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**Potential labour supply in the regions of the Nordic countries:
A method to forecast and test regional patterns of potential labour supply**

Aki Kangasharju ^a, Torben Dall Schmidt ^b, Daniel Rauhut ^c

Abstract

Ageing is a central issue in policy debates in many countries. Much of the attention in the current debate is focused on (a) the labour supply and (b) aggregate problems at national levels. The present paper asks a distinct but related question by examining how ageing changes the regional variation in the future potential labour supply in different countries embedding different labour market systems. The paper, first introduces a new concept of Labour Potential. Second, projections for the level of Labour Potential in the Nordic regions are presented up to 2021. The results reveal large variations in the future levels of Labour Potential in the Nordic regions not necessarily revealed by the variation in ageing patterns.

Keywords: Potential labour supply, regional forecasting, ageing, Granger analysis

JEL: R11, R23, J11, J21, J26

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Introduction

Despite drastic changes in global economic conditions since the emergence of the banking crisis in 2008, the need to retain a sufficient supply of competent labour resources remains a continuing policy concern in the long run. This is particularly so on the regional scale of the Nordic countries, where a large majority of regions are rather small in size, sparsely populated and have rapidly ageing population structures. A policy issue thus emerges as to whether labour market resources in these regions can be ensured in the long-term or if the ageing process is casting a threat for vitality. The present paper develops a concrete method to analyse effects of ageing on regional labour markets and the policy concerns thereof. It furthermore implements this method for the Nordic regions to identify the future potential regional shortcomings in labour supply.

Policy challenges emerging from the labour supply effects of ageing have been illustrated in the literature through traditional population projections of working ages combined with different assumptions on labour market participation, e.g. the number of employed or unemployed people participating in the labour market relative to the total working age people (Boersch-Supan, 2001). Effects on labour market participation and other economic outcomes are important, since projections of working aged population only tell one part of the story. The official population projections consider the future population in different age groups taking into account regional differences in fertility and mortality rates as well as migration propensities within and between countries. However, the projections do not account for labour market behaviour. Labour market adjustments may materialize through various channels, including participation and labour mobility (Decressin and Fatás, 1995). Changes in economic behaviour caused by ageing are also highlighted in simulation exercises based on theoretical models (Burniaux et. al., 2004; Dixon, 2003).

The approach taken in the present paper introduces and operationalises a new concept Labour Potential, which reflects a non-working but employable population in working ages. Labour Potential includes all kinds of potential labour supply, i.e. unemployed, inactive and labour market states in between unemployment and inactivity. Examples of such in between labour market states are discouraged workers and long-term sick, which in sense also represents a potential labour supply and should be included in the concepts of Labour Potential. People not within the working ages do not belong to the Labour Potential without effective policy initiatives shortening studying times and postponing the retirement age, but the present paper does not consider such discretionary policies, which are by nature hard to predict in terms of magnitude and timing.

The concept of Labour Potential is highly topical, as the challenge of financing the ageing society calls for the highest possible ratio of people actually employed. A low Labour Potential is beneficial since the high share of the population in employment finances public expenses originating from population out of working age and remaining potential (i.e. unemployment, and inactive working age population). However, a low potential also has potentially harmful effects, since it is an indication of labour shortages, which may hamper future growth prospects.

The paper evaluates changes rather than levels of Labour Potential, since the level is hard to estimate for three reasons. First, it is difficult to evaluate the extent to which a group of people enters a potential labour supply due to “incentive traps”, i.e. distortions from welfare benefits and the marginal tax rates. Also, discouragement from previous labour market experiences may have an effect (see e.g. Long, 1958; Holst and Spieß, (2002, 2004); Bradbury, 2006). Similarly, labour supply may vary regionally, as the compensating differentials differ due to preferences for local amenities (Hamilton, 1976; Graves, Sexton and Arthur, 1999; Knapp and Graves, 1989). Second, labour demand interacts with a potential labour supply. It is difficult to evaluate whether or not a certain group of people represents a potential due to lack of demand at prevailing wages or due to a low productivity in general. Third, on top of such distinct supply and demand side reasons, they may affect the level of Labour Potential jointly. For example, regional variations in the matching process of job seekers and employers may have an effect on Labour Potential. One determinant behind regionally differing matching rates is the efficiency of the local labour offices in promoting matching, which may differ regionally (Hynninen et al 2009). Therefore, instead of focussing on levels, this paper considers changes in the Labour Potential.

Two baseline contributions are, to the best of our knowledge, new in this paper. The paper first of all estimates the effects of regional ageing on the new concepts of Labour Potential. It does not mechanically utilise population projections, but also uses empirical elasticities of ageing on the potential. Furthermore, the paper takes indirect economic behaviour and dynamics into account by evaluating the extent to which ageing affects Labour Potential through Unemployment Rate and Activity Rate. The paper does in that respect also take accounts of effects accruing from changes in labour demand, by assuming that direct changes in unemployment, distinct from those indirect effects originating from ageing, reflects evolution of the labour demand.

As a second contribution, this paper for the first time presents regional projections for the Labour Potential up to 2021. The aim is to draw a picture of a possible future for the regional structure in

the Nordic countries. These projections are valuable for political decision makers facing the consequences of regional differences in ageing. Population projections alone may produce information on future age compositions for regions. However, they do not provide information on the regional propensity to be active in the labour market. Such propensities may be influenced by the underlying institutional enforcement of labour market regulations, industry structures and educational levels. Also barriers to migration play an important role in the underutilisation of regional labour supply worth considering in this context (Tervo 1992, 1993). A baseline problem in attaining an adequate forecast of the regional patterns of potential labour supplies is the lack of data with a sufficient level of detail on factors determining regional labour demand and supply behaviours, e.g. retirement patterns, the integration of immigrants in regional contexts. The forecast approach taken here will therefore be based on the elasticities of labour supply on the changes in specific age groups. Combining that information with changes in the age groups presented in the population projections will give us a more precise impression of the regional patterns of a potential future labour supply.

The analysis is based on data for the period 1990 – 2007 from the harmonized Nordregio database, which includes 72 regions in Denmark (11 provinces/landsdel), Finland (20 regions/maakunta), Iceland (2 – capital/outside capital), Norway (18 regions/fylke¹) and Sweden (21 regions/län). Additionally, some data from the statistical bureau of Iceland has been included.

2. The Labour Potential in the Nordic regions

A first step in identifying the Labour Potential will be to define the Employment Rate of region r in the year t as the ratio of employment relative to the working age population:

$$\text{Erate}_t^r = E_t^r / \text{WP}_t^r, \quad (1)$$

where WP is the working age population in a region and E is the number of employed. The Employment Rate was lowest in Finland and highest in Iceland (Figure 1). The severe economic crisis of the 1990s left long lasting marks on the Finnish labour market. Part of the low Employment Rate may also be explained by differences in the occurrence of non-standard working hours, such as part-time jobs.

¹ These are based on NUTS3 regions apart from the NUTS2 region Oslo og Akershus.

[Figure 1 about here]

The ultimate target of employment policy in every country is expectedly that the Employment Rate would be as high as possible. If all working age people were employed, the Employment Rate would equal 1. Therefore, the simplest way to approximate the potential labour supply is to subtract the Employment Rate from one (1-Erate). This is of course a mirror image of Figure 1.

A one hundred percent Employment Rate is neither a plausible policy objective nor a realistic approximation of the real Labour Potential, as different processes of marginalization and discouragement will prevent such. The following will define the Labour Potential as a concept that uses temporary changes in the extent of marginalization to analyse the potential labour supply and depicts its evolution over time for different countries and regions.

