

Empirical Bayes estimation of local demographic rates

An application using Norwegian registry data

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Stefan Leknes and Sturla A. Løkken

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Preface

The document `Empirical Bayesian estimation of local demographic rates: an application using Norwegian registry data' presents and applies a method for estimating demographic schedules to be used in the regional population projections of Norway. The method is called hierarchical empirical Bayes estimations and is particularly suitable in settings where samples are small, which is the case for many municipalities in Norway. Enclosed are fact sheets showing the demographic rate results for each municipality.

The projections are an important product of the Research Department of Statistics Norway and are widely used for planning and policy purposes. This work is part of an effort to modernize the modelling framework of the regional population projections.

Statistics Norway, 29 January 2020

Brita Bye

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Abstract

Local governments and businesses rely on regional population projections to make informed planning and policy decisions. A prerequisite for producing reliable regional projections is access to high quality demographic rates. However, it is difficult to produce local demographic rates in a setting where many populations are small.

To solve the small area problem, we propose the use of hierarchical empirical Bayes (EB) methods. It provides a unified framework for estimating local age-specific rates for fertility, mortality, internal migration and emigration. This method also produces rates that are stable and regular across all types of municipalities while still allowing substantial local heterogeneity.

In this document, we contribute by describing an efficient and low-cost method for implementing the technique, which can easily be used by other practitioners using off-the-shelf statistical software packages. We demonstrate how the EB-method outperforms naïve estimates of local demographic rates. Finally, we provide fact sheets with results for all municipalities, demonstrating the performance of the method.

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$1 \quad Introduction^1$

Reliable regional population projections are an invaluable tool for state and local government planners, and producing such projections is one of the official tasks of Statistics Norway. The regional projections assist local government planners and policy makers in forming realistic expectations of the future population in their domain. They inform choices concerning investments in and scaling of public services, such as kindergarten, health care, infrastructure and education. The projections are also used by other agents belonging to the private sector, and are a vital input factor in economic models used by the central government. As local population projections serve as a basis of knowledge in many costly decisions, it is important that they are of high quality and are presented in a transparent and easily accessible manner. Ideally, local government officials should be able to assess the accuracy and relevance of the projections, and use superior knowledge of the local setting in interpreting and adjusting the projection results.

Most Norwegian municipalities are small and most demographic events are rare.² This makes it challenging to produce local population projections of a certain standard since sampling error³ will be prevalent and traditional demographic rates tend to be unstable. The regional projection framework for Norwegian municipalities obscures the underlying demographic processes. Specifically, only local population size by sex and age is produced and reported to the public, which means that the demographic events underlying the results - deaths, births and migrations - are unknown. In addition, the current method tends to extract only a small part of the relevant demographic information from the local level, even when reliable information exist.

In recent years, Bayesian statistical methods has gained in popularity (Bijak and Bryant, 2016). This is partially because such methods are computationally demanding and benefit greatly from the dramatic increase computing power that has become available to researchers, but also because these types of models also have many favorable properties when estimating demographic rates. Especially hierarchical Bayesian models have many favorable properties when estimating many population parameters at the sub-national level (Alexander et al., 2017), and typically lead to plausible estimates when data are sparse (Schmertmann and Gonzaga, 2018). This report is a first step in improving the local projections for Norway, describing a method for measuring the characteristics of local demographic processes in an accurate and reliable way. Specifically, we propose a new method for estimating demographic rates for Norwegian municipalities called hierarchical⁴ empirical Bayes estimation (EB). The method tackles issues related to small population sizes, and makes it possible to produce and communicate the demographic processes underlying the projection results for each municipality, benefiting the users. This indirect model uses hierarchical large-region demographic rates as priors; in effect, noisy local demographic rates are penalized in a way that weights the estimates closer to the large-area demographic rate. In other words, it is a procedure that borrows statistical strength from related units to create stable and demographically plausible rates. Applications of this method can be found across many fields, for instance demography (Assunção et al., 2005; Schmertmann et al., 2013), economics (Chetty et al., 2014), and epidemiology and public health (Manton et al., 1989; Marshall, 1991).

The hierarchical EB method solves one of the major data challenges for regional population projections. Nonetheless, it has not achieved widespread use. This has been attributed to the time and resource constraints faced by practitioners (Wilson, 2015). We contribute by describing an efficient and low-cost method for implementing the technique, which can easily be used by other practitioners using off-the-shelf statistical software packages.⁵ Also, using a common estimation

¹We are grateful for helpful comments from Terje Skjerpen, Nico Keilman, Marte Rønning, Astri Syse and colleagues at the Research Department of Statistics Norway. For questions or comments please contact us on email: sal@ssb.no or sfl@ssb.no.

 $^{^2}$ The median municipality has less than 5000 inhabitants, which means there are less than 25 people in each age-by-sex specific cell, on average. Such small cells means that sampling error is likely to be prevalent.

³We do not have sampling error in the traditional sense as we observe the full population. Instead, we rely on the commonly used interpretation of the population as drawn from a super-population. We seek the latent outcomes of the super-population, in contrast to the readily available outcomes of the population.

⁴The model class is often also referred to as multilevel or mixed models.

⁵Review of the software and packages used can be found in Appendix C, together with a brief summary of alternative methods tested and reflections on possible avenues of development of the EB-framework.

framework across all demographic behaviors has the advantage of increasing transparency and ease of interpretation.

The report is structured as follows. Section 2 describes the small area statistics problem in detail. Section 3 reviews how demographic rates are constructed for the projection models used by Statistics Norway. We will discuss how small area issues have been handled in the present modeling framework of Statistics Norway and the shortcomings of these workarounds. In Section 4, we describe the empirical Bayes method. Next, in Sections 5-8, we show how different demographic rates can be constructed with empirical Bayes estimations. Finally, Section 9 concludes.

2 Small Area Statistics

Rao (2017) defines a statistical domain as a sub-population that shares a certain set of properties. Typically the properties are determined by geographical proximity, but it could also be defined by individuals belonging to a certain socioeconomic category or being employees in the same firm. Examples of geographical domains are state, county, municipality, school district, health districts and labor market regions. Domains can be regarded as large or small. A large domain encompasses a sample of sufficient size to produce direct estimates with adequate precision. Conversely, a domain is small if this is not the case.

In the following, we use the computation of fertility rates as an example to illustrate the problem with small area estimations. However, the issue of statistical support in small areas would be analogous for other demographic measures like mortality and migration, as well as other types of behavior, for instance related to labor supply, retirement, use of public services, etc. Imagine a municipality with no population at risk. This means there are no women of fertile age currently living in the municipality. But the hypothetical fertility rates of these women exist independently of the availability of data at the time of measurement. In the coming years, young women will reach fertile age, and other women in the fertile age span may be moving into the municipality. It is worth noticing that a municipality may be "small" not only because data support is limited to the geographical region of the municipality, but also gender and age category limit the number of observations behind each statistic. In our example, we have an extreme case with no information regarding the municipality's age-specific fertility. Studying the municipality in isolation will not get us anywhere. Consequently, it is necessary to attain information elsewhere.

Small area statistics is a term that describes methods used to increase the support and precision of estimates by making structural assumptions. Usually, these assumptions involve "borrowing strength" from related observations, hence, the approach is often labeled as an indirect method. Traditionally, researchers have been "borrowing strength" along several dimensions. It is fairly common for researchers to aggregate small areas into groups with a sufficient number of observations, which means "borrowing strength" from nearby or similar areas. Another way to go about this, is to assume regularity over age, for instance by using a standard age schedule or fitting a functional form of different age cohorts, which basically means "borrowing strength" from other age groups. Yet another method is to aggregate the population over time, which means "borrowing strength" from past local populations. In practice, often several of these methods are used together to minimize loss of precision when estimating rates. However, it is largely an empirical question whether (fertility) rates are best predicted by "borrowing strength" from the past, or neighboring municipalities, or even from municipalities that are similar in characteristics such as unemployment, income, industry, geography or demography.

In a regional population projection setting, there are some very specific problems related to retaining statistical support from past observations and the same cohort. Aggregation over time may seem like an attractive approach, but raises several issues. A concern is that the estimation is biased by outdated behavior. For instance, the fertility in Norway has fallen over time and we observe shifts in the age schedule. Using data for too many periods will therefore overestimate the fertility rates and provide inaccurate timing of births. Another issue is of a more practical nature, many countries do not have sufficiently long time periods to overcome the small area problem. This

problem is exacerbated by frequent border adjustments that deteriorate the data quality. Statistical support from the same cohort disregards space altogether. It can therefore provide biased estimates of regional behavior, as much of the variation would originate from where the majority resides, typically in cities. As regional variation is the main concern in regional projections, one could question the appropriateness of relying too much on non-geographical information.

If one does not have the proper tools, there are also pitfalls from aggregating over space. Mechanical aggregation of data over space typically provides stable rates, but at a cost. Small areas with small population will have a minuscule influence on the regional rates, but are assigned the same statistics as more populous places. Consequently, relevant information from the local level are also mostly disregarded (for instance if a small area has sufficient observations for some age and sex groups). If one chooses to produce projections at an aggregate level, the results are of less interest for local government. Therefore, one typically have to follow up with procedures to break the numbers down to the relevant geographical units. These procedures tend to be non-transparent and produce projected population size only and not the underlying demographic events. This hinders the municipalities from making informed judgments about the relevance of a given projection as there are several sets of demographic behavior that correspond to the resulting population size. We propose a method that aggregates over space, but carefully extracts the relevant information from the municipality level based on statistical criteria.

3 Background

Conventionally, a population projection is defined as the deterministic outcome of a particular set of assumptions (Smith et al., 2013). In most modern applications, these assumptions are concerned with the development of fertility, mortality and migration processes of populations. Population projections should therefore not be judged as right or wrong, as they are simply conditional statements about the future. Statistics Norway uses two cohort-component-models to project the Norwegian population size and composition (Syse et al., 2018). The model BEFINN projects the national population based on one-year age, sex and immigrant characteristics. The regional model BEFREG projects population by one-year age and sex in Norwegian municipalities. The regional model is affected by the national results, as demographic rates are tempered to reflect the national mortality, fertility and international migration trajectories.

Small municipalities have small risk populations that typically yield unstable estimates of demographic rates. To create stable rates, the BEFREG model aggregates information both over time and space, in a rather mechanical manner. In the last publication (in 2018), up to ten years of demographic data were used, which raises the concern of including demographic behavior that is outdated. In the model, the population is projected at an aggregated regional level (economic regions) where demographic rates are stable. Information from relatively small municipalities will therefore provide minor influence on the rates. Projected demographic events and populations at the aggregate level are of little interest to the municipal governments. The projected regional populations are therefore distributed to each of the underlying municipalities using a "share of growth" type of model. Although "share of growth" models have reasonable accuracy (Smith and Shahidullah, 1995), they possess several unfortunate traits related to plausibility, for instance, producing instances of negative populations (Smith et al., 2001; Hachadoorian et al., 2011). The methodology in BEFREG is rather standard, and our aim is to improve on it with frontier methods.

4 Empirical Bayes Method

Empirical Bayes method was first described by Robbins (1964) and later extended to the parametric case by Morris (1983). Empirical Bayes method is particularly suited for problems regarding small area statistics as it lends support from larger domains to produce unbiased estimates of small

⁶The Norwegian economic regions which correspond to the European NUTS4 regions, have a median population of 26,433 in 2018, with minimum and maximum of 5,155 and 673,469, respectively.

area characteristics. The empirical Bayes estimator is also referred to as the best linear unbiased predictor (BLUP) and is useful for "regularizing" estimates to reduce the influence of statistical noise and overfitting. These properties are especially convenient when estimating a large number of parameters, such as local demographic rates. When we have a hierarchical data structure, such as municipalities within counties within country, the higher level estimates will function as an informative prior for lower level estimates. Imprecise small area statistics with limited support in the data will be weighted towards the country and county estimates. In a more abstract sense, empirical Bayes method is useful when we are interested both in the individual parameters and in the distribution of parameters. This means that we are, for instance, both interested in the fertility rates of individual municipalities and in the distribution of fertility rates across municipalities.

