 65.34 |
| Population growth (1995-2001) | IV | -4.87 | 3.60 | -11.58 | 6.78 |
| Employment growth - all individuals (1995-2001) | IV | -0.98 | 7.60 | -17.56 | 31.89 |
| Employment growth - individuals with higher education (1995-2001) | IV | 12.17 | 10.94 | -22.39 | 53.40 |
| Employment growth - individuals with low education (1995-2001) | IV | -3.91 | 7.34 | -20.52 | 29.57 |
| Interaction term: Population growth (1995-2001) * DNUC | IV | -311.22 | 361.72 | -1,793.35 | 352.98 |
| ***Controls (all models)*** | | | | | |
| Dist. to nearest urban center (DNUC) - in minutes | IV | 53.93 | 33.39 | 17.59 | 234.27 |
| Squared distance to nearest urban center (DNUC) - in minutes | IV | 4,017.64 | 6,574.31 | 309.54 | 54,882.20 |
| Additional dist. to a large urban center - in minutes | IV | 148.84 | 147.44 | 0.00 | 594.90 |
| Share of population in working age (20-64) (in 1995) | IV | 54.48 | 1.90 | 49.26 | 61.11 |
| Population in 1000s (1995) | IV | 16.76 | 10.82 | 2.85 | 58.25 |
| Share of individuals with higher education in the workforce (1995) | IV | 9.80 | 2.13 | 6.36 | 17.10 |
| Employment growth in nearest urban center (1995-2001) | IV | 5.85 | 4.20 | -1.77 | 24.21 |

*Note: DV (Dependent variable), IV (Independent/explanatory variable)*

**APPENDIX 3 – Description of the urban hierarchy measure (DNUC and AddDist)**

Figure A1 illustrates how DNUC and AddDist are created and the relationship between rural and urban municipalities in the data material. In Figure A1, three rural municipalities are considered and their relation to three urban centers (of which two are smaller and one is large).

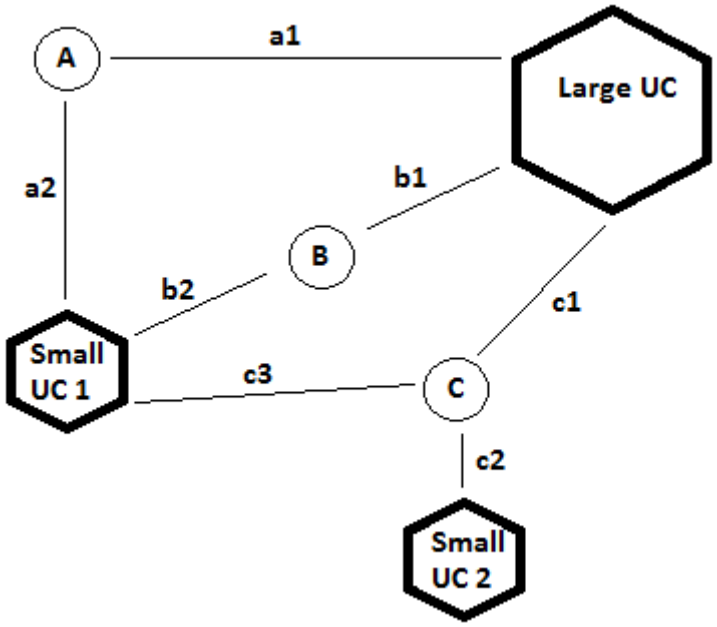


**FIGURE. A1: The relation between DNUC and AddDist.**

The traveling times between places correspond to the small letters a1, a2, b1,…. For rural municipality A, DNUC equals the distance a2 (since a2<a1) and the additional distance to a large urban center is the difference a1-a2. Municipality B is located exactly between a smaller urban center and a large urban center. In that case, the large UC is considered as the nearest for rural municipality B (i.e. DNUC corresponds to the distance b1). Rural municipality C has, in contrast to rural municipality A and B, two smaller urban centers in proximity (UC 1 and UC 2). The interrelation between these urban centers does not matter in this framework. For instance, suppose that UC 1 > UC 2 in size (e.g. population), the latter is still considered as the nearest UC.

## ENDNOTES

[1] Several different thresholds have been tried with no or small discrepancies.

[2] The geographical classification of rural and urban municipalities initially stems from the Swedish Board of Agriculture. These definitions have been employed in a sizeable amount in earlier research (see e.g. Hacker et al., 2013). Urban areas consist of municipalities where all population lives in or within 30 kilometers distance to urban agglomeration economies (Stockholm, Malmö and Gothenburg) or where the municipalities' population size is at least 30 000 individuals and there is a city within the municipality that has at least 25 000 inhabitants. Municipalities in urban proximity are defined as urban if at least 50% of the labor force is out-commuting from their place of residence. According to this definition there are 93 municipalities classified as urban in Sweden in 2009. Rural municipalities consist of the ones not included in the urban definition.

[3] Higher education is defined as having at least three years of university studies or higher education. Workers with less education than this are considered as low educated.

[4] Fully specified models are found in Appendix 1.

[5] In this paper, a municipality is considered as an urban center if it is classified as urban (according to the definition from the Swedish Board of Agriculture) and has at least 50 000 individuals. According to this definition, 39 urban centers are discerned in the data.

[6] The distance measures and commuting costs are constant over time and based on time distances in 2009. Using the lag of RUC (measured in 1995) makes it independently determined from commuting costs.

[7] In the data, 36 of the 39 urban centers are considered as small while the remaining three are larger (Stockholm, Malmoe and Gothenburg). Large urban centers have at least 250 000 individuals.

[8] For further reference on how the set of distance variables are created, see Partridge et al., 2008, Partridge et al., 2010 and more specific for this paper Appendix 3.