A first step to improve the approximation is to use the highest regional Employment Rate across all Nordic regions as a benchmark and compare it with that of every other region. This gives us an idea of how far each region currently is from the highest level reached in the Nordic countries during the period of investigation. One objection to this approach is that the institutional settings vary between the Nordic countries. An alternative would be to consider the maximum regional Employment Rate within each country as a benchmark. One obvious weakness of this approach is that the population structure also varies across regions within countries, e.g. the level of education and the age structure of the population in the capital region of Finland, Uusimaa, differ distinctively from those in Lapland. Furthermore, the differences in such structure tend to be persistent (Pekkala and Kangasharju 2002). Consequently, the approach applied here uses as a benchmark the maximum Employment Rate (Erate) in each region over the period considered and compares the regional Employment Rate of any year to this maximum. The essence of this measure is how far each region is from the level, which it once reached. Let us call this the Labour Potential Rate (LPR), which is defined as:

$$LPR_t^r = Erate_t^r / \text{MAX}(Erate_s^r) \quad s=1991,1992,\dots,2007 \quad (2)$$

The simple mean of LPR over the regions for each Nordic country measured for the most recent year 2007 varies between 1.5 % in Norway to 6 % in Iceland (Figure 2).² An interesting difference

² The result for Iceland should, however, be interpreted with some caution. The data for Iceland is based on survey data, while the data for Denmark, Finland, Norway and Sweden is register data. The data heterogeneity could explain the high LPR for Iceland.

between this and the approach above of equation (1) is that the potential is highest in Iceland, where the Employment Rate has been the highest as well. This signals a deterioration of the labour market conditions over time.

[Figure 2 about here]

The Labour Potential can also be evaluated by calculating LPR for every year instead of just the most recent year (2007). The average of such calculated LPR over regions and years for each Nordic country shows the highest potential in Finland (7 %) and the lowest in Denmark (2 %) (Table 1). The standard deviation over the regions and years has also been the highest in Finland (4 percentage points), whereas it has been the lowest in Denmark (less than 2 percentage points). The maximum over all regions occurred in Päijät-Häme, Finland in the gloomiest year of the last recession, 1994.

[Table 1 about here]

Apart from Finland, the LPR has evolved rather similarly in each country. The potential was high in Finland in the early 1990s due to a severe economic crisis (Figure 3). This suggests that labour demand is a crucial determinant of Labour Potential. Since then the rates have been converging towards each other and the most recent figures are between 2 and 5 percent across the Nordic countries. The LPR has been the lowest in Denmark for the majority of the years considered. The rate was particularly low in 2002.

[Figure 3 about here]

The evidence of such country differences in LPR and the regional variation within each country clearly indicates that considering the potential labour supply across the Nordic regions is of importance. The maximum employability over the time period 1991-2006 reveals a potential that will not be exhausted at any given point in time for the different Nordic regions. This reveals that the differences in labour market participation and behaviour unfolds differently over time in the Labour Potential of the different regions. In addition, considerable differences exist between the various Nordic Countries with respect to the Labour Potential. Being in a regional context among relatively similar countries, such as the Nordic, does nevertheless see very different Labour

Potentials emerge. Even small differences in the policy regimes of countries can therefore result in different Labour Potentials in different regional contexts.

3. Determinants of regional Labour Potential in the Nordic countries

3.1 Decomposing the Labour Potential

Instead of focussing on the level of the Labour Potential, it is more plausible to evaluate changes in the Labour Potential, due to reasons discussed previously. We assume that a given decline (increase) in the Employment Rate equals a corresponding incline (decrease) in the Labour Potential at any level of potential. For the analysis, this means that the size of marginal and discouraged groups relative to the whole working age population does not change over time. Thus, we decompose the Employment Rate (Erate) to analyse the determinants of the Labour Potential (LPR). A decomposition exercise to analyse the Labour Potential can be pursued in several ways. As the present focus is on the importance of the Employment Rate for the Labour Potential, a decomposition of the Employment Rate will be pursued here to analyse the background of the Employment Rate.³ The Employment Rate (Erate) can be expressed as:

$$\frac{E_t^r}{WP_t^r} = \frac{E_t^r}{L_t^r} * \frac{L_t^r}{POP_t^r} * \frac{POP_t^r}{WP_t^r} \quad (3)$$

where E is the number of employed in a region, WP is the working age population, L is the labour force and POP is the population including all ages. Equation (3) states that the Employment Rate consists of employment per labour force (E/L), Activity Rate (L/POP) and Total Age Ratio (POP/WP).⁴ After taking a time derivative of each component, a change in the Employment Rate equals the sum of changes in the Employment Rate, changes in the Activity Rate and changes in the Total Age Ratio, i.e. using the Divisia index.

An increase in employment per labour force relates to a corresponding decrease in the Unemployment Rate (U/L) and it reflects changes in labour demand. A priori, we would expect that in the short run a higher Unemployment Rate would yield a higher Labour Potential, because of

³ Note that the decomposition exercise pursued in equation (1), (2) and (3) implicitly looks at age groups typically considered being in the labour force and in the working age population. The following decomposition of Erate will extend the analysis to include age groups that are not considered in the labour force or working age population at any given point in time. This is to allow for dynamics effects of persons entering or leaving the working age population.

⁴ Below we will decompose this into two parts: Young Age Ratio and Old Age Ratio.

lower the Employment Rate. In the longer run, the effect may change, as a higher Unemployment Rate means lower labour demand, which may induce outmigration among the non-employed population. An increase in the Activity Rate (L/POP) in turn should decrease the potential and increase the Employment Rate as long as most of the people entering the labour market find employment. Finally, more people not within the working ages (POP/WP) should also decrease the potential, since school age children and retired people do not belong to the potential.

Using this decomposition, how is population ageing likely to affect Labour Potential? This will depend on the Employment Rate of the retiring cohort. In the more likely case that the Employment Rate of the cohort is very low relative to the Employment Rate of all cohorts combined, a larger retiring age cohort will increase the overall Employment Rate and decrease the LPR, since the Employment Rate of the remaining cohorts is higher. This shift in Total Age Ratio should create a downward trend in the LPR. To sum up, we can decompose the change in the Labour Potential, i.e. $\Delta LP = -\Delta E/WP$, into three subcomponents:

$$\Delta LPR_t^r = \frac{\Delta U_t^r}{L_t^r} - \frac{\Delta L_t^r}{POP_t^r} - \frac{\Delta POP_t^r}{WP_t^r}, \quad (4)$$

where Δ refers to the first time derivative. The last term on the right can change if either the population under or over the working age grows differently from the population in working ages. Thus, the last term on the right hand side can be decomposed into:

$$\frac{\Delta POP_t^r}{WP_t^r} = \left(\frac{\Delta WP_t^r}{WP_t^r} + \frac{\Delta Y_t^r}{WP_t^r} + \frac{\Delta OLD_t^r}{WP_t^r} \right), \quad (4a)$$

where Y is the number of young persons in the population of age less than 15 years, OLD is the number of elderly people in the population of age more than 65 years, Y/WP is the Young Age Ratio and OLD/WP is the Old Age Ratio. Hence, equation (3) can be expressed as:

$$\Delta LPR_t^r = \frac{\Delta U_t^r}{L_t^r} - \frac{\Delta L_t^r}{POP_t^r} - \left(1 + \frac{\Delta Y_t^r}{WP_t^r} + \frac{\Delta OLD_t^r}{WP_t^r} \right) \quad (4b)$$

Simple pair-wise contemporaneous correlations among the variables in equation (4b) show that changes in the Unemployment Rate and in the Labour Potential are the strongest correlated. Also, the changes in the Activity Rate (L/POP) and the changes in the LPR are strongly correlated (Table 2). The age structure ($\Delta Y/WP$, $\Delta OLD/WP$ and $\Delta POP/WP$) has the lowest correlation with the other variables. Interestingly, a worsening Total Age Ratio ($\Delta POP/WP$) is associated with a decline in the Labour Potential, indicating that the Employment Rate of the retiring age cohort is lower than that of younger cohorts. A change in the Old Age Ratio ($\Delta OLD/WP$) has a similar negative association with the change in the LPR as a change in the Total Age Ratio ($\Delta POP/WP$), whereas that of a change in the Young Age Ratio ($\Delta Y/WP$) has a positive correlation with the change in the LPR.

