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**Résumé**

L'article analyse la variation géographique du vieillissement démographique en Flandre. Nous examinons les évolutions combinées de la population âgée de plus de 65 ans et de celle des 20 à 49 ans, ainsi que leur lien avec la croissance naturelle et la migration. Les séries temporelles utilisées concernent la période 2001-2015 et proviennent du Registre National de Population publiées par l'office belge de statistique (Statbel). Elles sont complétées par les Projections démographiques pour les municipalités flamandes 2015-2030, préparées par le Gouvernement flamand. Les municipalités sont regroupées sur la base d'une analyse typologique des séries temporelles sur la composition de la population, l'évolution de la population de 65 ans et plus et de la population de 20-49 ans ainsi que sur les changements dans la migration nette et la croissance naturelle. La typologie issue de cette analyse discerne six modèles de vieillissement dont les plus proéminents sont : un important et ancien vieillissement à la côte ; un futur vieillissement dans le Limbourg oriental et dans le nord de la province d'Anvers et, finalement, une croissance démographique et un vieillissement limité dans le centre de la Région flamande.

**Mots-clés**

Projections démographiques, vieillissement, variations géographiques, la Flandre, model-based clustering.

**Abstract**

The paper analyses the geographic variation in demographic ageing patterns in Flanders. We examine the combined evolutions of the elderly population aged over 65, and the young adult population aged 20-49, in relation to natural growth and migration. The data concern time-series on the period 2001-2015 from the National Population Register as published by the Belgian statistical office (Statbel). We complemented the time series with the Population Projections for the Flemish Municipalities, 2015-2030, prepared by the Flemish Government. A Finite Mixture Model is applied to cluster municipalities on the basis of population composition, change in the population aged 20-49 and over 65, and change in net migration and natural growth.

1. Statistics Flanders, Brussels.

We discern six ageing patterns. The most prominent ones are: first, a strong ageing in the past along the coast; second, a strong future ageing in Eastern Limburg and the North of the province of Antwerp; and third, population growth and limited ageing in the center of the Flemish Region.

**Keywords**
Demographic forecasts, ageing, spatial variations, Flanders, model-based clustering.

The objective of this paper is to highlight the geographic diversity of demographic ageing patterns in Flanders. In Flanders and in Europe, a significant growth of the elderly population and a stagnation or even a decline of the working age population is expected. However, due to geographical differences in natural growth and migration, the timing and extent of the ageing process differs between regions and cities within them.

In 2010, the European Spatial Planning Observation Network (ESPON) presented the results of its project «Demifer: Demographic and migratory flows affecting European regions and cities» (ESPON, 2013). This research project studied differences in demographic change between European regions and cities in the EU27, Iceland, Liechtenstein, Norway and Switzerland. Within Flanders, little variability was detected. However, the unit of analysis used in the project – the NUTS level 2, in Flanders corresponding to five provinces – does not allow a useful distinction to be made between coastal, rural or metropolitan areas, which at European level, proved relevant for distinguishing demographic processes. Therefore, the Research Institute of the Flemish Government conducted a study to complement the Demifer results by using the individual cities and municipalities of Flanders as the unit of analysis. This paper synthetizes this research (Schockaert *et al.*, 2016).

Following the analytical strategy proposed in the Demifer-project, a typology of population dynamics is constructed by means of a cluster analysis. Four indicators of change are combined, i.e. the evolution of the elderly population, the evolution of the young adult population, natural growth and net migration. By jointly considering population composition and growth, as well as the components of growth, the typology provides insights not only into the actual shifts in the age structure, but also into how they come about.

The indicators are constructed on the basis of time series covering the period between 2001 and 2030. This way the typology reflects recent (2001-2015) as well as expected future demographic change (2016-2030). Data on the period 2001-2015 were extracted from the National

Population Register and published by Statistics Belgium[2]. Figures for the period 2016-2030 were provided by the latest local population projections prepared by the Research Institute of the Flemish Government in 2015. The results as well as the projection methodology are publicly available on their website[3].

In the first part of the paper, we clarify some important hypotheses and methodological choices of the projections and we explain the methodology of the cluster analysis. In the second part, we describe the resulting typology of demographic growth patterns in the Flemish Region. In the third part of the paper, we locate these patterns geographically and reflect on the challenges for policy making they may present.