Empirical Bayes methods have recently gained greater popularity. Within the field of economics, Chetty et al. (2014) use empirical Bayes methods to consistently capture teacher value added effects which are usually measured with severe error due to the limited number of students in a class. This approach parallels recent work applying shrinkage methods to estimate causal effects of schools, neighborhoods, and hospitals on various outcomes (Abdulkadiroglu et al., 2017; Angrist et al., 2017; Chetty and Hendren, 2018; Finkelstein et al., 2017). In demography, several studies use empirical Bayes methods in conjunction with other methods to solve specific small area problems. Assunção et al. (2005) use a combination of moving neighborhoods and empirical Bayes to estimate demographic schedules for local areas in Brazil, while Schmertmann et al. (2013) use a combination of empirical Bayes and Brass schedules to estimate total fertility for many small areas using sparse census data. In this following sections we will use this method to develop a common framework for estimating local age-specific rates for several demographic behaviors such as fertility, mortality, internal migration and emigration.

4.1 Statistical Method Overview

In the following, we will describe how the formal empirical Bayes approach with two hierarchical levels can be operationalized. Let $j \in \{1, ..., J\}$ denote index groups (e.g. municipalities), and let $i \in \{1, ..., N\}$ index individuals within groups. Let θ_j be an unknown parameter for group j (e.g. the fertility rate for 30 year old women in municipality j) and Y_{ij} is an observed outcome (e.g. child or no child) for individual i in group j, assumed to follow the distribution:

$$Y_{ij}|\theta_i \sim f(y;\theta_i)$$
 (1)

In the next level of the hierarchy, we assume a distribution of the group level parameters:

$$\theta_i \sim g(\theta; \Omega)$$
 (2)

In the Bayesian framework, $g(\cdot)$ is a prior distribution, and Ω is a hyperparameter describing the prior. In the case of fertility, this distribution would characterize the spread of municipality specific fertility rates. Alternatively, we can think of this as a random coefficient model where $g(\cdot)$ is the distribution of the random coefficients. It may be worth emphasizing that this is not the distribution of the measured outcomes, but rather the distribution of the unobserved group parameters.

We want to estimate the individual θ_j , which tells us about each group parameter (e.g. municipality fertility rates). But to estimate the group parameters, we first need to estimate the hyperparameter Ω which informs us about the between group heterogeneity (the distribution of rates across municipalities).

To estimate Ω , we construct an integrated likelihood function from Equations (1) and (2) that expresses the distribution of the data for group $j, Y_j = (Y_{1j}, ..., Y_{Nj})$, as a function of the hyperparameters:

$$\mathcal{L}(Y_j|\Omega) = \int \prod_i f(Y_{ij};\theta) g(\theta;\Omega) d\theta$$
 (3)

From this we can write up the empirical Bayes maximum likelihood estimator:

$$\hat{\Omega}_{EB} = \underset{\Omega}{\operatorname{arg\,max}} \sum_{j} log \mathcal{L}(Y_{j}|\Omega)$$
(4)

Using Bayes' rule, the posterior density for the group-specific parameter θ_j conditional on the observed data is:

$$h(\theta_j|Y_j;\Omega) = \frac{\prod_i f(Y_{ij};\theta_j)g(\theta_j;\Omega)}{\mathcal{L}(Y_j|\Omega)}$$
 (5)

$$\theta_j^* = \int \theta h(\theta|Y_j; \Omega) d\theta \tag{6}$$

The empirical part of empirical Bayes comes from plugging the $\hat{\Omega}_{EB}$ estimate into Equations (5) and (6).

In many aspects, this approach is more frequentist than Bayesian. The prior does not contribute any new information to the likelihood function other than the structure of the data and Bayesian statisticians sometimes criticize this approach for using the same data twice. For frequentists, on the other hand, the absence of a subjective prior is a welcome feature of the empirical Bayes estimator

An alternative, more instructive, way to interpret the empirical Bayes estimator is to write it as a weighted mean of the local mean \bar{Y}_i and the $\operatorname{grand} \operatorname{mean}^7 \bar{Y}$ which takes the form:

$$\theta_j^* = \tau_j \bar{Y}_j + (1 - \tau_j) \bar{Y} \tag{7}$$

$$\tau_j = \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_{\theta_s}^2/N_j} \tag{8}$$

The weight τ_j is typically referred to as the *shrinkage factor* and is a function of the overall variation in the *grand mean* (σ_{θ}^2) , the variation of the local mean $(\sigma_{\theta_j}^2)$ and the municipality sample size (N_j) .

Plugging the corresponding sample moments (estimated from the data) into Equations (7) and (8) returns the empirical Bayes estimator. From Equation (8) we see that the EB estimator is weighted closer to the local mean if the local mean is either precisely estimated or the local population size is large. Also, it is apparent that the empirical Bayes estimates are unbiased, as τ_j will approach 1 as $N_j \to \infty$, which again means empirical Bayes estimates will approach the unbiased sample means. This is why the empirical Bayes estimates are the best linear unbiased predictor.

4.2 Modeling demographic rates

In this section we will set up a simple hierarchical clustered model of age-specific demographic behavior. As a guiding example we will focus on modeling age-specific fertility rates. Assume a simple three-level model of fertility where age-specific fertility rates are determined at the national, regional and municipal level:

$$Y_{ijr} = \theta A_i + \theta_r A_i + \theta_j A_i + \epsilon_{ijr}$$

$$\tag{9}$$

⁷Grand mean (or pooled mean) is the mean across all subsamples. In hierarchical models it refers to the mean of the top hierarchical level.

$$\epsilon_{ijr}|\boldsymbol{A}_i,\boldsymbol{\theta}_r,\boldsymbol{\theta}_i \sim N(0,\sigma_{\epsilon}^2)$$
 (10)

where Y_{rji} is a binary outcome of individual i, in municipality j, in region r is having a child or not. \mathbf{A}_i is a vector of age-indicators for all fertile years (ages 15-50) for women in the sample.⁸ In the fixed part of the model, $\boldsymbol{\theta}$ is the national age-specific fertility rates. $\boldsymbol{\theta}_r$ is the vector of region-level random age effects, while $\boldsymbol{\theta}_j$ is the vector of municipality-level random age effects. The regional and municipality age-specific random effects ($\boldsymbol{\theta}_r$ and $\boldsymbol{\theta}_j$) are both normally distributed with age specific variance and no covariance across age-groups.

$$\theta_r | A_i \sim N(\mathbf{0}, \Omega_r^2)$$
 (11)

$$\boldsymbol{\theta}_j | \boldsymbol{A}_i, \boldsymbol{\theta}_r \sim N(\mathbf{0}, \boldsymbol{\Omega}_j^2)$$
 (12)

where Ω_r^2 and Ω_j^2 are hyperparameters describing the regional and municipal distribution of the age-specific fertility rates.⁹ Equation (11) characterize how the regional-level age-specific fertility deviates from the national age-specific fertility and (12) characterize how the municipality-level age-specific fertility deviates from the regional age-specific fertility.

5 Fertility

Fertility is a complex demographic process that are affected by biological, social and economic factors. Reproduction and family are popular areas of study within the field of demography, as well as other fields (Rowland, 2003). As in most developed countries, Norway has experienced a fall in fertility over time, especially pronounced after paid work for women and contraception became more common (in the 70s). The fertility has fluctuated quite a bit after this period. Female total fertility rate (TFR) ranges from about 1.66 in 1984 to 1.98 in 2009. The fertility has dropped steadily since 2009 and is now at the lowest level ever measured for Norway, 1.56 in 2018. Typically, fertility in Norway has been high in the south-west of the country, while the eastern part has experienced low fertility. There is substantial variation in fertility over space; in 2018 the maximum difference in TFR across counties was 0.29. There are reason to believe that there may be differences also across smaller geographical units and along other geographical characteristics, for instance, between rural and urban municipalities.

Small area problems

Giving birth is a relatively rare event which most women in Norway only experience once or twice in their lifetime. As events are rear, estimates of the age-specific fertility rate can be noisy when the sample is not sufficiently large. Sample sizes tend to be small for Norwegian municipalities, for instance, the municipality at the 50th percentile w.r.t. population has just above 4,600 inhabitants and 27 females that are 30 years of age. As a hypothetical experiment, let us assume that the sample size is fixed at 27 and the women have a true fertility rate of 0.111, i.e. they are expected to give birth to three children a year. In a random draw, these women will only give birth to 3 children in 24 percent of the cases. In 4.5 percent of the cases these women will give birth to no children, 1 child in 14 percent of the cases and 2 children in 23.5 percent of the cases. The small sample size means that the estimated fertility rate will fluctuate wildly; and in this case, the sample estimate will be either 50 percent larger or smaller than the underlying rate in more than 35 percent of the cases.

⁸ All vectors has the length equal to the number of age groups estimated simultaneous. In the fertility example the vector length is 36 (50-15+1).

⁹ As we do not allow for covariance across age groups, Ω_r^2 and Ω_j^2 will be diagonal matrices with dimensions equal to the number of age groups. In the fertility example the dimensions will be 36×36 .

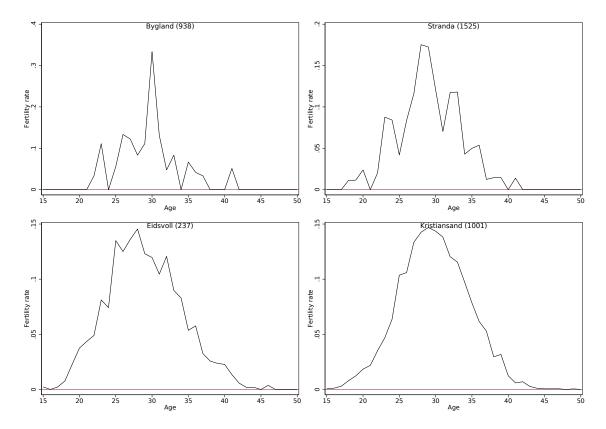


Figure 1: Fertility and small area problems

Note: The figure displays results for four municipalities with name and number (in paranteheses) at the head of each subfigure. The top left panel shows the raw mean age-specific fertility rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are computed using the female population in Norway in the period 2014 to 2016.

To avoid this problem, demographers and other practitioners typically aggregate the populations across space (neighboring municipalities), over time (several years) and across groups (e.g. 5-year age groups) to attain enough observations to minimize sampling error and produce reliable measurements. This approach comes at a cost, for small cell sizes the level of aggregation needs to be substantial, which dilutes the heterogeneity across municipalities.

Figure 1 illustrates the small area problem when estimating age-specific fertility rates. The figure shows four graphs displaying raw fertility rates using three years of observations for municipalities on the 10th, 50th, 90th and 99th percentile w.r.t. population size. The top left panel shows the raw age-specific fertility rates for a municipality with a population at the 10th percentile. Here, the fertility rates are very unstable, jumping up and down from 0 to over 0.3. Some of these rates are not demographically plausible, for instance, 34 years old women have a zero probability of birth. Also, for all ages below 21 and above 42 the rates are nil. The top right panel shows the raw fertility rates for a municipality with population at the 50th percentile. These rates look more convincing, as there are less zeros and extreme values, but the distribution over age is still hilly. The bottom left panel shows the raw fertility rate for a municipality with a population at the 90th percentile. The fertility rate clearly becomes more continuous moving from the 50th to 90th percentile, but it is still a little jagged. The bottom right panel shows the raw fertility rate estimates for a municipality with a population at the 99th percentile. We see that the fertility rates become markedly smoother as the population increases and we can be more certain that all age groups relevant for fertility are represented.