[Table 2 about here]

3.2 Granger analysis

Contemporaneous effects are not necessarily important. A Granger-causality analysis reveals whether the age structure and other subcomponents in equation (4b) can forecast any future change in Labour Potential, after the LPRs own lags and other relevant factors are controlled for. Provided that there is forecasting power, we can estimate how much the Labour Potential will change in an ageing society of the Nordic regions. To do this, we build a system of three equations, where a regression model for the change in LPR indicates the direct effect of ageing on LPR. Two other equations capture the indirect effects via unemployment and Activity Rates. The unemployment regression shows how much ageing affects the LPR due to influence on unemployment. Similarly the Activity Rate equation shows how much ageing affects the LPR by influencing the Activity Rate.

$$\Delta LPR = L. \Delta LPR + L. \Delta YAR + L. \Delta OAR + L. \Delta UN + L. \Delta AR + \text{year dummies} \quad (5a)$$

$$\Delta UN = L. \Delta LPR + L. \Delta YAR + L. \Delta OAR + L. \Delta UN + L. \Delta AR + \text{year dummies} \quad (5b)$$

$$\Delta AR = L. \Delta LPR + L. \Delta YAR + L. \Delta OAR + L. \Delta UN + L. \Delta AR + \text{year dummies} \quad (5c)$$

where LPR is the Labour Potential Rate, YAR is the Young Age Ratio, OAR is the Old Age Ratio, UN is the Unemployment Rate, and AR is the Activity Rate all defined above. Each equation in the system can be estimated separately, since the explanatory variables are the same in each equation. Changes in the Labour Potential Rate are regressed on their own lags, lags of the covariates and year effects in equation (5a)-(5c). Lag operators are denoted by Ls in the equations above. First differences remove regional fixed effects and avoid the difficulties of evaluating the level of LPR.

Annual dummies transform the variables into deviations from the cross-section means, thus controlling for trends and business cycles that are common to all regions. Since the population structure evolves slowly over time, we start with as many as four lags. It appears however that the fourth lags are redundant disregarding if the Age Ratio is measured either with one variable or two distinct variables (Table 2 and 3). A F-test shows that they can be left out with 55 percent confidence. The third lags are important both when the Age Ratio is measured with one variable and when it is measured with two distinct variables (Table 3).

[Table 3 about here]

The model is rather aggregate in nature. A number of additional covariates would have been of interest in the estimation procedures. Variables for the level of education, share of immigrants and sick leaves are examples of such. Including such additional covariates does, however face the problem of restricted data availability. These kinds of data are only available for 2007. Including the variables would therefore not be feasible in the present approach to analysing and forecasting the Labour Potential in the Nordic regions. Introducing more covariates into the analysis will therefore be left for future work using the approach developed here.

[Table 4 about here]

Long-term elasticities are reported in table 4. The most important variable in this analysis is “ Δ POPWP” and it has as expected a negative elasticity. Doubling the ratio of total population over people in working age decreases the Labour Potential and increases the Employment Rate by 6 per cent (Table 4). The joint significance of all the lags does not however differ from zero. The effect of the Unemployment Rate has a rather similar magnitude of -4 per cent but with a surprising sign. A rise in unemployment will therefore predict a decline in the Labour Potential in the long run. In the short run the effect is of course the opposite, but in the long run a higher Unemployment Rate may indicate a low labour demand, which triggers labour outmigration. If unemployed labour moves out of a region this yields a lower potential. The point estimate of the Activity Rate (AR) is the highest, indicating that the doubling of employment relative to the inactive part of the total population decreases the Labour Potential by 10 per cent. This effect, however, is statistically insignificant. A weak Granger-causality from the Activity Rate to LPR is somewhat surprising. Two opposing forces may explain this. Two groups lead to a wedge between the Activity Rate and LPR: the population outside the working ages and the inactive share of the working age population. As is

well known, these two groups have a lower migration propensity than those of working age and especially those in the younger part of the working age population. However, this cannot affect the LPR, since the estimated models control for Total Age Ratio. On the other hand, the rising Activity Rate reflects a higher participation of the previously inactive share of the population in the labour market. This decreases the future Labour Potential, since it increases the Employment Rate. The magnitude of the effect is fairly high, but surprisingly inaccurate, i.e. standard error of the estimated coefficient is high.

Model (5a) works much better, when the Total Age Ratio is split into two parts, one depicting the share of less-than-working age population relative to the working age population and the other capturing the retired part of population. This indicates the potential of the young generation. If the size of the young generation decreases by 50 per cent, the Labour Potential decreases by 10 per cent. In contrast, when the retired part of the population increases by 50 per cent, the potential decreases by 5 per cent. Since an increase in the Old Age Ratio (OAR) is going to dominate the future development in the Nordic regions, the ageing population will decrease the LPR in the future. The effect of the other variables is robust under the alternative specification with age groups.

[Table 6 about here]

The models (5b & 5c) estimate the indirect effect of ageing on the Labour Potential, LPR (Table 6). In the unemployment equation (5b), we end up estimating the model with two lags, as the third lags were not statistically significant, whereas the Activity Rate equation (5c) has three lags.

[Table 7 about here]

The long run elasticities show that the age structure affects the Activity Rates more clearly than the Unemployment Rates, i.e. coefficients have higher t-values. However, the point estimates for the changes in the Unemployment Rates with respect to changes in the Age Ratios are higher than those for the changes in the Activity Rates.

[Figure 4 about here]

To sum up the results of the Granger causality analysis, ageing – measured by increases in the Old Age Ratio (OAR) – affects the Labour Potential (LPR) both directly and indirectly (Figure 4). The

direct effect indicates that doubling the Old Age Ratio decreases LPR by 9 per cent. This is counterbalanced with indirect effects, since the rising Old Age Ratio will contribute to an increase in the LPR. Doubling the Old Age Ratio will decrease the unemployment rate, UN, by 38 per cent, but the decrease in the unemployment rate will increase the LPR by 1.1 per cent⁵. Similarly, the Old Age Ratio will decrease the Activity Rate, AR, by 15 per cent, but this decrease will increase the LPR, since the elasticity of the LPR with respect to a change in the Activity Rate is -0.011. Thus, the combined effect through the AR is 0,002⁶. The total effect is obtained by combining the direct effect with the two indirect effects. This yields an 8 per cent decrease⁷ in the LPR as a response to the 100 per cent increase in the Old Age Ratio.

4. Forecasting the potential regional labour supply

4.1 Population projections

In the most disadvantaged Nordic regions the total population in 2007 was about 1.6 times greater than the working age population (Figure 5). It means that for every 10 people in working age there are 16 people either younger than 15 years of age or more –than 64-years of age. In the most favourable region, Copenhagen, the Total Age Ratio was less than 1.4 in 2007. In all other regions, the Total Age Ratio was more than 1.4. The population is heavily ageing in all the Nordic regions up to 2021, which is the latest year there is consistent population projections for all Nordic regions. According to these projections, Copenhagen keeps the same Total Age Ratio up to 2021. In all other regions, the population will grow older, as indicated by the dots located above the diagonal in figure 5. For some regions the Total Age Ratio will grow dramatically. For example, the ratio in the region of Etelä-Savo in Finland will grow from 1.57 in 2007 to 1.80 in 2021 - the dot at the top of the scatter plot (Figure 5).