## Methodology

### *Assumptions and method of the population projections*

The latest local population projections prepared by the Research Institute of the Flemish Government were published in 2015. These projections concern all Flemish cities and municipalities, with the exception of the tiny municipality of Herstappe (85 inhabitants on 01/01/2014) and cover a time period between 2015 and 2030. The projections provide yearly population figures by 1-year age categories and sex as well as the estimates in terms of natural growth and net migration (Pelfrene *et al.*, 2015).

The projections use the deterministic cohort-component method; the population at $time\ t$ is estimated prospectively by multiplying the density of the population vector by age, sex and place of residency at $time\ t -$ 1 with estimated fertility, mortality and emigration rates between time t and t + 1 and by adding immigration estimates. The baseline population concerns the population on 01/01/2014 extracted from the National Population Register and published by Statistics Belgium (ADS).

For each municipality fertility, mortality and internal and international migration were estimated by age and sex and with yearly variation between 2014 and 2030. Generally, this was accomplished by extending past trends observed from the National Register (as published by ADS),

2. Algemene Directie Statistiek (ADS).

3. http://regionalestatistieken.vlaanderen.be/vooruitzichten-demografie.

into the future following some statistical model. At the Flemish regional level, at the moment of the projections, information regarding live births and deaths was available by age and sex between 1971 and 2013. Data on the local level were available as of 1997. No explicit use was made of information other than demographic data, such as, for example, housing projects or other infrastructural development, to «foresee» potential shifts in population developments. However, expert opinions were gathered during interviews and steering committees composed of academics as well as government officials, experts in housing, education, regional development, etc. Their knowledge on population trends at the local level was used to make adjustments to some of the projected trends. A detailed description of the methodology can be found on the website of the Flemish Research Institute (Pelfrene *et al*., 2015).

Following the cohort approach proposed by Li and Wu (2003) and Cheng and Lin (2010), fertility at the Flemish Regional level was projected for the generations born between 1967 and 1998. For the youngest generations, born after 1984 the results were adapted to take into account the impact of the economic crisis (Pelfrene *et al*., 2015). Estimates show an increase of the total parity from 1.75 children per women for the cohort born in 1968 to 1.82 for the 1980 cohort followed by a slight decrease for the cohorts born thereafter. In addition, from one generation to the next, births are more concentrated around the central ages of fertility (25-35 year). To obtain the fertility estimates for individual municipalities, the projected fertility curve was «corrected» by the age specific differences in fertility rates at the municipal and the Flemish level observed during the last five observation years (2009-2013).

Mortality rates at the Flemish Regional level were estimated by extending the trend by age and sex observed between 1971 and 2013 into the future using a negative exponential function. To capture regional differences, trends were determined for the two largest cities of the Flemish region (Ghent and Antwerp) and for three mortality risk groups with similar standardized morality ratios (2009-2014). Differences in life expectancy was very small between the risk groups, ranging in 2014, from 81 for the low risk group and Antwerp to 82.5 for the high risk group. The expected rise in life expectancy over the projection period is, however, slightly larger in the low risk mortality municipalities (+3 years) than in the high risk ones (+2.5 years). Antwerp and Ghent gain about 2.2 and 2.4 years respectively.

Internal migration projection is based on the absolute number of in- and out-migrations for each municipality, including the exchanges with Brussels and the Wallonia. The common matrix-approach was not used because of the large number of geographical areas (310) involved; many areas had no connection to each other or only for some age groups. To avoid the problem of small numbers by age and sex at the local level, first the total number of internal immigrations and emigrations were projected by a moving average over all observation years (1997-2013). The net migration was divided over the two sexes according to the average sex ratio calculated over all ages, years of observation and municipalities. Finally, the smoothed age profile of individual municipality observed during the last five observation years provided the age structure (constant for all projection years). Although in- and out migrations were estimated separately, the total numbers projected were practically equal to each other, ensuring a balance at the level of the Flemish region.