Model

We model fertility using the clustered hierarchical model from Equation 9 in Section 4. The data sample consist of all females in the fertile age range (15-50) in Norway in the period 2014 to 2016. The data include information about municipality of residence, region affiliation, and child birth in every year. Since we count the total number of newborns within each municipality-by-age cell, we allow multiple births to influence the estimated fertility rate. We fit the following specification:

$$Birth_{ijr} = A_i \alpha + A_i (\alpha_r + \alpha_j) + \epsilon_{ijr}$$
(13)

where $Birth_{ijr}$ is a binary outcome of having a child or not for female i, in municipality j, in region r. A_i is a vector of age-indicators for all fertile years (ages 15-50). The fixed part of the model α is the vector of national age-specific fertility rate. α_r is the vector of region-level random age effects, while α_j is the vector of municipality-level random age effects. The regional and municipality age-specific random effects (α_r and α_j) are both normally distributed with age-specific variance and no covariance across age-groups.

Results

Figure 2 shows the estimated age-specific fertility rates using the EB method for the four municipalities introduced in the previous figure. These municipalities belong to the 10th, 50th, 90th and 99th percentile of population, respectively. Compared to the raw fertility rates, an apparent feature is that the EB estimates produce smooth fertility rates independent of population size. The rates are strictly positive at all relevant ages (no zeros). The procedure also maintains municipality level heterogeneity, where all figures have a somewhat different level and timing of births.

In Figure 3, we compare the performance of raw rates versus rates produced with the EB method. The top graph shows the distribution of fertility rates at age 30 across municipalities with the two different rate procedures. The dispersion of the raw rates is great for small municipalities and decreases with population size. This pattern is expected, as sampling error becomes less of a problem as population size increases. The raw rates for small municipalities are rather extreme and demographically implausible; they range from zero to over 35 percent. The rates estimated using the empirical Bayes method, on the other hand, have less dispersion overall and do not display extreme values for low population sizes.

The panel at the bottom shows the municipalities' total fertility rates (TFR) using the two types of rates. TFR is a synthetic measure of lifetime fertility calculated by summing up the age-specific fertility rates. Such a measure should mitigate some of the sampling error problems as these errors average out as we aggregate fertility. Still, the dispersion is much larger for the TFR calculated from raw rates than for the TFR based on EB rates. The raw TFRs are distributed from a little under 1 up till 2.8, while the TFRs based on EB are located between 1.5 and 2. Consequently, if used in a projection model, the "naive" raw rates would translate into large discrepancies in the number of births across the small municipalities.

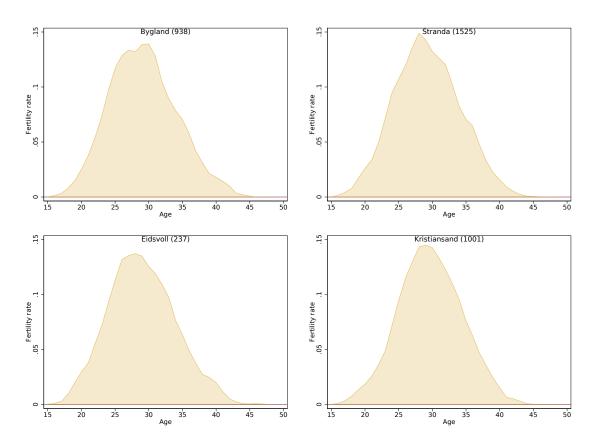
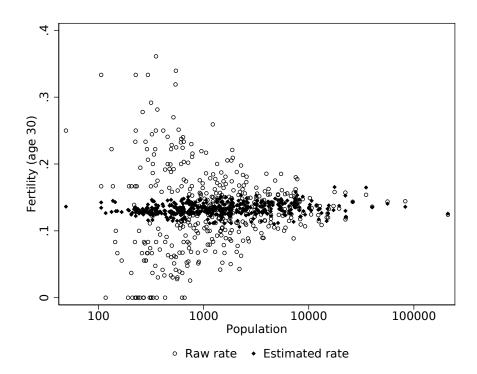


Figure 2: Estimated age-specific fertility rates for selected municipalities of different sizes Note: The top left panel shows the empirical Bayes estimates of age-specific fertility rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are estimated using the female population in Norway in the period 2014 to 2016. The rates have been smoothed using a procedure that is explained in detail in Appendix A, but the EB estimates are reasonably stable even without this procedure.



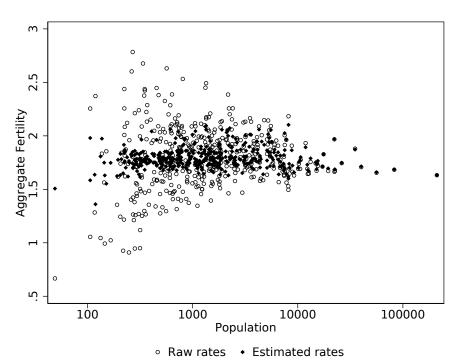


Figure 3: Performance of fertility rates estimated by the empirical Bayes method versus raw mean rates. Fertility differences across municipalities of different sizes

Note: These figures show differences across municipalities of different population sizes in fertility. Age-specific fertility rates are derived using two methods: raw means and empirical Bayes estimations. The top panel shows the age-specific fertility rates of females at age 30, while the bottom panel shows total fertility rate (TFR). The rates and aggregate measure are derived using data for three years, 2014-2016.

6 Mortality

Similar to fertility, mortality is one of the vital processes determining population change. Norway has experienced gradual increases in life expectancy over time. In the base period for the latest population projection, 2018, life expectancy at birth for men and women were 81 and 84.5 years, respectively. Compared to 1990, the life expectancy has increased by 7.6 and 4.7 years. Consequently, in the last 30 years or so the life expectancy of men is converging towards the life expectancy of women. There are persistent regional differences in mortality. For the 2011-2015 period, there is a max difference in life expectancy at birth between counties of 3.4 years for men and 2.9 years for women. These figures motivate the computation of heterogeneous demographic rates across geographical areas.

Small area problems and mortality

For a given individual, death is a one time event. Also, timing of death is in general strongly related to age. This data process poses several problems when estimating age-specific mortality rates. First, there will be very few deaths for people in younger ages. As death events are non-existent for many age-sex-municipality cells in this age range, it is challenging to get at the underlying mortality pattern. Also, when deaths occur in young age groups, the link to the local mortality pattern may be weak as the deaths tend to be caused by random shocks (e.g. car accidents, drownings, rare decease etc.) that can happen anywhere. A concern is that we will obtain many implausible rates - zero values and other "extreme" values (relatively high values for younger persons in small municipalities with deaths in the age interval). Second, the mortality rate is very high for elderly people. This introduces a censoring problem, as many municipalities have no observations in advanced ages. A consequence is that the raw mortality rate fluctuates between zero and unity for very old people.

In Figure 4, we illustrate the small area problem for mortality by displaying the raw mean rate for municipalities at the 10th, 50th, 90th and 99th percentile w.r.t. population size. The top left panel shows the raw mortality rates for a municipality with a population at the 10th percentile. The rate is very unstable, jumping up and down from 0 to almost 100 percent for some age groups. For instance, there is a spike in mortality for girls around ten years of age. And, while 97 years old women have a raw mortality rate close to 0.9, 98 years old women have a mortality rate of zero. Most people would question the plausibility of these results. The top right panel shows the raw mean mortality rate for a municipality with a population at the 50th percentile. The distribution of mortality rates across age is smoother for this municipality and there is less prevalence of zero rates in high ages. The bottom two graphs show age-specific mortality rates for females in municipalities belonging to the 90th and 99th percentile w.r.t. population size. It is clear that the mortality rates become smoother over age as the population of the municipality increases. However, even for the largest municipality of the four, the distribution of rates possesses some ruggedness.

Model

We employ the clustered hierarchical model from Equation 9 in Section 4.2 to estimate mortality rates with improved statistical properties. The data sample consists of all males and females in all one-year age groups (truncated at age 100) in the period 2012-2016. The estimation is conducted separately for the sexes. The data contain information on municipality and region of residency, and whether the individual died in a given year.

$$Death_{ijr} = \mathbf{A}_i \mathbf{\beta} + \mathbf{A}_i (\mathbf{\beta}_r + \mathbf{\beta}_i) + \epsilon_{ijr}$$
(14)

where $Death_{ijr}$ is a binary outcome of dying or not for individual i, in municipality j, in region r. \mathbf{A}_i is a vector of age-indicators for all ages for men and women in the sample. In the fixed part of the model $\boldsymbol{\beta}$ is the vector of national age-specific mortality rate. $\boldsymbol{\beta}_r$ is the vector of the region-level random age effects, while $\boldsymbol{\beta}_j$ is the vector of municipality-level random age effects. The regional

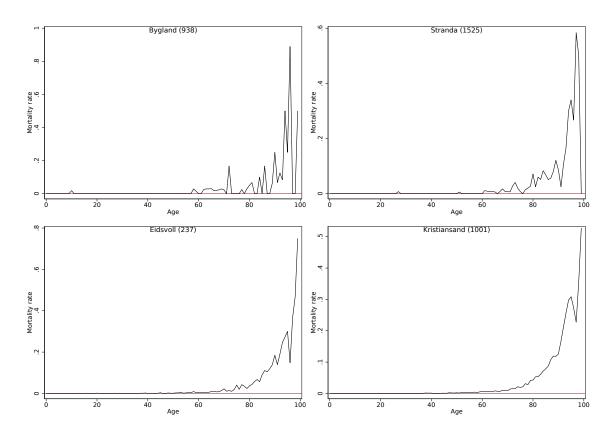


Figure 4: Mortality and small area problems

Note: The top left panel shows the raw mean age-specific mortality rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are computed using the female population in Norway in the period 2012 to 2016.

and municipality age-specific random effects $(\boldsymbol{\beta}_r \text{ and } \boldsymbol{\beta}_j)$ are both normally distributed with age specific variance and no covariance across age-groups.

Results

In Figure 5, we display the results for the empirical Bayes estimations on mortality. We expect to see a smooth increase of mortality over age for both sexes, also for small municipalities. As can be seen, the distribution of rates over age is smooth compared to the distribution of raw mean rates. In addition, the issue of incidents of very low mortality in advanced ages is solved.

The EB-method should allow for quite some variation across municipalities in mortality. From the example municipalities, we can see some distinct features. Men have a higher probability of dying young in Bygland compared to the other municipalities. A result, perhaps viewed with curiosity, is that for the most populous municipality in the figure, Kristiansand, females have a higher mortality rate than males at age 100. There are at least two alternative explanations. First, men die earlier. This suggests that selection on health is stronger for males, and they may therefore experience lower mortality rates late in life compared to females. Also, there are very few males that reach 99 of age, which may affect the result. This data feature may make the age specific rates for older ages inplausibly high or low. To avoid this issue, the last observations for males could be tempered to be closer to the national average and thereby based on more observations. This is the approach used in the projections to ensure demographically plausible rates. The age specific mortality rates are similar for men and women for high ages in Eidsvoll.