[Figure 5 about here]

Ageing will be driven by the growth in the Old Age Ratio, i.e. people more than 64 years of age relative to the working age population. This can be seen in the right-hand panel of figure 6 showing the Old Age Ratio (OAR) in 2007 and 2021 for the Nordic regions. In contrast, the share of the young, i.e. people less than 15 years of age relative to the working age population, will evolve very

⁵ $-0.375 * -0.029 = 0.0108$

⁶ $(-0,153 * -0,011 = 0,0017)$

⁷ $-0.093 + 0.0108 + 0.0017 = -0.0805$

differently, as every other dot in the left-hand panel of figure 6 lies on the diagonal. Focussing on the Labour Potential of different age groups will thus become an increasingly important aspect for the Nordic regions in future years.

[Figure 6 about here]

It should also be taken from figure 6 that the changes in regional dispersion among Nordic regions are quite different for Old Age Ratio (OAR) and the Young Age Ratio (YAR). The dispersion in the Young Age Ratio remains rather constant over time. It ranges between 0.2 and 0.35 among the Nordic regions in 2007 and 2021. The corresponding dispersion in the Old Age Ratio (OAR) will grow threefold. It ranged between 0.2 and 0.3 in 2007, whereas it will range from 0.2 to 0.6 in 2021. The challenges related to ensuring a sufficient labour supply will therefore unfold significantly differently in the various Nordic regions, with some regions having to focus on both young and older persons in their labour market policies and other regions being highly dependent on the elderly to ensure the potential regional labour supply.

4.2 Labour Potential in the future

To forecast the Labour Potential for a given region, we utilise population projections for the Total Age Ratio (TAR) and its subcomponents, Young Age Ratio (YAR) and Old Age Ratio (OAR) up until 2021. Multiplying these changes with the elasticities obtained from the Granger causality analysis, we will produce a forecast for the Labour Potential by region taking into account the different patterns of ageing and age specific labour market participation in the different Nordic regions. The projections are defined in equation (6).

$$LPR_t^r = e_{AGE} * POPAGE_t^r, \quad t=2007, 2008, \dots, 2021 \quad (6)$$

where LPR is the projection of the Labour Potential, e_{AGE} is the elasticity of age group a , from the Granger causality analysis, and POPAGE is the size of a given age group at some future point in time t following the official population projections of the region r in the Nordic countries. There are no projections available for the unemployment and Activity Rates. Therefore, we assume that they do not change over time and use the elasticities with respect to ageing result from the regressions controlling for region specific unemployment and Activity Rates.

The population projections reveal that the average change in the Total Age Ratio (TAR) over the years and regions is 7.3 per cent between 2007 and 2021 (Table 8). Using these population projections, the estimated elasticities indicate that this will reduce the Labour Potential, *ceteris paribus*, by a minimal 4 tenths of a per cent on average (Table 8). The effect has to be interpreted as a deviation from the baseline, i.e. the level that would have occurred without ageing. For example, if the level of Labour Potential in 2021 were the same as the average over the historical data for 1991-2007, i.e. 4.9 per cent on average, the change in the Total Age Ratio until 2021 would decrease the LPR to 4.5 per cent⁸.

[Table 8 about here]

As explained in the previous section, the model renders more significant coefficients when the Total Age Ratio is split into the young and old segments. The Young Age Ratio will have a small effect. On average it will grow by 1.5 per cent (YAR in the Table 8) and on average it increases the Labour Potential by one third of a per cent (grYLP in Table 8). In contrast, the Old Age Ratio will grow by 42 per cent and its effect on LPR will be -4 per cent on average. This implies that in regions experiencing an average population ageing, the LPR is 0.9 per cent compared to 4.9 in regions facing no population ageing and having the average LPR of the period 1991-2007. The effect is large, and implies that the Labour Potential will fall, if there is no other adjustment in the economy with respect to the labour market participation rates of the elderly in particular. Regions will thus experience changes in Young Age Ratio and Old Age Ratio simultaneously. When combining the two effects from the population projection, the direct effect on the LPR decreases to -3.6 per cent. This is a comparably large decrease relative to the average level of the LPR in our historical data in 1991-2007 of 4.9 percent. The indirect effect, coming through reactions in the Unemployment Rates and Activity Rates, slightly counterbalances the direct effect. The indirect effect is on average positive in the historical data from 1991-2007. Combining the direct and indirect effects accounts for an effect of -3.0 percent. This will accordingly decrease the average LPR of 4.9 per cent to 1.9 per cent in the long run.

These effects are large using the average values of Total Age Ratio (TAR), Young Age Ratio (YAR) and Old Age Ratio (OAR), and they are even larger, when considering regions at the minimum and maximum values of the age variables in the population projections (Table 8). The

⁸ The decrease of 4.5 percent arrives from subtracting 0.4 percent from 4.9 percent.

Labour Potential will decrease by 7.8 per cent in the region facing the strongest ageing problem. At the other extreme, the Age Ratio of Copenhagen will change only very slightly in the next 15 years. This will hardly have any effect on the Labour Potential, which is shown by the maximum of grLP in Table 8. Therefore, the future of Copenhagen in terms of the potential labour supply seems fairly promising.

4.3 Future Labour Potential and the current structure

Finally, we examine how ageing will change the current levels of Labour Potential. It appears that young and old cohorts work in opposite directions. The population entering the labour market (YAR) is positively associated with the current level of LPR, i.e. the left hand side scatter plot in Figure 7. The higher the current LPR level, the more the Young Age Ratio will increase the future LPR. This implies that the net fertility and in-migration is higher in regions where the current Labour Potential is higher. A regression of the change on the level, i.e. the regressions line in left-hand side panel of figure 7, indicates that the LPR will be 4 per cent higher when the current level is 10 per cent higher⁹.

[Figure 7 about here]

The Old Age Ratio will work in the opposite direction by reducing the potential more in regions where Labour Potential is currently higher. This implies that the Labour Potential is currently higher and ageing will be stronger in regions where there are already more retired people. A simple regression of the change of LPR on the level of LPR, i.e. the regressions line in the right-hand side panel of figure 7, indicates that a one-percentage point increase in the current LPR level is associated with a 0.23 per cent decline in the future LPR due to the Old Age Ratio¹⁰.

[Figure 8 about here]

Since the young and old segments of a population move the Labour Potential in opposite directions in the future, the forecasted LPR will only be weakly correlated with the current level of LPR. Figure 8 shows the mean LPR for the period 1991-2007 on the horizontal axis against the forecasted relative changes in LPR in the period 2007-2021. It appears that the potential will decline less in regions where current potential is higher. This implies divergence, i.e. that an ageing population

⁹ Coefficient 0.406, t-value 3.8, and R-squared 0.16

¹⁰ Coefficient -0.234, t-value -3.9, and R-squared 0.17

will increase the regional variation in the Labour Potential. A regression of the change in LPR on the level of LPR, i.e. the solid and thin regression line in Figure 8, indicates that a one percentage point increase in the current level of the LPR is associated with a 0.17 percentage point decline in the future potential¹¹.