After a period of fast growing immigration since the turn of the 20th century, a stagnation and downturn in this trend was observed between 2008 and 2013. According to other projections (Federal Planbureau, 2014) and expert opinions, international immigration would continue this downward tendency for some years due to economic crisis and increasingly restrictive immigration laws (Pelfrene, 2015a). This expectation was translated into the projection hypothesis of a regression of immigration levels by age, sex and municipality to the average immigration influx of 2003-2007 by the year 2025. The external emigration rate was expected to fluctuate along the average observed in 2014-2015. These trends were estimated for each municipality and by age and sex.

Needless to say that the results of the projections are sensitive to the assumptions advanced. Particularly the last one on migration will have an important impact. In view of the recent migration waves from Syria and the enhanced migration pressure due to wars, economic inequalities and climate change, the assumed decrease in immigration has become less likely. In fact, the newest data indicate that for Flanders as a whole, immigration figures are higher in 2014-2015 than in previous years, while emigration numbers have become smaller. The impact of an alternative hypothesis on the projection results will be largest for the adult population. The evolution of the elderly population, which in less prone to move, is much less affected.

*Methodology of the cluster analysis*

The data on population by age and sex, natural growth and net migration from the National Register as published by Statistics Belgium (2001-2015) and the results from the projections of the Research Institute of the

Flemish Government (2016-2030) were used to construct a typology of local population dynamics. We did so by means of a model-based cluster analysis, combining the following elements: the population composition, the evolution of the elderly population and the adult population, and the evolution in the natural balance and net migration.

The elderly population is defined as the population aged over 65. This is the delineation most often used, congruent with the retirement age of the generations that will enter retirement in the near future. For the adult population, we focus on the 20-49 year-olds. This delineation is different from the usual definition (20-64 year-olds). This choice is justified by two reasons. First, the age range 20-49 is in line with both the main reproductive and productive ages, in Flanders the population over 50 years being treated as a separate labour market category (VDAB Studiedienst, 2014). Secondly, the Demifer-research project also focused on the young adult population and hence a comparison with their results perused in the original research report of the Flemish Government (Schockaert *et al.*, 2016) was facilitated. Finally, today's 50-64 year-olds is a relatively large group of baby boomers. Including them in the analysis would exaggerate trends in generational turnover as in the coming 15 years they *exit* the adult age category *and enter* the group of over-65's.

The natural balance is defined as the yearly differences between the number of newborns and the number of deaths. Net migration indicates the difference between the number of people entering and leaving the municipalities taking into account international as well as internal migration. No distinction between internal and international migration was introduced in order to avoid very small numbers, especially on international migration, in many of the municipalities.

The time series on the four indicators were constructed as follows. In 2001, the first observation year, we indicate for each municipality, the *proportion* per 1'000 residents of the population aged 20-49 and over 65. For all the consecutive years, we calculate the cumulative growth in the *number* of individuals aged 20 to 49 and over 65, starting from the value computed for 2001. If, for instance, in a given municipality, there are 300 elderly per 1,000 inhabitants in 2001 and the growth between 2001 and 2002 was 2%, then the value in the time series for 2001 equals 300 and 306 for 2002. If the growth between 2002 and 2003 is 1.5%, then the value for 2003 equals 310.5. In this way we take into account both population composition and annual population growth. Natural growth and net migration are shown per 1'000 residents in each municipality and for each year between 2001 and 2030.

To build a typology of demographic change patterns, we used a cluster analysis, more specifically, the «Finite mixture model for generalized regression models» as developed within the R project framework (Leisch, 2004). This procedure is a segmentation technique that divides observations, in the case of the present analysis municipalities, into clusters in such a way that within each of them a regression model fit is optimized. The regression model concerns a multivariate random regression of time (calendar years 2001-2030) against yearly growth in (1) the population aged 20 to 49, (2) the population aged over 65, (3) natural growth and (4) net migration. In other words, we regroup the municipalities that have a similar combination of trends regarding these four indicators.

Details of the model are explained in Box. 1.