In Figure 6, we investigate the distribution of mortality across all municipalities in Norway using both the EB method and more naive calculation of rates (mean raw rates). The top figure shows

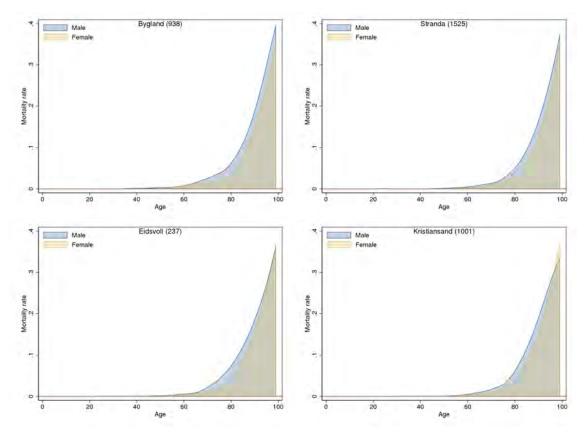
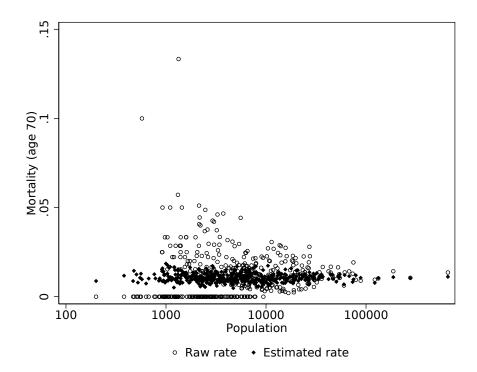


Figure 5: Estimated age-specific mortality rates in selected municipalities of different sizes Note: The top left panel shows the empirical Bayes estimates of age-specific mortality rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are estimated using the female and male populations in Norway in the period 2012 to 2016. The rates have been smoothed using a procedure that is explained in detail in Appendix A, but the EB estimates are reasonably stable even without this procedure.

mortality rates at age 70 for women. The distribution of raw rates fan out for small population sizes, varying from values between 0 and close to 1. There are especially many zero values. Accordingly, the small area problem is illustrated well in this graph. The rates estimated with the EB method follow a less disperse pattern, centered around a value close to 0.01. There are no zero values produced with this method.

In the bottom panel, we calculate life expectancy at birth for women using the raw and estimated age-specific rates (truncated at 100). The familiar pattern from the top figure emerges once again. Although life expectancy at birth is a measure that cancels out extreme rates if they go in both directions, the EB method produces more conservative estimates. The life expectancy based on raw rates varies from 75 to just over 90, while the empirical Bayes computed life expectancy has a narrower distribution between 81 and 86 years of age. There are still some heterogeneity across municipalities, but of plausible magnitudes.



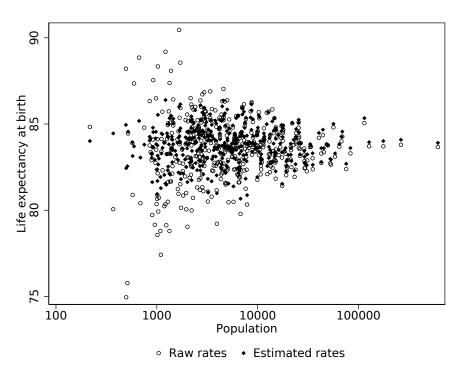


Figure 6: Performance of mortality rates estimated by the empirical Bayes method versus raw mean rates. Mortality differences across municipalities of different sizes

Note: These figures show differences across municipalities of different population sizes in mortality. Age-specific mortality rates are derived using two methods: raw means and empirical Bayes estimations. The upper panel shows the age-specific mortality rates of females at age 70, while the lower panel shows estimated life expectancy at birth. The rates and aggregate measure are derived using data for five years, 2012-2016.

7 Internal migration

Compared to giving birth and death, relocations typically happen more often over the lifetime of an individual. Internal migration has a distinct age schedule with high values before school age and as young adults. The first rise is often put in relation to changed housing demand after family expansion and relocations to areas with family amenities (low crime neighborhoods, high-quality schools, etc.), while the second rise relates to attending higher education/training and early career choices. The internal migration pattern varies systematically over time (with the business cycle), where internal migration propensities are pro-cyclical (Saks and Wozniak, 2011). Arguably, the returns from relocations are believed to be higher in upturns. In 2018 the internal migration rate across municipalities was 46 per thousand. As such, using more years of observations may better predict the long run internal migration pattern. Although internal migration is neutral in national projection models, migration is often the main component of regional population change (Rowland, 2003).

Small area problems and internal migration

Figure 7 displays the female internal out-migration rates for four municipalities of different sizes, belonging to the 10th, 50th, 90th and 99th percentile of the population distribution. The top left and top right panels show raw internal migration rates for municipalities belonging to the 10th and 50th population percentiles, respectively. Although relocations happen relatively frequent, we observe a ragged pattern of internal migration rates and multiple zero values. The feature is clearly related to population size as the larger municipalities in the bottom panels show smoother distributions of rates.

Model

We model internal migration using the clustered hierarchical model from Equation (9) in Section 4.2. The estimation is conducted separately for the sexes. The data sample consists of all males and females in all age groups (censored at age 100), with information about the region and municipality of residence and whether they moved in the current year or not. Relocations are derived from changes in the municipality of residence from one year to the next. This means we do not allow multiple relocations within the same calendar year for a given individual. We estimate the following specification:

$$Move_{ijr} = A_i \gamma + A_i (\gamma_r + \gamma_j) + \epsilon_{ijr}$$
 (15)

where $Move_{ijr}$ is a binary outcome of relocating to another municipality for individual i, in municipality j, in region r. A_i is a vector age-indicators for all ages for men and women in the sample. In the fixed part of the model γ is the vector of national age-specific internal migration rate. γ_r is the vector of region-level random age effects, while γ_j is the vector of municipality-level random age effects. The regional and municipality age-specific random effects (γ_r and γ_j) are both normally distributed with age specific variance and no covariance across age-groups.

Results

The four panels in Figure 8 show the empirical Bayes estimates of age-specific internal migration rates for the four example municipalities belonging to different population percentiles. The rates are displayed separately for men and women. One of the most apparent features is that the EB estimates produce smoother internal migration rates which are strictly positive at all ages, also for small municipalities. All figures have the recognizable shape of internal migration behavior where children are less likely to move during compulsory schooling, but with a large increase in the rates just after upper secondary school, which starts to taper off in the thirties.

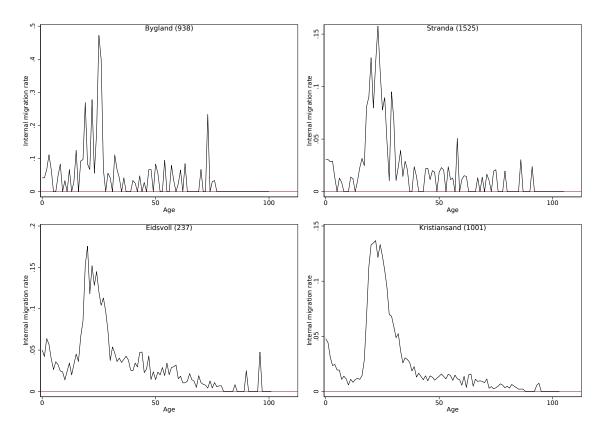


Figure 7: Internal migration and small area problems

Note: The top left panel shows the raw mean age-specific internal migration rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are computed using the female population in Norway in the period 2014 to 2016.

The method maintains municipality level heterogeneity. Compared to the other two municipalities, Bygland and Eidsvoll have higher peaks early in life and for young adults. The latter pattern is especially pronounced for females. They also display higher relocation propensities later in life. For all municipalities, females are more likely to relocate in early adulthood, while men catch up in the thirties.

Figure 9 illustrates the variation in internal out-migration rates across all municipalities utilizing the raw mean rates and empirical Bayes estimates of rates. The panel on the top shows the difference in age-specific internal out-migration rates of females aged 20. The dispersion of the raw rate estimates is decreasing with population size, which is the type of pattern one would expect as sampling error becomes less of a problem. Many of the raw rates at the low end of the distribution are implausible, they range from 0 percent probability of moving to close to 40 percent. On the other hand, the empirical Bayes estimates are much more evenly distributed and do not seem to vary much with municipality population size. The range of values using the EB estimates is plausible.

The panel on the bottom shows the difference in an aggregate measure calculated by summing up the age-specific internal migration rates. This is not a standard demographic measure. It provides information on total intensities of out-migration, somewhat analogues to measures such as total fertility or life expectancy. However, as relocation entails switching municipality affiliation, it can not be interpreted directly. A aggregate measure should mitigate some of the sampling error problems as these errors average out as we aggregate. Still, the dispersion is much larger using the aggregate raw values than for the aggregated EB values. The former varies from about 1.8 to just above 7, while the latter is between 2.1 and 5.

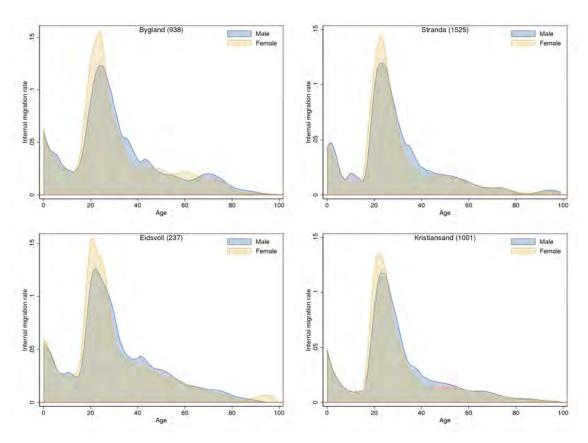
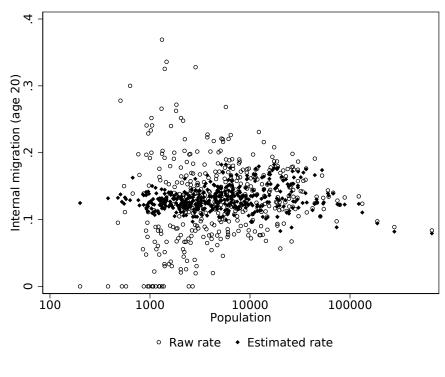


Figure 8: Estimated age-specific internal migration rates in selected municipalities of different sizes Note: The top left panel shows the empirical Bayes estimates of age-specific internal migration rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are estimated using the female and male populations in Norway in the period 2014 to 2016. The rates have been smoothed using a procedure that is explained in detail in Appendix A, but the EB estimates are reasonably stable even without this procedure.



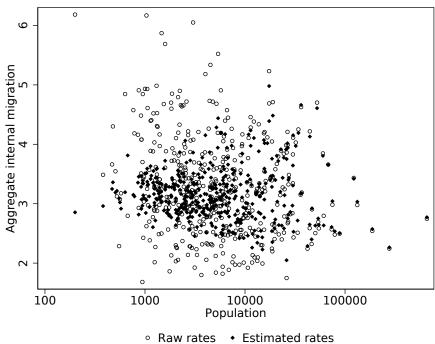


Figure 9: Performance of internal migration rates estimated by the empirical Bayes method versus raw mean rates. Differences in internal migration across municipalities of different sizes Note: These figures show differences across municipalities of different population sizes in internal migration propensities. Age-specific internal migration rates are derived using two methods: raw means and empirical Bayes estimations. The top panel shows the age-specific internal migration rates of females at age 20, while the bottom panel shows a aggregate measure of expected internal relocations derived from the sum of the age-specific rates. The rates and aggregate measures are derived using data for three years, 2014-2016.