The dashed fat line shows how strong the effect is compared to the historical average of 1991-2007. There are quite a few regions where ageing will decrease the LPR more than the historical average, i.e. regions located below the dashed fat line. In reality, the LPR cannot of course take negative values, because other reactions in the economy will offset the adjustment process before the LPR goes below zero. Figure 8 highlights those regions, where the future total decrease in the LPR for the projection period will be higher than the current level, and thus identifies those regions facing the most severe challenge in respect of ageing. About 32 percent of the regions or 23 regions out of the total of 72 regions are below the line. Ten of them are in Denmark, one in Finland and 12 in Norway. There are no regions in Sweden or Iceland that are below the dashed and fat line.

[Table 9 about here]

In order to provide a more detailed impression of the spatial structure of the change in the LPR between 2007 and 2021, Table 9 presents the change in LPR in three categories. One category indicates regions facing the greatest threat of ageing where the analysis shows a negative value for the Labour Potential. The second category indicates the regions having a LPR between 0 and 4 per cent in the projection period. The final category indicates regions having LPR of over 4 percent in the projection period.

Taking the regional variation in the labour market behaviour of different age groups into account changes the pattern of LPR considerably (Table 9). Even if the ageing problem in Norway is moderate in a Nordic perspective, some regions will still see their LPR deteriorate. The results also change considerably in Sweden and Finland as compared to an analysis based solely on the population age structures. These countries face moderate to severe ageing processes, but the Labour Potential measured by the LPR increases considerably in spite of this, a similar situation should evolve in the northern and eastern regions of Finland. Only Denmark sees that ageing problems are

¹¹ Coefficient -0.172, t-value -1.5.

not compensated by labour market behaviour. Denmark thus faces both increasing ageing problems and a diminishing Labour Potential.

5. Discussion

The results of the paper can be summarized the following way: Doubling the ratio between the total population and the population in the working age decreases the Labour Potential. The effect of the Unemployment Rate has a similar magnitude. A doubling of the employment relative to the inactive part of the population decreases the Labour Potential by 10 per cent. The Granger-causality model however works much better, when the Age Ratio is split into two parts. If the size of the young generation decreases by 50 percent, the Labour Potential decreases by 10 per cent. If the retired part of the population decreases by 50 percent, the potential decreases by 5 per cent. The results of this paper therefore produce a number of crucial results when dealing with potential labour supplies in the Nordic regions. Activating marginalized groups in and out of the working age population is not insensitive to regional contexts and policies directed towards these must be designed accordingly. Long-term elasticities of the potential labour supply in the Nordic regions also show important differences. Unemployment and being inactive in the labour market is essential, as this reduces the long-term potential labour supply by 27-28 per cent, while ensuring a higher Young Age Ratio improves the long-term potential labour supply by 20 per cent. This also illustrates the importance of a proper age structure in the population for the potential labour supply and the problems associated with different migration patterns of different age groups for the various Nordic regions. Policies to handle such differences and asymmetries in the Nordic context will be decisive for the distribution of future potential labour supplies across different types of regions and thus for the growth potentials embedded in an ageing society.

The results also indicate that the estimated future decrease in the Labour Potentials due to population ageing tends to be higher in regions that currently have a larger total population per working age population. This is an expected result. Regions with a relatively larger Labour Potential will have a larger buffer as they have a lower total population per working age population. The top-three regions with respect to ageing and therefore with the strongest ageing processes from 2007 to 2021 are Etälä-Savo (14.6 percent), Kainuu (14.3 percent) and Satakunta (13.7 percent). The corresponding three regions with the weakest ageing process are Copenhagen (0.3 percent), Oslo-Akerhus (1.2 percent) and Vest-Agder (1.5 percent). The regions facing the most severe ageing process are therefore all located in Finland, while the regions with the least severe ageing process are located in Denmark and Norway. This changes when turning to the Labour Potential.

The top three regions with the strongest growth in the Labour potential from 2007 to 2021 are Lappi (6.5 percent), Skåne län (6.1 percent) and Pirkanmaa (5.6 percent), while the three regions with the largest decline in the Labour Potential are Sydjylland (-4.0 percent), Vestjylland (-3.7 percent) and Østsjælland (-3.6 percent). The main result is therefore that ageing and Labour Potentials render quite different regional patterns across the Nordic countries, which must be addressed when designing labour market policies. Ageing then is only one measure of changing regional structures.

This paper developed a methodology taking into account the differences in ageing patterns and the regional differences in labour market behaviours in different age groups. The analysis showed that there is a high regional dependency on the potential labour supplies available in incumbent workforces to solve for future ageing processes. While a traditional ageing analysis based on age compositions in population projections would render specific regions to be the most endangered by ageing processes, the approach developed here pointed to quite different regions being endangered from ageing. Age composition of population bases is one measure for the ageing process, but a more elaborate analysis based on the concept of a Labour Potential may render rather different results, indicating that regional patterns of labour market behaviours remains important. The issues remaining for future research are clearly numerous. A first step in terms of research is to include more covariates in the methodology proposed in the present paper. This would however have to await the gradual availability of such data.

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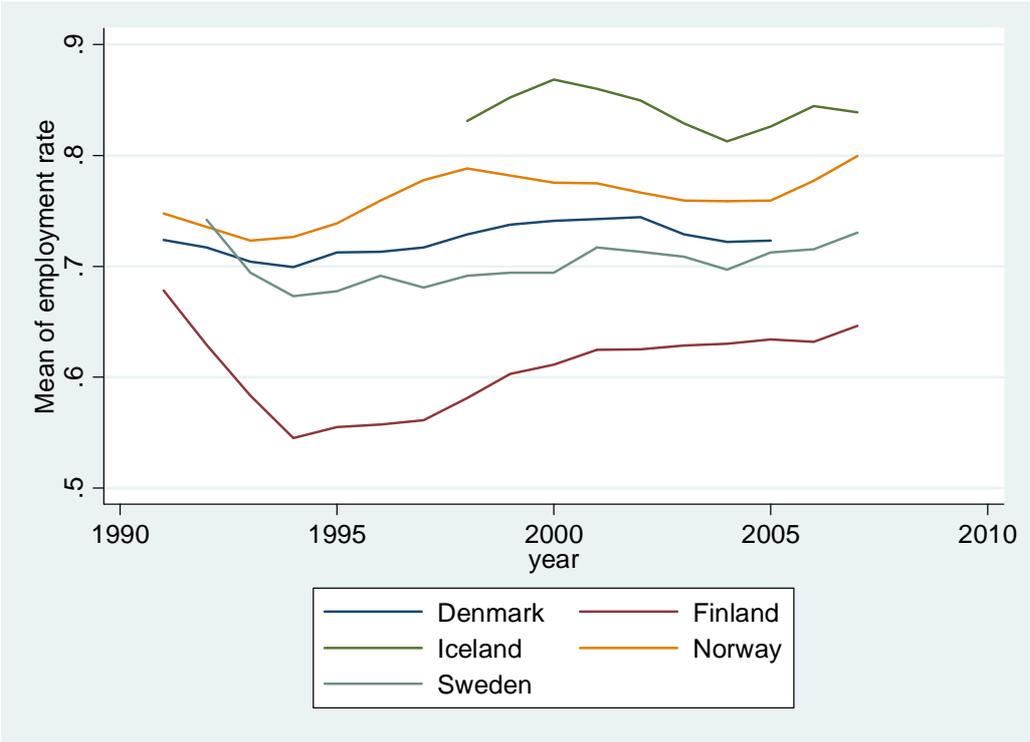
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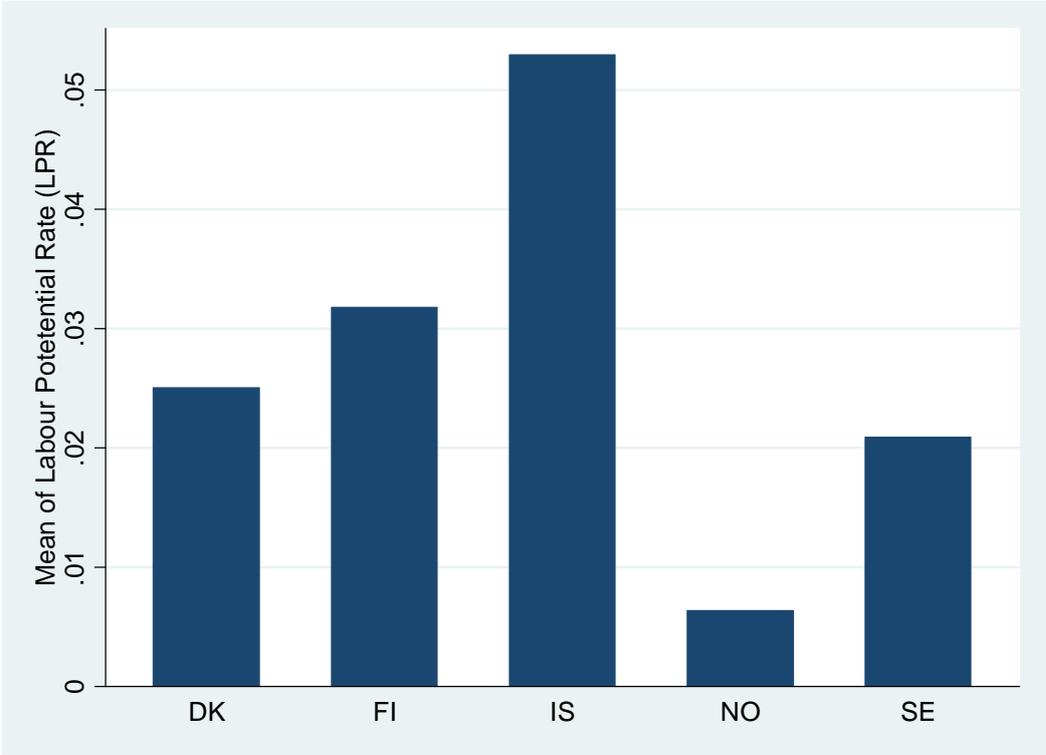
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Figure 1. Mean Employment Rates (Erate) by country, 1991-2006