A Finite Mixture Model with K components is defined as

$$h(\mathrm{y}|x,\varphi) = \sum_{k=1}^{K} \pi_k f(y|x\,,\theta_k)\ ;\ \pi_k > 0, \sum_{k=1}^{K} \pi_k = 1 \qquad (3)$$

where $y$ is the (multivariate) dependent variable with conditional density $h$, $x$ is a vector of independent variables, $\pi_k$ is the prior probability of component k, $\theta_k$is the component-specific parameter vector for density function $f$ and $\varphi = \pi_1, \dots, \pi_k, \theta_1, \dots, \theta_k)$ is the vector of all parameters. The posterior probability is used to segment data and each observation is assigned to the class with the maximum posterior probability (clustering). The posterior probability that an observation $(x, y)$ belongs to class $j$ is given by

$$p(j|x,\varphi) = \frac{\pi_j f(y,x,\theta_j)}{\sum_k \pi_k f(y,x,\theta_k)} \qquad (4)$$

The parameter vector $\varphi$ is estimated through the iterative EM algorithm (expectation-maximization) for log-likelihood estimation. If the clusters are well delimited and clearly distinct from each other, the ratio between the prior and posterior probabilities will be close to 1.

The classical mixture of standard linear regression models, known as latent class regression (DeSardo, 1988), was extended to the mixture of the generalized linear model (Wedel *et al.*, 1995). This extension allows for the model used in this paper to be specified as a multivariate random regression of time (calendar years 2001-2030) against yearly growth in (1) the population aged 20 to 49, (2) the population aged over 65, (3) natural growth and (4) net migration:

$$\begin{aligned} P_{20-49}(t) &= \beta_1 + b + \beta_2 t + \varepsilon_1 \\ P_{65}(t) &= \beta_3 + by + \beta_4 t + \varepsilon_2 \\ N(t) &= \beta_5 + bz + \beta_6 t + \varepsilon_3 \\ M(t) &= \beta_7 + bq + \beta_8 t + \varepsilon_4 \end{aligned} \qquad (5)$$

where $b$ stands for the random effect common to all models and $\varepsilon_1, \dots, \varepsilon_4$ the individual errors. The parameters $y, z\ and\ q$ are used to scale the shared random effect $b$. We note that the model assumption of independence between the dependent variables is somewhat violated – the evolution of the population is by definition not independent of migration and natural growth. However, since only a time variable is introduced in the model and the shared random effect does not go beyond the random intercept, this relaxation of the basic assumption should not affect the results too much (Verbeke *et al.*, 2014).

Finally, we adapted the model to take into account the non-linearity of the time series, using a cubic spline of the independent time variable. The principle of a spline is that the regression model is segmented over the range of the independent variable $t$ by $k$ knots. The truncated cubic polynomial associated with each knot $\delta_k$ is the function equal to 0 to the left and to $t - \delta_k$ to the right of $\delta_k$.

The regression models are transformed as follows:

$$Y(t) = \beta_1 + bz + \sum_{d=1}^{3} \beta_d t^d + \sum_{K=1}^{3} \beta'_k (t - \delta_k)^3 + \varepsilon_1 \quad (6)$$

where Y stands for one of the dependent variables $P_{20\text{–}49}$, $P_{65}$, *N or M*, $bz$ is the scaled random effect $b$ for each of the regression equations, $\sum_{d=1}^{3} \beta_d t^d$ is a polynomial regression of degree 3 and $\sum_{K=1}^{3} \beta'_k (t - \delta_k)^3$ the spline function with $K = 3$ and $\varepsilon_1$ the individual error term (Durrleman *et al.*, 2006).

**TABLE 1** Relative growth in the total population, the population aged 65+ and the population 20-49 years old, Flemish municipalities, 2001-2015, 2016-2030 (‰)

| | 2001-2015 | | 2016-2030 | |
|---|---|---|---|---|
| | Avg.[1] | s.d.[2] | Avg. | s.d. |
| Total population | 72 | 47 | 45 | 51 |
| Population 65+ | 290 | 165 | 345 | 100 |
| Population 20-49 | -57 | 67 | -47 | 70 |

**TABLE 2** Share of the population 65+ and the population 20-49 (‰), Flemish municipalities, 2001, 2015, 2030

| | 2001 | | 2015 | | 2030 | |
|---|---|---|---|---|---|---|
| | Avg. | s.d. | Avg. | s.d. | Avg. | s.d. |
| 65+ | 164 | 24 | 195 | 25 | 255 | 37 |
| 20-49 | 428 | 20 | 376 | 20 | 340 | 25 |

[1] Average. [2] Standard deviation.