8 Emigration

As a demographic phenomenon emigration resembles internal migration. They have similar age schedules. Emigration events may happen several times during life, but typically do not. And, a great majority of the population does not display emigration incidents during life. Emigration is linked to immigration, as immigrants have a higher propensity to emigrate than natives. This means that following relatively large inflows of international migrants, one will typically observe larger outflows. As emigration is rear, it is challenging to estimate plausible rates.

Small area problems and emigration

Figure 10 illustrates the small area problem when computing emigration rates. The figure shows female emigration rates for four municipalities of different sizes, belonging to the 10th, 50th, 90th and 99th percentile of the population distribution. The rates are derived from five years of data. The least populous municipality in the set, Bygland, has experienced emigration incidents for only two age groups, 19 and 46. The other age groups have rates valued at zero. A majority of rates at zero over the age schedule is a serious defect (in principle every person in the population should have a positive propensity to emigrate, although small) and makes them rather useless in a projection setting. The rates improve in plausibility as the population size increases. Kristiansand, at the 99th population percentile, has very few zero values.

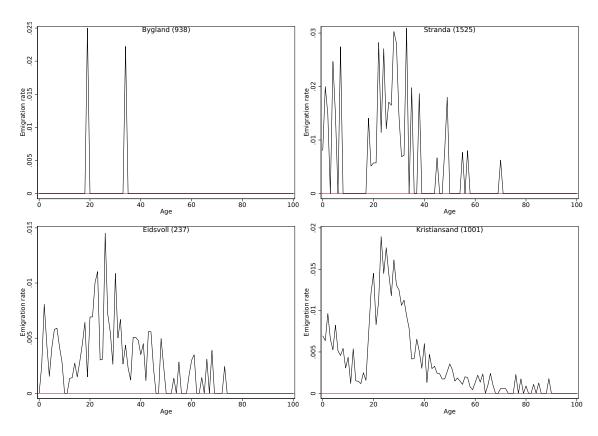


Figure 10: Emigration and small area problems

Note: The top left panel shows the raw mean age-specific emigration rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are computed using the female population in Norway in the period 2012 to 2016.

Model

To handle the small area problem, we model emigration using the clustered hierarchical model from Equation (9) in Section 4.2. The estimation is conducted separately for the sexes. The data sample consists of all males and females in all age groups (censored at age 100), with information about the region and municipality of residence and whether they emigrated in the current year or not.

Emigrations are derived from changes in the country of residence from one year to the next, where the individual is registered in a Norwegian municipality at the start of the year and living abroad at the end of the year. This means that we do not allow for multiple emigrations within the same calendar year for a given individual. We estimate the following specification:

$$Emigrate_{ijr} = \mathbf{A}_i \mathbf{\delta} + \mathbf{A}_i (\mathbf{\delta}_r + \mathbf{\delta}_j) + \epsilon_{ijr}$$
(16)

where $Emigrate_{ijr}$ is a binary outcome of emigrating for individual i, in municipality j, in region r. A_i is a vector of age-indicators for all ages for men and women in the sample. In the fixed part of the model $\boldsymbol{\delta}$ is the vector of national age-specific emigration rate. $\boldsymbol{\delta}_r$ is the vector of region-level random age effects, while $\boldsymbol{\delta}_j$ is the vector of municipality-level random age effects. The regional and municipality age-specific random effects ($\boldsymbol{\delta}_r$ and $\boldsymbol{\delta}_j$) are both normally distributed with age specific variance and no covariance across age-groups.

Results

The four graphs in Figure 11 show the empirical Bayes estimates of age-specific emigration rates for four municipalities in the previous figure. The graphs display results separately for men and women. The EB estimates produce smooth emigration rates which are strictly positive at all ages. All figures have the recognizable shape of emigration behavior, resembling that of internal migration. Children and young adults have high propensities, while teenagers and persons over 60 are less likely to emigrate. We observe that the EB method extracts municipality level heterogeneity reflected in the corresponding rates, as the magnitude of the rates varies and there is also substantial variation across the sexes. For instance, men are more likely to emigrate late in life. Bygland and Eidsvoll display lower emigration rates compared to the other two municipalities.

Figure 12 illustrates the variation in emigration rates across all municipalities utilizing the raw mean rates and empirical Bayes estimates of rates. The panel on the top shows the difference in age-specific internal out-migration rates of females aged 20 with the two methods. The dispersion of the raw rate estimates is decreasing with population size, which is the type of pattern one would expect as sampling error becomes less of a problem. Many of the raw rates are zero. The empirical Bayes estimates are more evenly distributed around 0.01 and do not seem to vary much with municipality population size.

The bottom panel shows the difference in an aggregate measure calculated by summing up the age-specific emigration rates. This is not a standard demographic measure. It provides information on each municipality's total emigration intensity, somewhat analogues to measures of total fertility or life expectancy. However, as emigration entails leaving the country, the measure does not have a direct interpretation. A aggregate measure should mitigate some of the sampling error problems as these errors average out as we aggregate. Still, the dispersion is much larger for the aggregate raw rates than for the aggregated EB rates. The former displays many zeros while the latter has relatively more centered values. The measure seems to be somewhat increasing in population size. Persons in cities are more prone to emigrate in total. This pattern is most probably an artifact of cities having a disproportionaly large immigrant population.

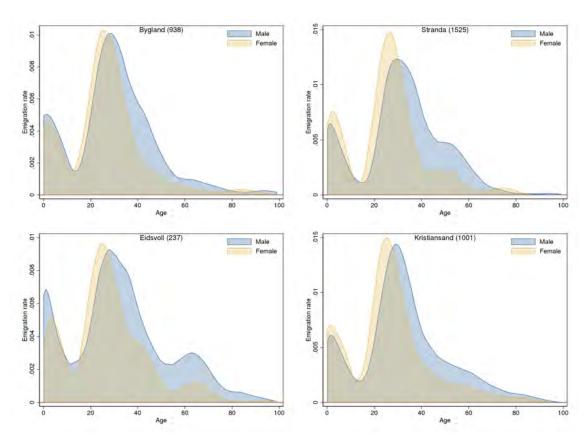
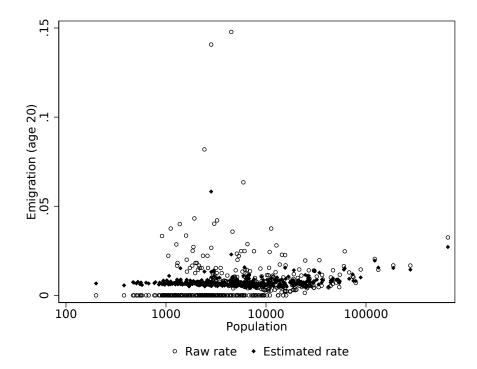


Figure 11: Estimated age-specific emigration rates in selected municipalities of different sizes Note: The top left panel shows the empirical Bayes estimates of age-specific emigration rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are estimated using the female and male populations in Norway in the period 2012 to 2016. The rates have been smoothed using a procedure that is explained in detail in Appendix A, but the EB estimates are reasonably stable even without this procedure.



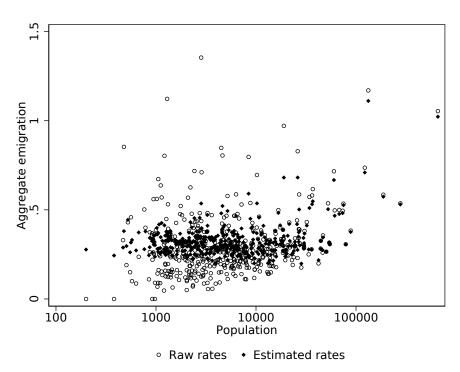


Figure 12: Performance of emigration rates estimated by the empirical Bayes method versus raw mean rates. Differences in emigration across municipalities of different sizes

Note: These figures show differences across municipalities of different population sizes in emigration propensities. Age-specific emigration rates are derived using two methods: raw means and empirical Bayes estimations. The top panel shows the age-specific emigration rates of females at age 20, while the bottom panel shows a aggregate measure of expected emigration derived from the sum of the age-specific rates. The rates and aggregate measure are derived using data for five years, 2012-2016.

9 Conclusion

In this document we propose a new method for computing small area demographic schedules to be used in the Norwegian regional population projection model. The process of computing demographic schedules for individual municipalities in Norway is riddled with small area estimation problems. In most municipalities only a few demographic events happen within each sex and age group, causing the corresponding rates to become unstable and demographically implausible. We solve this problem by utilizing hierarchical mmpirical Bayes estimations. In our application, the EB method borrows strength from higher-level geographic areas, such as economic regions or the country as a whole. Consequently, **small** municipalities with **imprecise** estimates of the local rates will be penalized such that the EB estimate of the rate will be drawn closer to the aggregate level rates.

Comparing the small area estimates of fertility, mortality, migration and emigration rates for Norway derived from the use of different methods, we show that the EB method has superior performance. In contrast to more naive rate computations, the EB method produces demographically plausible results by limiting the occurrence of rates with extreme values. In that sense, it complements the projection models well, as we desire conservative rates that do not affect the local population unduly. In addition, we avoid using other aggregation techniques to provide statistical support, all of which have their own pitfalls.

The EB method is well-known and has seen applications across many fields of study. Nonetheless, time and resource restrictions have hindered widespread use of the method. We show in this report, with standard statistical software, how one can reduce the cost of implementation and benefit from this powerful tool. Consequently, the methodology herein may assist practitioners worldwide in creating state-of-the-art small area projections. The computation of reliable demographic behavior for small areas is an important first step in making quality regional population projections. ¹¹

⁹Combined with local linear regressions with bias correction to smooth over age, we find that a linear and flexible specification of the EB model performs better with respect to computational time and avoidance of extreme values in the tails of the age distribution compared to non-linear estimators and specifications with spline functions.

¹⁰ The EB method also produce estimates that are relatively smooth, even before the we apply the local polynomial regression smoothing procedure. See Appendix A for comparisons.

regression smoothing procedure. See Appendix A for comparisons.

11 The second step entails the successful implementation of these rates in a projection model. An obvious obstacle in the small area setting is the small populations at risk and small rates, which may produce too few demographic events. This issue is outside of the scope for this report.

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A Smoothing procedure

The demographic rates, generated using the empirical Bayes method, may be used directly in the projection model. However, smoothing over age tend to be the standard and preferred by users. It is in some sense more plausible that the rates are "well-behaved" and do not jump and dive from one age group to the next. Therefore, we smooth the gender-specific rates for each municipality over age.

We want a smoothing procedure that does not systematically bias the projection results. For that reason, we implement a bias corrected smoothing procedure based on local polynomial regressions. The bias-correction ensures that the smoothed rates do not unduly deviate from the EB estimates. The user-written Stata package *nprobust* is used for this purpose and a description of the method can be found in Calonico et al. (2019).

The package offers several kernel functions to construct local polynomial estimators. We use the default kernel function, Epanechnikov. The package also provides procedures to estimate optimal bandwidth size. For communication reasons we set the bandwidth to fixed values for each one year age group in the smoothing procedure. For fertility, the bandwidth is set to 3 for all age groups. The bandwidth for mortality is 20 years, except for those aged zero and one, where the bandwidth is 10 and 15, respectively. For internal out-migration, the bandwidth is 5 up till 40, and increase by half a year each year between 40 and 50, after 50 the bandwidth is 10. The emigration rates are smoothed with the following bandwidths: 10 for those 40 or younger, increased by half a year for each year between 40 and 50, and 15 after year 50.

Figure A1 illustrates the difference between the smoothed and unsmoothed EB estimates of age-specific fertility rates. The local polynomial based procedure preserves the overall shape while still smoothing out the jaggedness of the EB estimates from age to age. The bias-correction ensures that the difference between the overall fertility (sum of fertility rates) and the smoothed and unsmoothed rates are minimized. Accordingly, the population projection results will not be heavily influenced by the smoothing procedure.