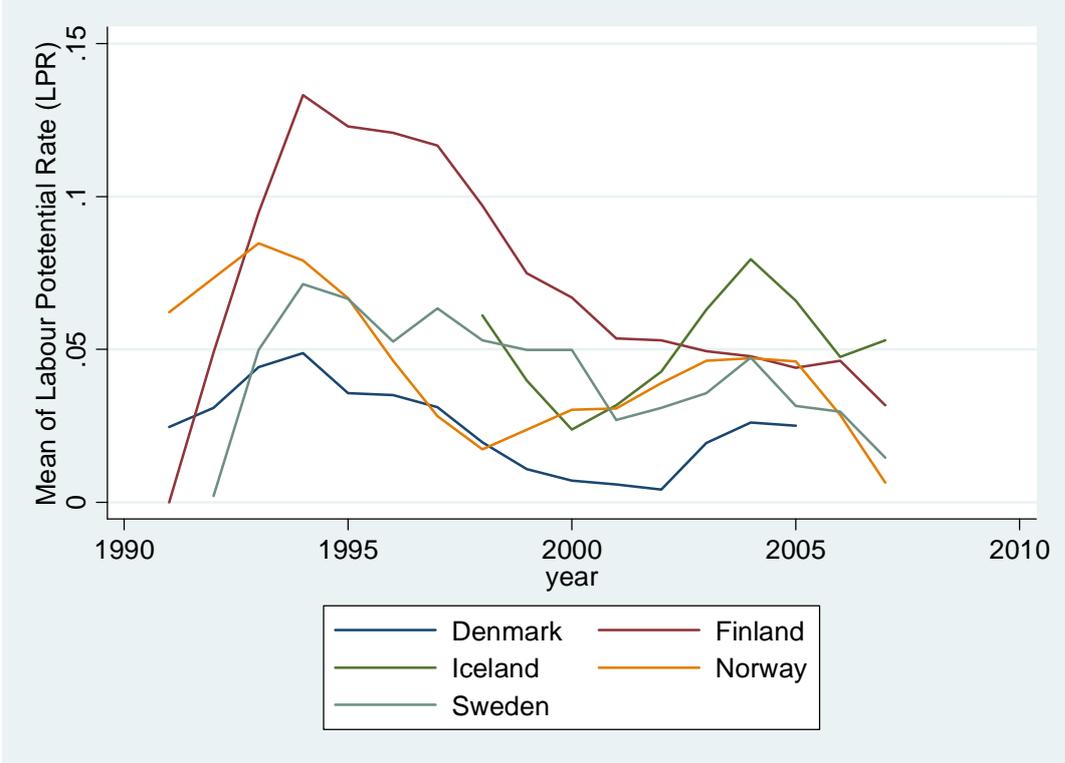
Source: Own calculations from Nordregio Database data

Figure 2. Labour Potential Rate (LPR), average over regions by country, 2007



Source: Own calculations from Nordregio Database data

Figure 3. The Labour Potential Rate (LPR) over time by country



Source: Own calculations from Nordregio Database data

Figure 4. Estimating the effect of ageing on the Labour Potential (LPR)