## Clusters of ageing patterns

Important population change exists over time (Table 1). On average, the Flemish municipalities experienced a population growth of a little more than 7% over the period between 2001 and 2015. For the coming 14 years we expect this growth to slow down to 4.5%. This change diverges greatly by age. The elderly population aged 65+ increased with nearly 30% between 2001 and 2015 and it is expected to grow even faster in the years to come. The population aged 20 to 49 in contrast has decreased since 2001 (-5.7%) and is expected to continue to do so in the future (-4.7%). Consequently, the population composition is substantially altered (Table 2). The share of the elderly population is expected to increase from 164 ‰ in 2001 to 255‰ in 2030, while in the same period the share of the population aged 20-49 decreases from 428‰ to 340‰. Nevertheless, the large standard deviations around the mean, regarding relative growth as well as population composition, suggests important variation among municipalities.

Figure 1 and Figure 2 show the results of the cluster analysis. The 307 municipalities concerned were regrouped in 6 clusters. These clusters are clearly distinct from each other and show very little overlap ($for\ k = 6, p(j|x,\varphi) > .9 > p(j|x,\varphi)$, *cf.* box 1).

Figure 1 represents the age composition and the population growth per age group (20-49 and 65+) between 2001 and 2030 in each of the clusters. The y-axis presents the values for the share of 20-49 year-olds and 65+ in 2001. The curves shows the cumulative change in the number of 20-49 year-olds and 65+ between 2001 and 2030. Each of the six clusters is given a distinct colour. The black curve represents the average for the Flemish Region. Figure 2 presents the estimated natural growth and net migration relative to the number of inhabitants of each municipality. Table 3 shows the number of municipalities in each of the clusters.

**FIGURE 1** Initial share (‰) and relative population change, age groups 20-49 and age group 65+, clusters of municipalities of the Flemish Region, 2001-2030

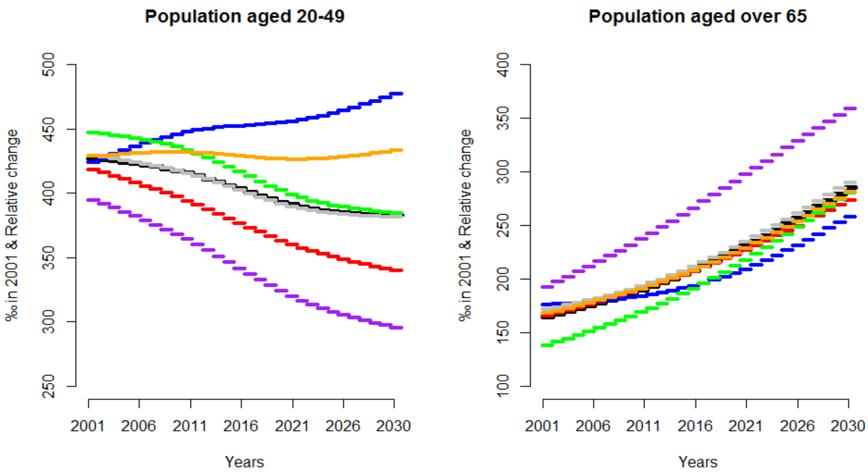
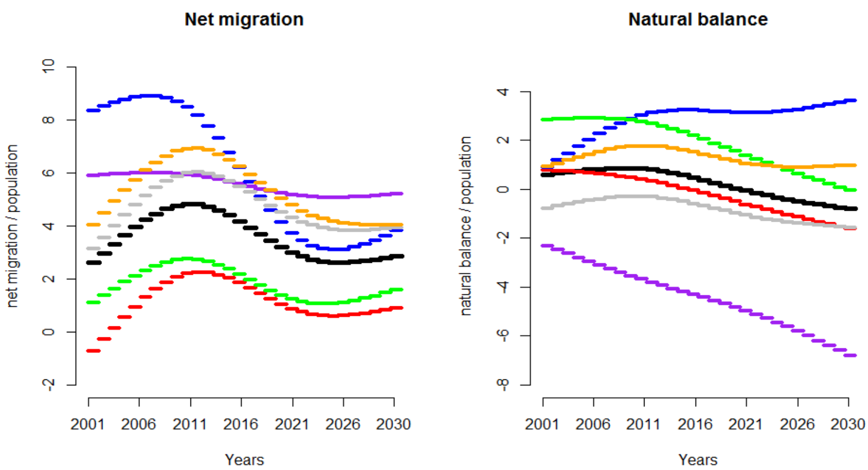