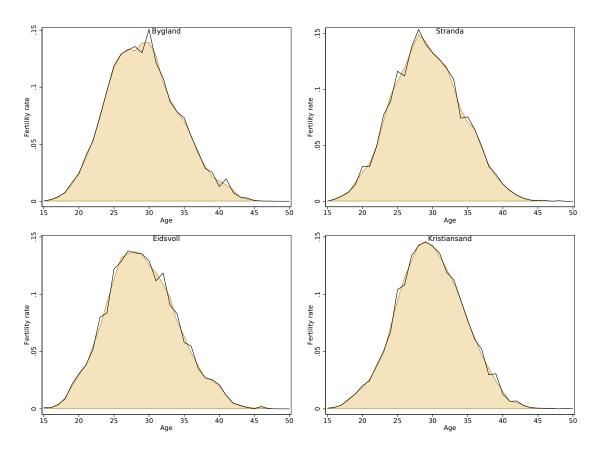


Figure A1: Comparison of smoothed and unsmoothed EB estimates of age-specific fertility rates in selected municipalities of different sizes

Note: The top left panel shows the smoothed (yellow area) and unsmoothed (black line) empirical Bayes estimates of age-specific fertility rates for a municipality with a population at the 10th percentile. The top right, bottom left and bottom right panels show the corresponding rates for municipalities with populations at the 50th, 90th and 99th percentile, respectively. The rates are estimated using the female populations in Norway in the period 2014 to 2016.

B Geographical units and aggregation

The official task of Statistics Norway is to make population projections for municipalities, of which many are small. There is limited information to be obtained from disaggregating further, and it worsens the small area problem. A natural starting point is therefore to use municipalities as the lowest geographical units in our estimation approach.

We choose to lean on higher levels of geographical aggregation to gain support for the demographic rates. Specifically, we specify a nested model where smaller units are nested within larger aggregate units. This is a simpler setup than, for instance, moving neighborhoods (Assunção et al., 2005). Our approach relies on that units grouped together possess a certain degree of commonality, as the implemented method is not set up to handle fine-grained spatial spillovers. We therefore choose to use the travel-to-work areas of statistics Norway, derived from commuting patterns. Municipalities within these areas belong to a common labor market.

Another necessary choice when using our EB approach is to decide the number of aggregated levels (above municipalities). It is a decision with a trade-off between complexity and computational time. Using many levels in the specification is computationally demanding, however, increasing the number of levels make sure that the regional heterogeneity is extracted. In our choice of specification we have two aggregate levels: economic regions and the national level. Economic regions have been used to compute regional variation in the regional population projections of Norway. In addition to having several favorable properties, regional units are used to ensure continuity. Support from the national age-specific rates is borrowed when there is two little information to

attain reliable local rates from the municipality and regional level. $\,$

C Testing of alternative models specifications

An aim of the current project was to have a procedure that could estimate reliable local rates for all demographic components without much adjustment. We implemented a regime where we tested several types of models. One of the model classes that was explored was spline specifications over age. The apriori attractiveness of such an approach was that rates would be estimated and smoothed over age in one step. The approach does however impose structure over the age schedule, also with very flexible specifications (i.e. with higher order polynomials). This method tended to be more computationally demanding and also causes some contra-intuitive results. Specifically, the structure over age tended create negative rates for age groups with very low propensities. This problem was especially pronounced when estimating mortality and emigration rates.

The experience with spline functions led us to explore the opportunities provided by empirical Bayes estimations. As in every estimation procedure, the researcher has to make many decisions concerning the finer workings of the estimation approach. We were attracted to the non-linear maximum likelihood type of the EB models, mainly to avoid negative rates. It turned out that these models where extremely tough to estimate and had to be abandoned. Instead, we ended up with a extremely flexible linear model, fully saturated with fixed age effects at all geographical levels. The specification has resemblance to variance decomposition exercises. In this case, the variation is decomposed (and extracted) over aggregation level for each age group. In practice, the model was estimated in Stata MP4 16 using the mixed command¹² on binary outcomes weighted using the appropriate population. Estimation times are reasonable overall, ranging from less than 3 minutes for the fertility estimations (36 age groups) to about 30 minutes for the gender-specific mortality estimations (100 age groups)¹³. Combined with local linear regressions with bias correction to smooth over age, we find that a linear and flexible specification of the EB model performs better with respect to computational time and avoidance of extreme values in the tails of the age distribution compared to non-linear estimators and specifications with spline functions.

While the framework proposed in this document describes a complete method for estimating regional variation in demographic rates, there are still interesting avenues of research left unexplored. One possibility is to let the data generating process be described by other distributions such as the Poisson and the binomial distribution. The Poisson model is popular for modeling processes with rare events such as fertility and mortality. As highlighted in Assunção et al. (2005), one benefit of the Poisson distribution is that it has (slightly) larger asymptotic variance than binomial models, which might reduce shrinkage in Equation (8), allowing for greater regional heterogeneity.

The framework can easily be extended to investigate heterogeneity in the demographic rates across subpopulations. For instance, investigating the demographic behavior of immigrants can explain important regional population patterns and is potentially important for policy makers. The hierarchical empirical Bayes framework is especially suitable for estimating such rates since the cell sizes quickly becomes small.

A central component of regional population projections is the internal migration matrix. This issue is not treated in this document. Instead, we have been focusing on fertility, mortality, internal out-migration and emigration since these processes can be modeled in similar ways. However the internal migration matrix is just as important and will likely benefit from the hierarchical empirical Bayes method since it is characterized by many cells with relatively few observations.

¹²Similar procedures are available in most statistical software packages such as *proc mixed* in SAS and *lme4* in R. ¹³Stata MP4 16 utilizes up to 4 cores on a server running Intel Xeon Platinum 8165 processors, which should be comparable to the performance on a modern desktop workstation. The server has 1 TB of ram available, however the estimation procedure does not require much memory.

D Municipality fact sheets

In this appendix we present the age- and gender-specific fertility, mortality, internal migration and emigration rates separately for each municipality. All rates are produced using the estimation procedures described in Sections 5–8.

Halden (101)

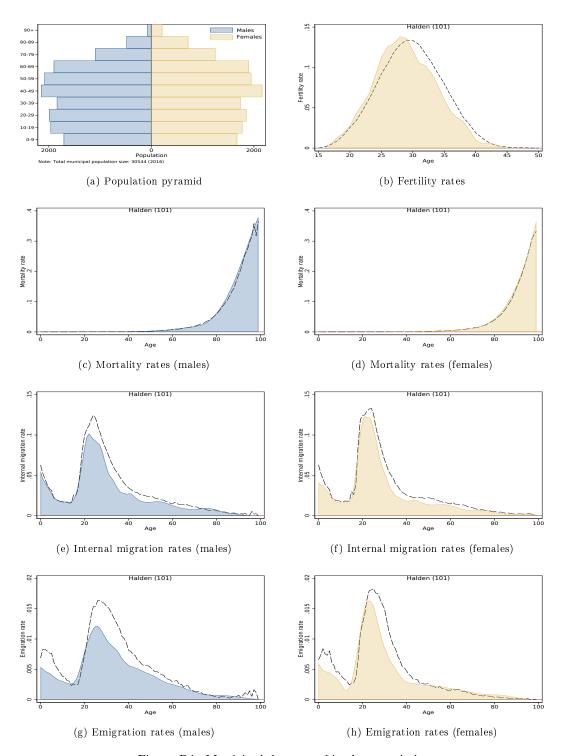


Figure D1: Municipal demographic characteristics

Moss (104)

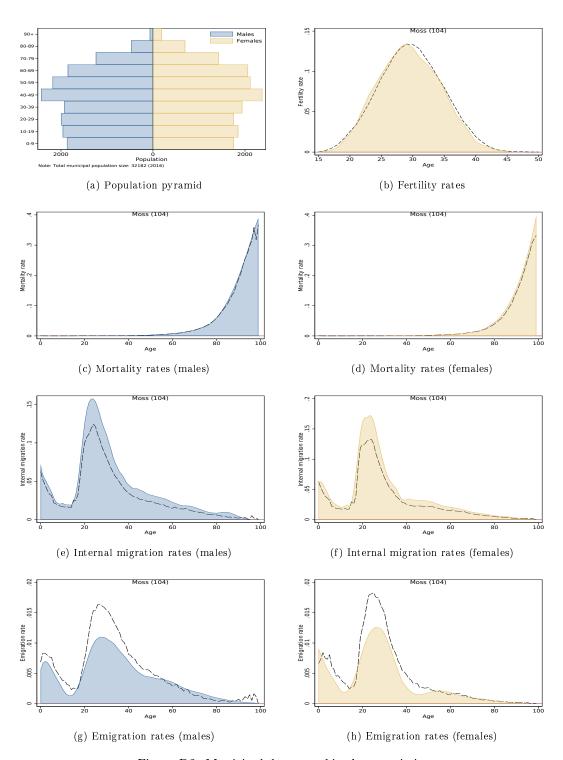


Figure D2: Municipal demographic characteristics

Sarpsborg (105)

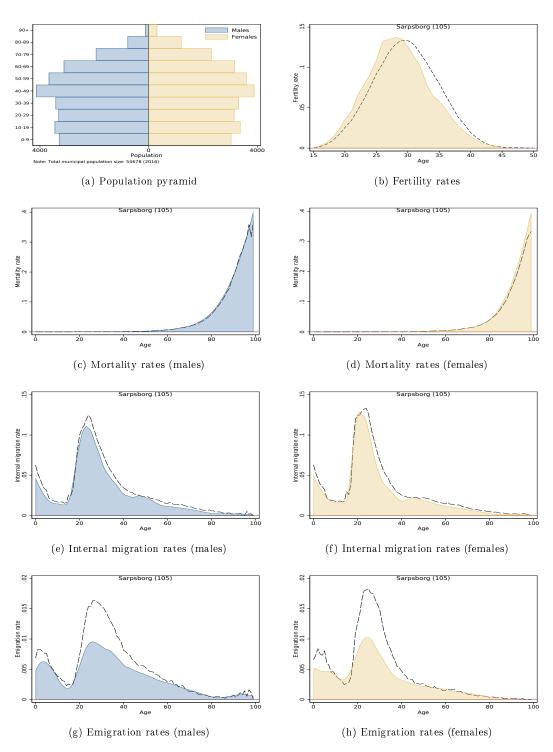


Figure D3: Municipal demographic characteristics

Fredrikstad (106)

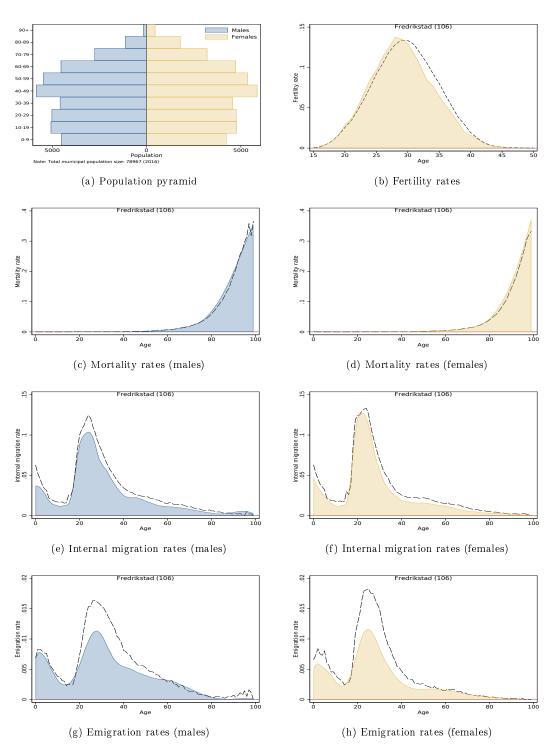


Figure D4: Municipal demographic characteristics

Hvaler (111)