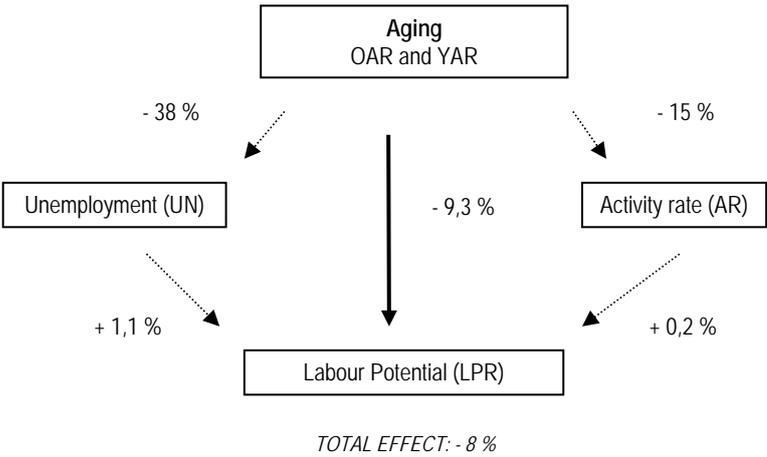
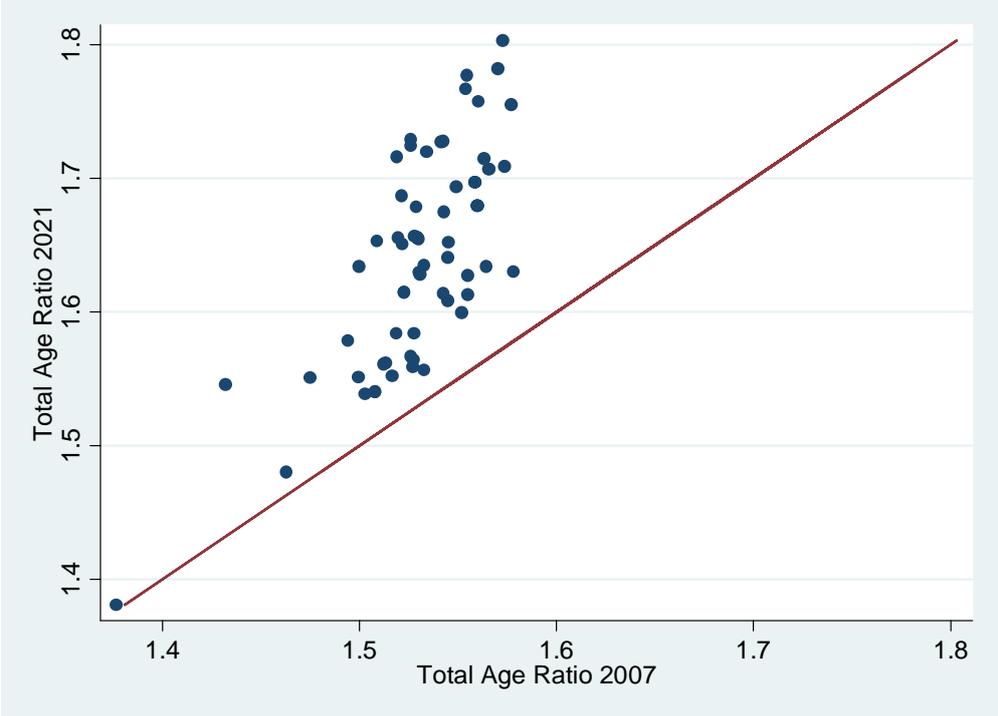
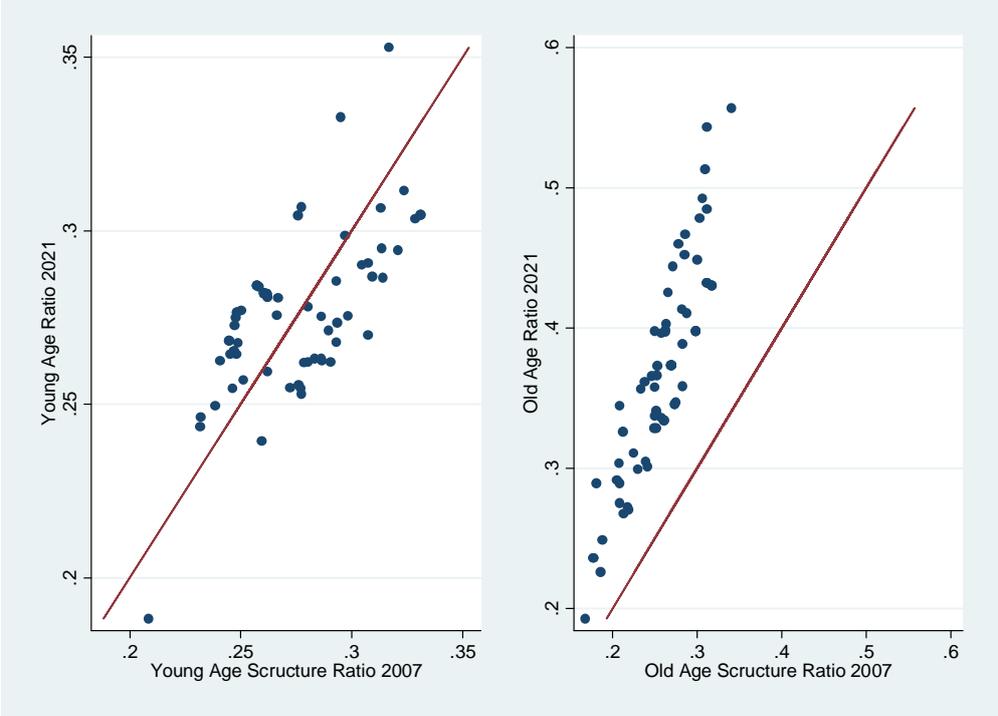


Figure 5. Number of total population per working age people by region (TAR)



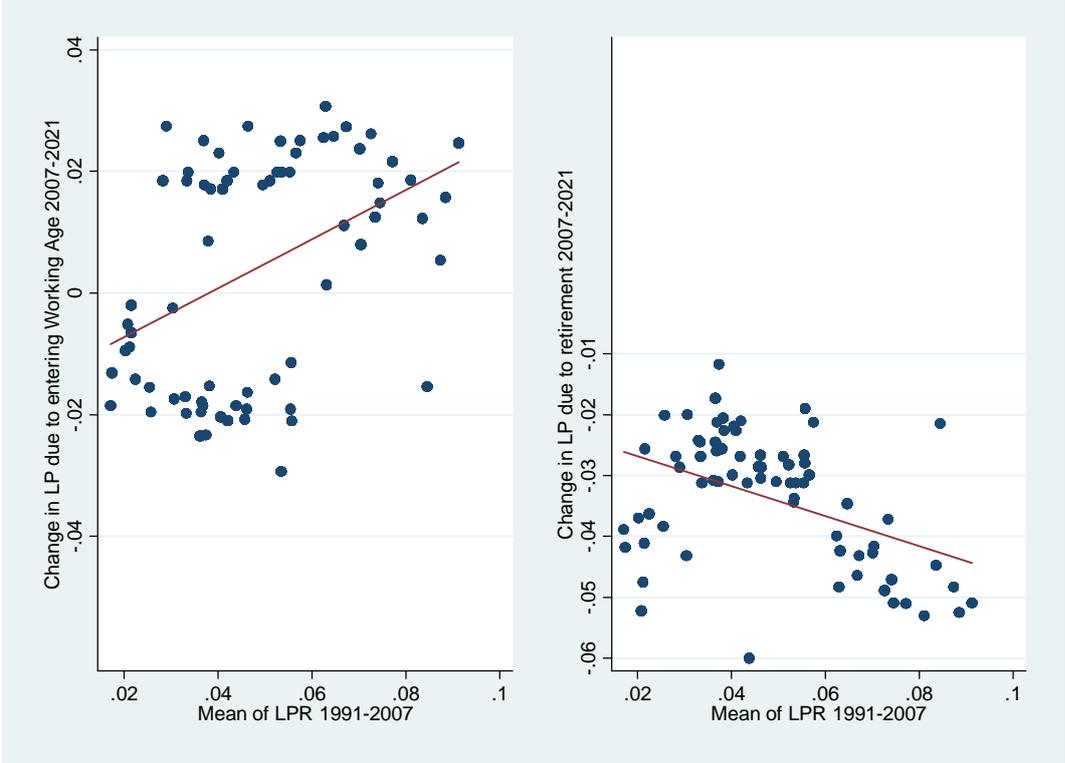
Sources: Nordregio datatbase and own calculations

Figure 6. Young- and Old-Age ratio (YAR and OAR)



Sources: Nordregio datatbase and own calculations

Figure 7. The mean of the current LPR and the change in LPR due to YAR and OAR



Source: Nordregio database and own calculations

Figure 8. Forecasted Labour Potential Rate (LPR) and the average of the current



Source: Nordregio and own calculations

Table 1. Descriptive statistics of Labour Potential Rate (LPR)

	Obs	Mean	Std.Dev.	Min	Max
Denmark	165	.024536	.0178472	0	.078
Finland	340	.0707606	.0395849	0	.164
Iceland	10	.0555402	.0337721	0	.106
Norway	267	.0436616	.0273332	0	.140
Sweden	326	.0428213	.0213592	0	.090

Source: Own calculations from Nordregio Database data

Table 2. Correlations of time derivatives

	Δ LPR	Δ U/L	Δ L/POP	Δ POP/WP	Δ Y/WP	Δ OLD/WP
Δ LPR	1.000					
Δ U/L	0.7563	1.000				
Δ L/POP	-0.6890	-0.3858	1.000			
Δ POP/WP	-0.1501	0.0105	-0.1496	1.000		
Δ Y/WP	0.1893	0.1058	-0.3491	0.2511	1.000	
Δ OLD/WP	-0.1816	-0.0090	-0.0599	0.8961	-0.0894	1.000

Note: Y refers to population less than 15 years old and OLD refer to that more than 64 years old.