**FIGURE 2** Natural growth and net migration relative to the number of residents, clusters of municipalities of the Flemish Region, 2001-2030




Number of municipalities per cluster: grey = 76, red = 72, green = 60, orange = 51, blue = 26, purple = 22.

Table 3 provides additional information on each of the clusters: the expected population growth between 2016 and 2030 and the current (2015) and future (2030) ratios of 20-49 year-olds versus the population aged over 65. The means for the Flemish Region are included in the last table row

**TABLE 3** Descriptive variables per cluster

| | N | 2016-2030 Average growth | 2016-2030 Mun. with growth < Vl. | 2016-2030 Mun with growth < 0.5 | 2001 65+/ 20-49 | 2015 65+/ 20-49 | 2030 65+/ 20-49 |
|---|---|---|---|---|---|---|---|
| Early ageing | 22 | 0% | 17 (77%) | 10 (45%) | 49 | 80 | 125 |
| Population decline | 72 | 0% | 71 (99%) | 37 (51%) | 40 | 55 | 81 |
| Late ageing | 60 | 3% | 35 (59%) | 11 (19%) | 31 | 46 | 73 |
| Standard | 76 | 4% | 31 (41%) | 2 (3%) | 40 | 53 | 76 |
| Young | 51 | 8% | 1 (2%) | 0 (%) | 39 | 49 | 65 |
| Growth by migration | 26 | 11% | 5 (19%) | 2 (8%) | 41 | 43 | 55 |
| Flanders | | 4% | | 60 (19%) | 39 | 53 | 76 |

The clusters can be characterized as follows:

*Standard:* The municipalities in the grey cluster largely follow the evolution we observe at the Flemish regional level. The increase in the population aged over 65, the decrease in 20-49 year-olds (Figure 1) and the evolution of the total population show similar trends (Table 2). However, migration is somewhat more important and natural growth has a smaller weight (Figure 2).

*Early ageing:* The purple cluster shows an advanced ageing of the population already in 2001. Ageing will continue in the future and will result from a severe reduction of the population aged 20-49 and the sharp increase in the population aged over 65. By the year 2030, we expect the latter group to be larger than the former (for every 100 20-49 year-olds we expect about 125 individuals older than 65!). The population is maintained by a constant and relatively high net migration. Over time, however, this will not be sufficient to offset the marked decline in natural growth: almost half of the municipalities in this cluster have a near-zero or negative population growth.

*Late ageing:* The green cluster depicts a rather young population in 2001. However, similar to the purple cluster, it shows a steep decrease in the population aged 20 to 49 and a fast increase in the population aged over 65. The ageing of the population structure will therefore mainly take place in the future. In 2015, we counted 46 over 65-year olds per 100 20-64 year-olds. In 2030, we expect this number to rise to about 73. The ratio between the age groups of 65+ and 20-

49 year-olds remains more favourable than in the Flemish average, but the difference clearly grows smaller over time. This cluster can still expect an average growth of 3% between 2016 and 2030. However, attention should be given to the low net migration and a drop in natural growth to a quasi-zero level.

*Population decline:* The red cluster is characterized by low net migration and a low natural balance. Consequently, no population growth is recorded for the future. The number of people aged over 65 increases in accordance with the Flemish average trend, but the working age population decreases dramatically. This results in a fast ageing population. In 2015, there were 55 people aged over 65 per 100 20-49 year-olds, while in 2030 this number will exceed 80.