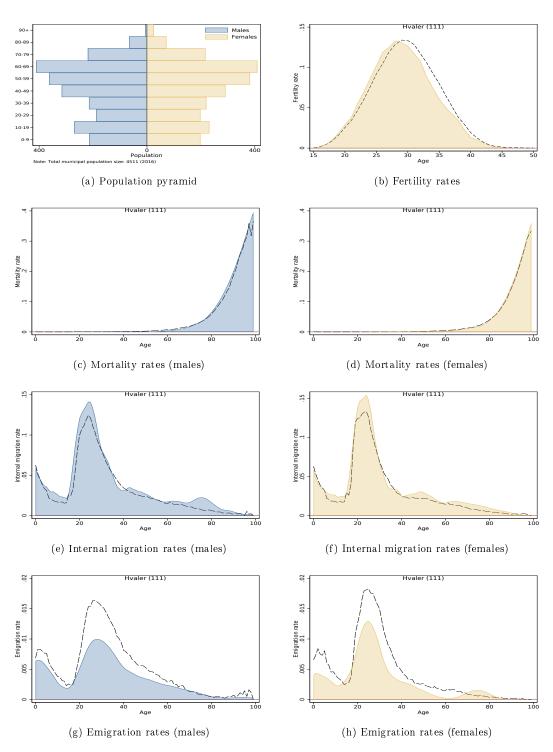


Figure D5: Municipal demographic characteristics

Aremark (118)

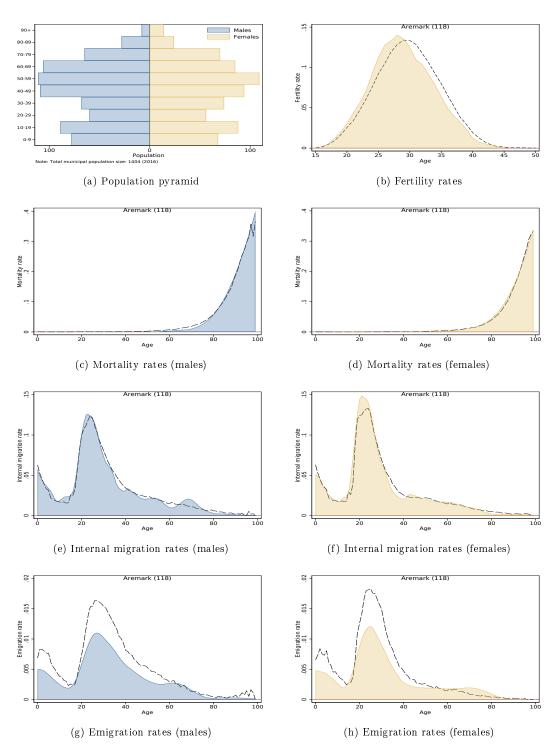


Figure D6: Municipal demographic characteristics

Marker (119)

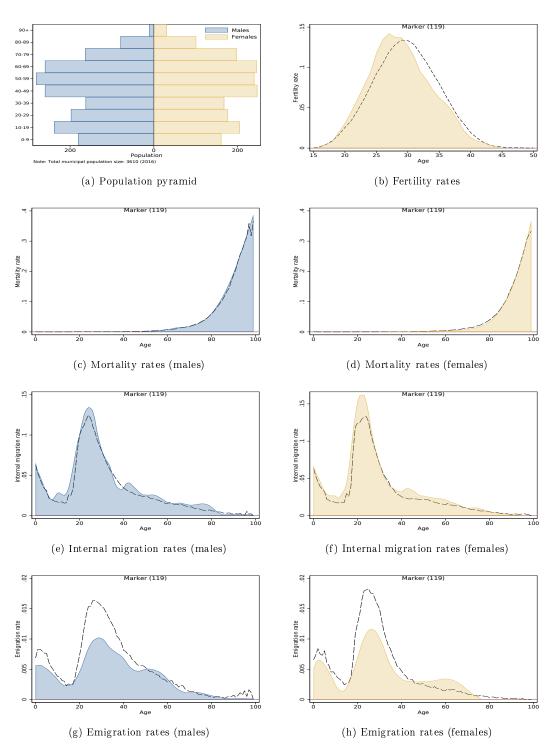


Figure D7: Municipal demographic characteristics

Rømskog (121)

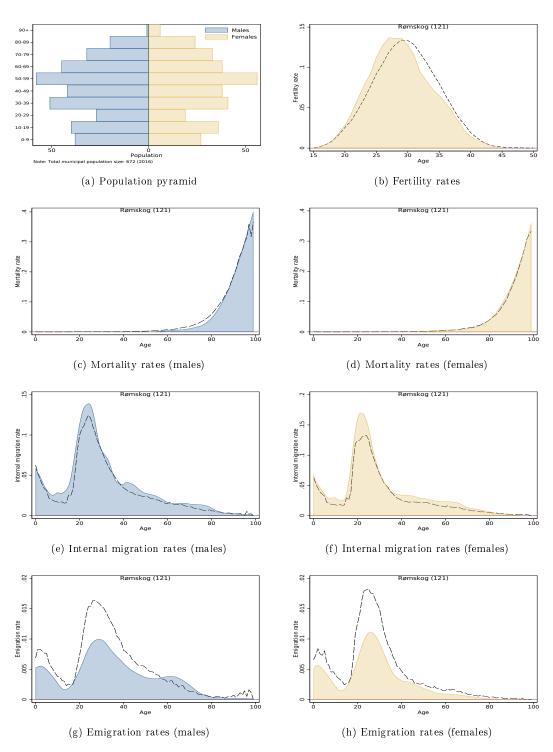


Figure D8: Municipal demographic characteristics

Trøgstad (122)

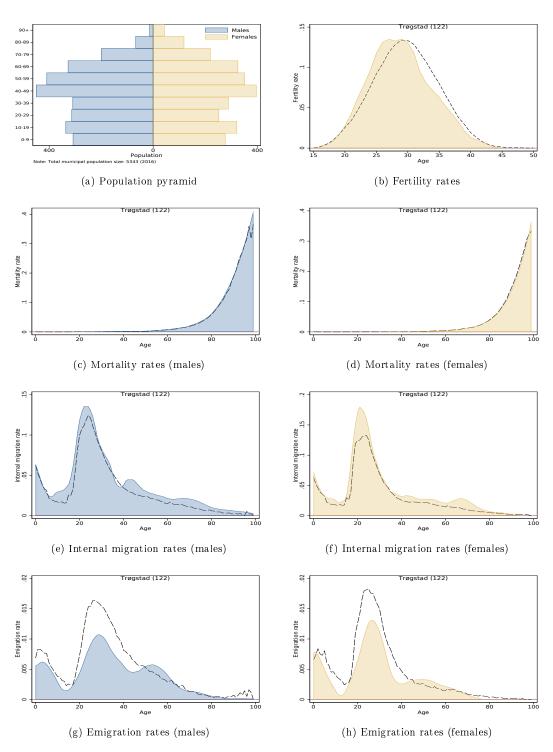


Figure D9: Municipal demographic characteristics

Spydeberg (123)

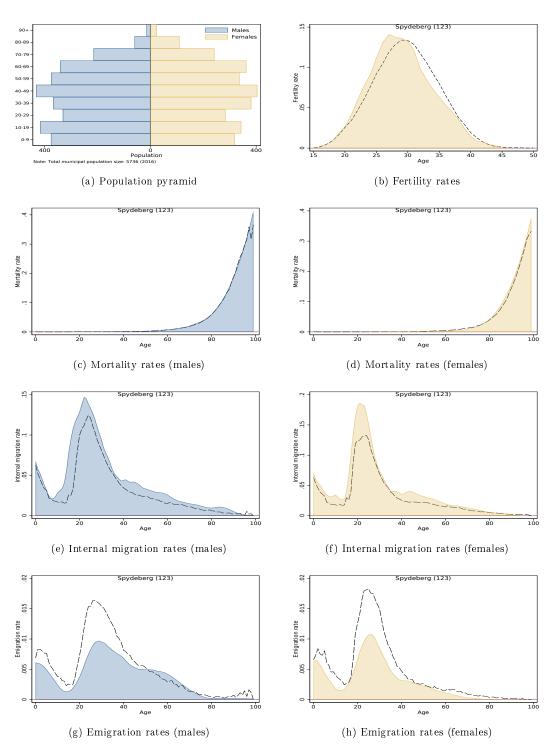


Figure D10: Municipal demographic characteristics

Askim (124)

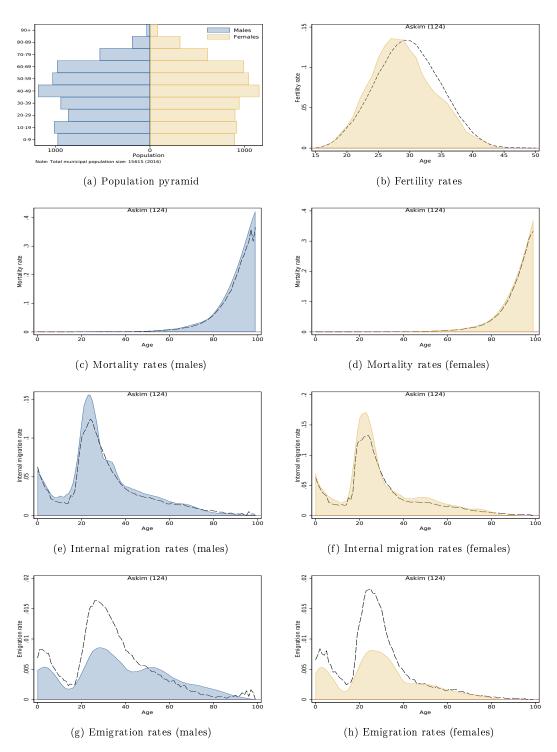


Figure D11: Municipal demographic characteristics

Eidsberg (125)

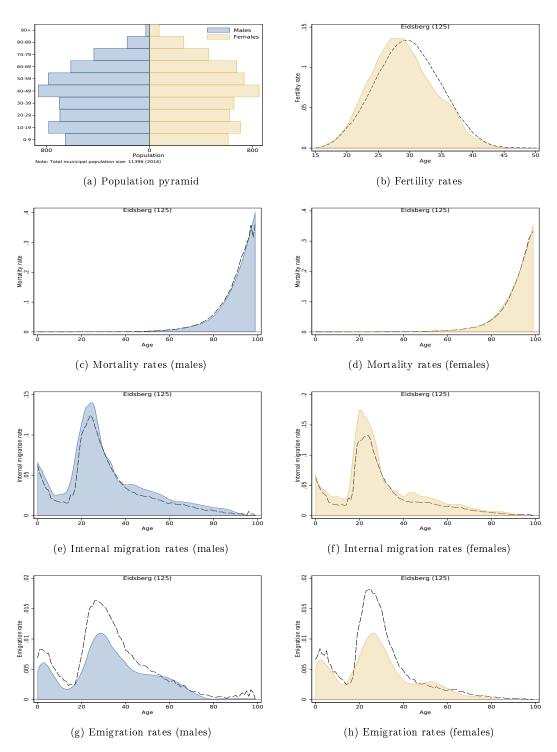


Figure D12: Municipal demographic characteristics

Skiptvet (127)