Source: Own calculations from Nordregio Database data

Table 3. Results of a Granger causality analysis, Model 5. a

	(1)	(2)	(3)	(4)
1st lag of Δ LPR (Labour Potential Rate)	0.274**	- 0.021	0.189*	- 0.087
2nd lag of Δ LPR	0.046	0.143*	0.005	0.137*
3rd lag of Δ LPR		0.119**	0.184**	0.139**
4th lag of Δ LPR	0.204***		- 0.006	
1st lag of Δ U/L (Unemployment Rate)	- 0.033	- 0.019**	-	- 0.015*
2nd lag of Δ U/L	0.036***		0.032***	
3rd lag of Δ U/L	0.006	0.003	0.006	0.003
4th lag of Δ U/L	-	- 0.012	-	-
1st lag of Δ L/POP (Activity Rate)	0.024***		0.023***	0.011***
2nd lag of Δ L/POP	- 0.004		- 0.005	
3rd lag of Δ L/POP	0.197*	- 0.154*	0.121	- 0.220**
4th lag of Δ L/POP	- 0.073	- 0.001	- 0.129	- 0.000
1st lag of Δ POPWP (TAR)	0.128	0.073	0.113	0.132*
2nd lag of Δ POPWP	- 0.132*		- 0.043	
3rd lag of Δ POPWP	- 0.114	- 0.469*		
4th lag of Δ POPWP	- 0.078	0.287		
1st lag of Δ Y/WP (YAR)	0.566*	0.140		
2nd lag of Δ Y/WP	0.082		- 0.189	- 0.097
3rd lag of Δ Y/WP			- 0.003	0.074
4th lag of Δ Y/WP			0.0237	0.195*
1st lag of Δ O/WP (OAR)			0.161	
2nd lag of Δ O/WP			- 0.003	- 0.110**
3rd lag of Δ O/WP			- 0.034	0.002
4th lag of Δ O/WP			0.025	0.033
			0.030	
Year dummies	yes	yes	yes	yes
N	686	776	686	776
R ²	0.455	0.438	0.466	0.452

Legend: * p<0.05; ** p<0.01; *** p<0.001

Note: "LPR" is the Labour Potential Rate, "popwp" is POP/WP, "urate" is U/L, "arate" is L/POP, Y/WP is Young Age Ratio (YAR) and OLD/WP is Old Age Ratio (OAR). All regressions include year dummies.

Source: Own calculations from Nordregio Database data

Table 5. The long run elasticities in the LPR equation

	A change in LPR	A change in LPR	YAR=OAR
With respect to a change in			
Total Age Ratio, TAR	-0.056		
Young Age Ratio, YAR		0.211***	
Old Age Ratio, OAR		-0.093**	no***
Unemployment rate, UN	-0.036***	-0.029***	
Activity Ratio, AR	-0.108	-0.011	

Note: The last column tests the hypothesis that the old age ratio elasticity equals the young age ratio elasticity.
Source: Own calculations from Nordregio Database data

Table 6. The Granger causality, the model 5b and 5c

	Unemployment, Three lags	Unemployment, Two lags	Activity rate, Three lags
1st lag of Δ LPR (Labour Potential Rate)	- 1.557**	- 1.091*	0.183***
2nd lag of Δ LPR	1.315**	0.635	- 0.037
3rd lag of Δ LPR	0.245		0.005
1st lag of Δ U/L (Unemployment Rate)	0.252***	0.214***	0.003
2nd lag of Δ U/L	- 0.139**	0.015	- 0.016***
3rd lag of Δ U/L	- 0.013		0.006*
1st lag of Δ L/POP (Activity Rate)	- 2.622***	- 2.428***	0.376***
2nd lag of Δ L/POP	0.400	- 0.459	0.073
3rd lag of Δ L/POP	0.107		- 0.036
1st lag of Δ Y/WP (YAR)	- 2.834***	- 3.008***	- 0.034
2nd lag of Δ Y/WP	2.053*	2.328***	0.078
3rd lag of Δ Y/WP	- 0.220		- 0.246***
1st lag of Δ O/WP (OAR)	- 0.202	- 0.185	0.034
2nd lag of Δ O/WP	0.114	- 0.104	- 0.106**
3rd lag of Δ O/WP	- 0.152		- 0.017
N	776	866	776
r ² _a	0.550	0.560	0.358

Legend: * p<0.05; ** p<0.01; *** p<0.001

Note: "LPR" is the Labour Potential Rate, U/L is Unemployment Rate, L/POP is Activity Rate, Y/WP is Young Age Ratio (YAR) and OLD/WP is Old Age Ratio (OAR). All regressions include year dummies.

Source: Own calculations from Nordregio Database data

Table 7. The long-run elasticities in the unemployment and activity rate equations, Model 5b and 5c

	A change in UN	A change in AR
With respect to a change in		
Labour Potential, LPR	-0.591	0.256**
Young Age Ratio, YAR	-0.883*	-0.344***
Old Age Ratio, OAR	-0.375	-0.153***
Unemployment rate, UN		-0.013
Activity Ratio, AR	-3.744***	

Source: Own calculations from Nordregio Database data

Table 8. Summary statistics for projected changes in Age structure and LPR between 2007 and 2021

Variable	Mean	Std.Dev.	Min.	Max.
Projection				
TAR	.073	.036	.003	.146
YAR	.015	.080	-.122	.127
OAR	.417	.133	.146	.745
Estimated effects				
LPR	-.004	.002	-.008	-.000
grYLP	.003	.016	-.026	.027
grOLP	-.039	.012	-.069	-.014
direct	-.036	.017	-.086	-.003
indirect	.006	.003	-.001	.011
Total	-.030	.018	-.078	.004

Sources: Nordregio datatbase and own calculations

Table 9. A typology of relative growth in the Labour Potential between 2007 and 2021

	Worse off than today (potential labour supply decreases)	Slightly better off than today	Better off than today (potential labour supply increases)
Regions	Københavns omegn, Nordsjælland, Bornholm, Østsjælland, Vest- og Sydsjælland, Fyn, Syddjylland, Østjylland, Vestjylland, Nordjylland, Åland, Østfold, Oslo og Akershus, Buskerud, Vestfold, Telemark, Aust-Agder, Rogaland, Hordaland, Sogn og Fjordane, Nordland, Troms, Finnmark	København by, Varsinais- Soumi, Kymenlaakso, Etelä- Savo, Itä-Uusimaa, Reykjavik, Iceland outside capital area, Oppland, Vest- Agder, Møre og Romsdal, Sør-Trøndelag, Nord- Trøndelag, Stockholm, Södermanland, Jönköping, Kronoberg, Kalmar, Halland, Västra Götaland, Värmland, Västmanland, Dalarna, Gävleborg, Västernorrland, Norrbotten	Uusimaa, Satakunta, Kanta- Häme, Pirkanmaa, Päijät- Häme, Etelä-Karjala, Pohjois- Savo, Pohjois-Karjala, Keski- Suomi, Etelä-Pohjanmaa, Keski-Pohjanmaa, Pohjanmaa, Pohjois- Pohjanmaa, Kainuu, Lappi, Hedmark, Uppsala, Östergötland, Gotland, Blekinge, Skåne, Örebro, Jämtland, Västerbotten