*Young families:* The orange cluster is characterized by a status quo to a slight growth in the number of 20-49 year-olds, a positive natural growth and a net migration which is sustainably higher than the Flemish average. The increase in the number of people aged over 65 similar to the Flemish average results in a (limited) ageing of the population structure. In 2015, there were 49 people aged over 65 per 100 20-49 year-olds and in 2030 we expect a ratio of 65 per 100. Therefore, we expect a significant average population growth of more than 8%.

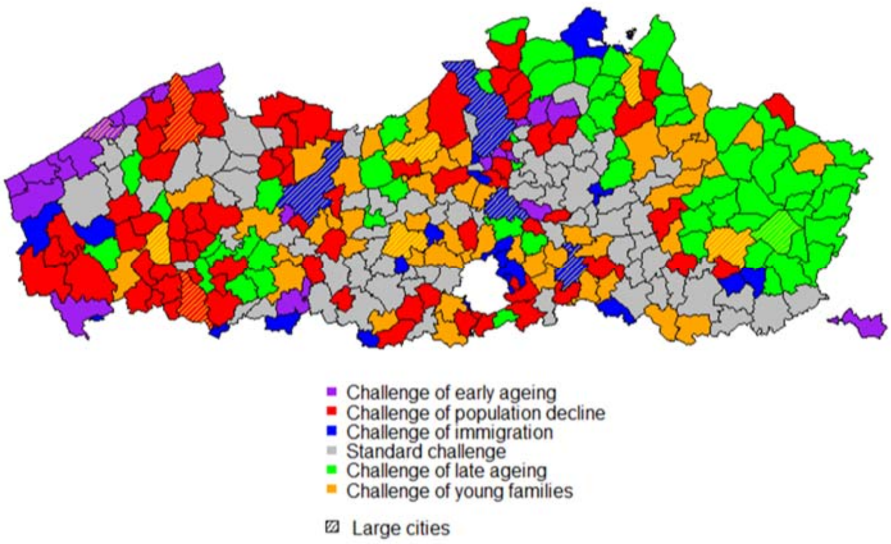
*Growth through immigration:* Characteristic of the blue cluster is the very high net migration during the 90s and early 2000s. This process is at the basis of the increase in the working age population, a sustained high natural balance, a very limited population ageing and an average population increase of about 11% for the next 14 years.

Since the time series are constructed using observed and projected demographic data, the results of this analysis should be interpreted with caution. As noted in the methodological section of this paper, international migration is higher than assumed in the latest local projections used in this study. Consequently, the decline of the young adult population is probably overestimated as well as the decrease of the natural balance. Nevertheless, the construction of the groups is only mildly affected by other assumptions; the courses of the curves of Figure 1 and Figure 2 are already clearly distinct before 2015, the last observed data point. In other words, the precise trends should be interpreted with caution, but the overall results will hold unless a marked breaking point in the demographic evolution occurs.

## Demographic change and regional challenges

Figure 3 locates the 6 clusters geographically. The colours on the map correspond to the colours of the clusters introduced in Figures 1 and 2. The thick lines delineate the administrative border of the five provinces. To distinguish the urban areas, we have shaded the most important cities («centrumsteden»[4]). The clusters clearly adopt a geographical pattern beyond the municipal borders.

**FIGURE 3** Geographical location of the clusters




A concentration of purple municipalities at the coast, corresponding to the cluster of early ageing, immediately catches the eye. It is well-known that ageing in the coastal region is not only related to its own generational turnover, but also to an important immigration of elderly from all over Flanders (De Klerck, 2011). The rest of West Flanders is predominantly red: the change in the population structure is pronounced and to a large extent related to the decline of the young adult population. This is due to generational turnover and exacerbated by a very low to negative net migration.

4. Antwerp, Ghent, Sint-Niklaas, Mechelen, Turnhout, Leuven, Hasselt, Genk, Aalst, Brugge, Kortrijk, Roeselare and Oostende. These cities are regarded as central to Flanders regional and social development.

Green municipalities are concentrated in the eastern part of the Flemish Region – part of Limburg and the Northern part of the Province of Antwerp. These municipalities constitute the cluster of late ageing. These regions profited from an important international immigration during the mid-60s, workers mostly from Turkey attracted by opportunities in the coal missing area. The arrival of young households in full family expansion certainly postponed the ageing process, but also intensified the recent growth of the elderly population.

In other words, challenges related to the strong ageing of the population structure are mainly situated in the outer eastern and western part of Flanders, although with a different timing. These changes may affect the economic and social organization of the municipalities involved. Ageing alters the local consumer markets, particularly in the areas of retail, restaurants and bars, and personal services. On the one hand, the demand may decrease due to the decline of the adult population (Vewest, van Dam, 2010; Smid, 2013). On the other hand, the nature of consumption changes due to the increase of the elderly population. Moreover, older people have other requirements with regard to accessibility of services, forcing developers and policy makers to rethink not only housing facilities themselves, but also the organization of larger living environment (shops and services close-by, diversified mobility strategy with, for example, shared taxis, intergenerational living arrangements) (De Decker *et al*., 2016; Royer, 2007; Hooimeijer, 2007). Local businesses may also find it harder to attract qualified workers as the number of potential employees shrinks (de Beer, 2008) while the demand for skilled labour rises as the baby boom generation, now a significant proportion of the workers, must be replaced in the coming years (Theunissen *et al*., 2011; Theunissen, Herremans, 2013). Finally, Gras *et al*. (1998) and de Groot *et al*. (2013) draw attention to the potential effect on the housing market. Currently, the large baby boom generation still occupies their original dwelling, resulting in a tight housing market. However, at advanced ages many will transfer to a collective living arrangement. With a decreasing young adult population, this may well lead to vacant housing.

Municipalities of the blue and orange clusters are often found in the central area of the Flemish Region – within the so-called Flemish diamond. This is the highly developed urban network between Ghent, Antwerp, Leuven and Brussels delimiting a region oriented towards the knowledge economy with universities, High Tech parks, Ports and Belgium's most important airport. In this already densely populated and urbanized area we expect a significant population growth combined with limited ageing.

Consequently, limited space and population pressure constitute the most important challenge of this area.

Growth of the young adult population is most pronounced in large cities like Antwerp, Ghent, and Leuven (blue cluster). International immigration is the most important factor behind this growth. This international migration is a push-factor for internal flows, on the autochthonous as well as the migrant population (Pelfrene, 2015b; Willaert, 2010). Municipalities around Ghent and Leuven and in the Northern border of Brussels can therefore count on an important net influx from the cities. This is also the case for the highly industrialized border region between the province of Limburg and Antwerp. These orange cluster municipalities as well as those in the blue cluster, will therefore face the challenges related to the integration of a diversifying (immigrant) population of diverging cultural and educational background, within the context of the highly developed knowledge economy.

## Conclusions

In this paper, we described the geographic diversity of demographic ageing patterns in Flanders. We looked at how municipalities combine evolutions in the elderly and the young adult population, and how these changes relate to natural growth and migration. The elderly population was defined as the population aged over 65, and the adult age population as the 20-49 year-olds. We used time-series data from the National Population Register as published by the Statistics Belgium covering a period between 2001 and 2015. These data were complemented with the results of the latest Population Projections for the Flemish Cities and Municipalities prepared by the Research Institute of the Flemish Government, providing population estimates up to 2030.

We analysed the variability in demographic processes between the municipalities by means of a model-based cluster analysis. We regrouped municipalities with similar population composition in 2001, similar relative change between 2001 and 2030 in the elderly and young adult populations, and in net migration and natural growth. We discerned six types of demographic patterns. Strong and early ageing was mainly found along the coast – related to generational turnover and net immigration of elderly. In the rest of Western Flanders ageing is to a large extent driven by a decrease in the working age population due to generational turnover and very low net migration. Eastern Limburg and Northern Antwerp may expect a strong growth of the elderly population mainly in the coming years. Recent literature suggests potential consequences of ageing on the local economy and social organization such as a decrease and changes in consumption patterns, necessary changes in housing and neighbourhood organization, and an imbalance between supply and demand on the labour market. The centre of the Flemish Region shows an important population growth and a relatively limited population ageing. In the large cities this is due to international immigration, whereas around the cities internal migration also plays an important role. The already densely populated centre of the Flemish Region will face continuous population pressure and an intense diversification.

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