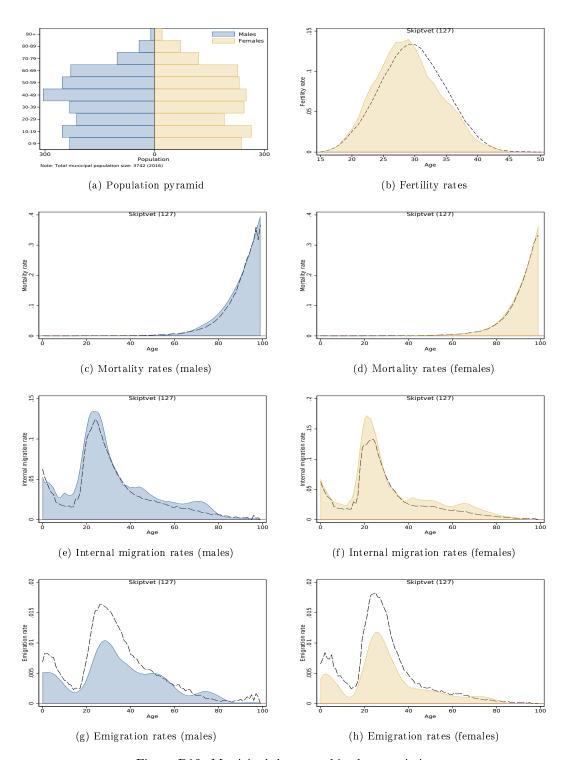


Figure D13: Municipal demographic characteristics

Rakkestad (128)

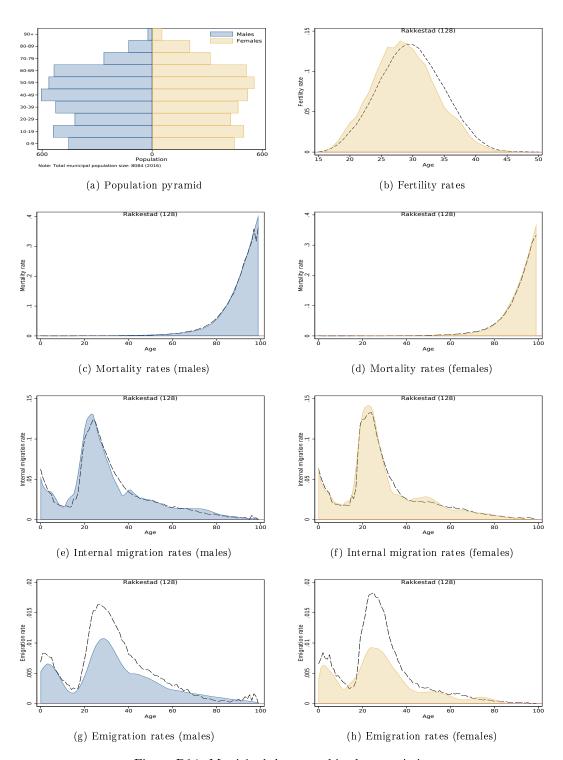


Figure D14: Municipal demographic characteristics

Råde (135)

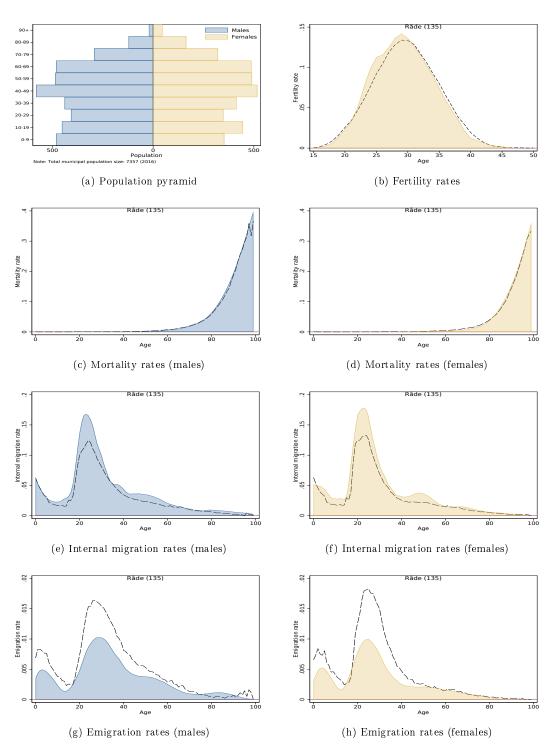


Figure D15: Municipal demographic characteristics

Rygge (136)

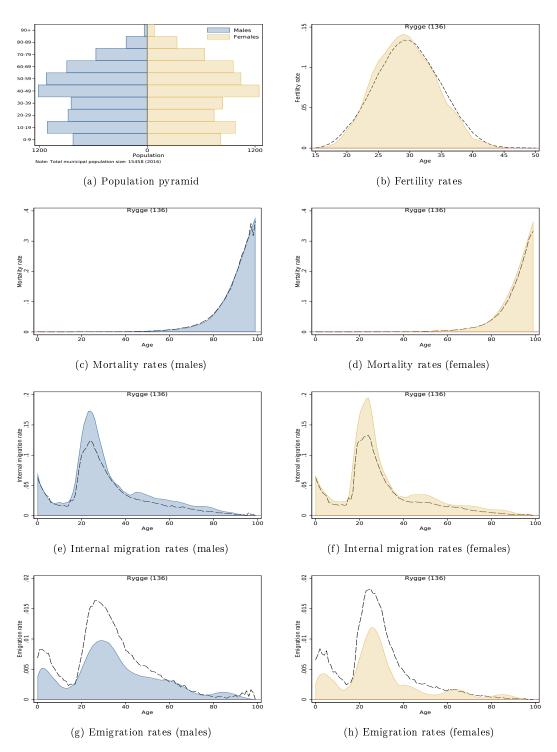


Figure D16: Municipal demographic characteristics

Våler (137)

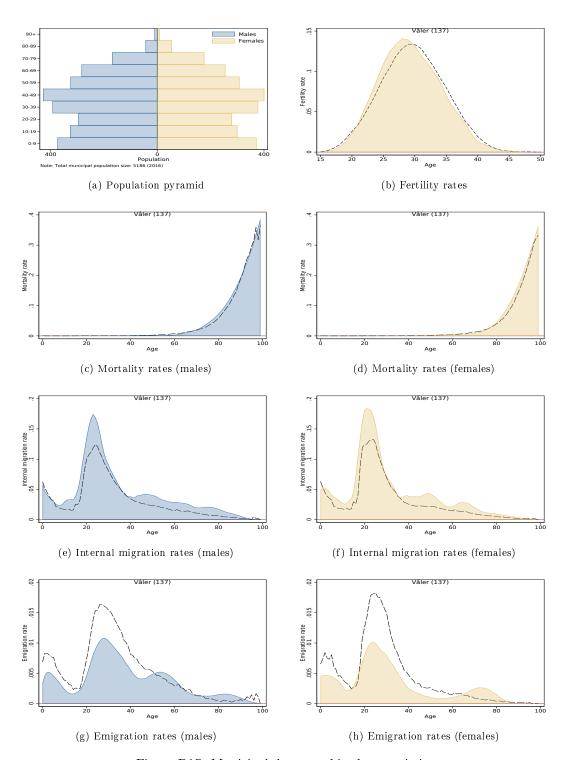


Figure D17: Municipal demographic characteristics

Hobøl (138)

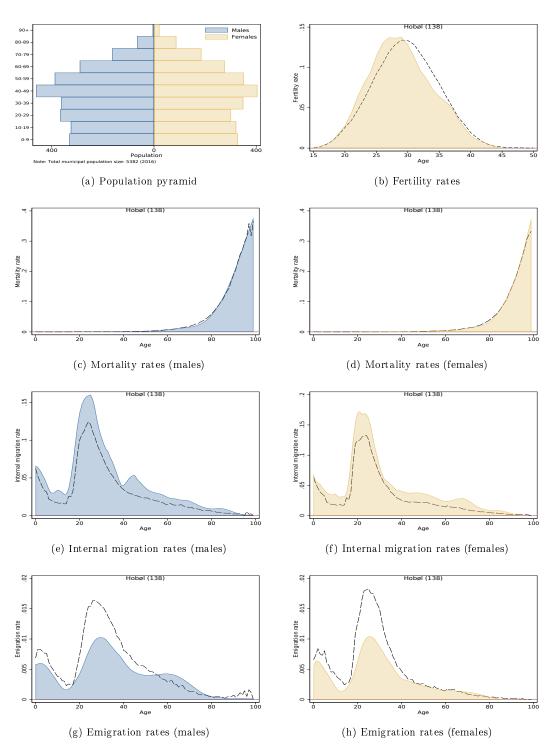


Figure D18: Municipal demographic characteristics

Vestby (211)

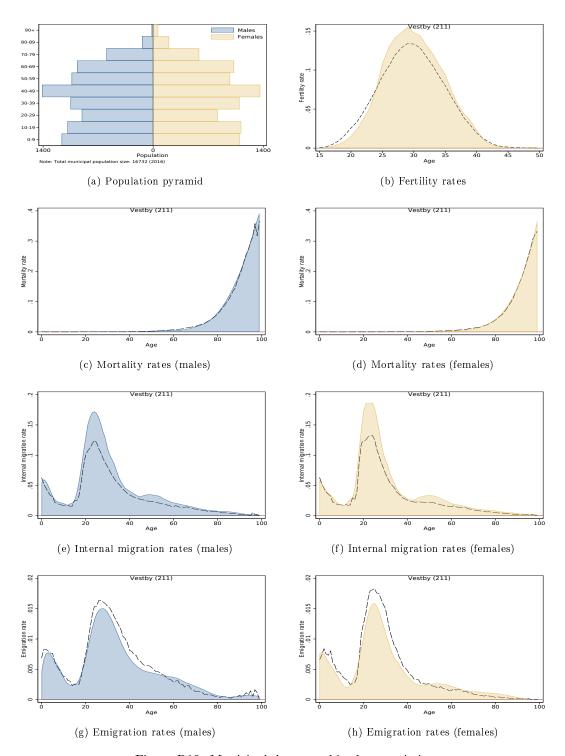


Figure D19: Municipal demographic characteristics

Ski (213)

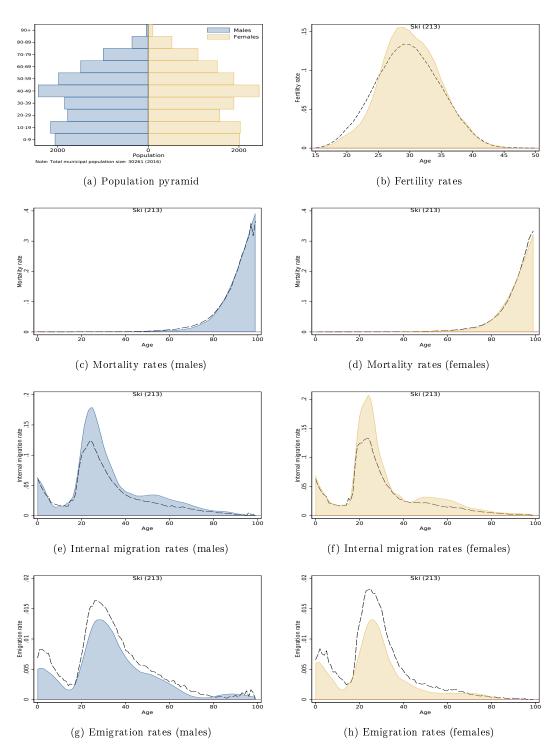


Figure D20: Municipal demographic characteristics

Ås (214)

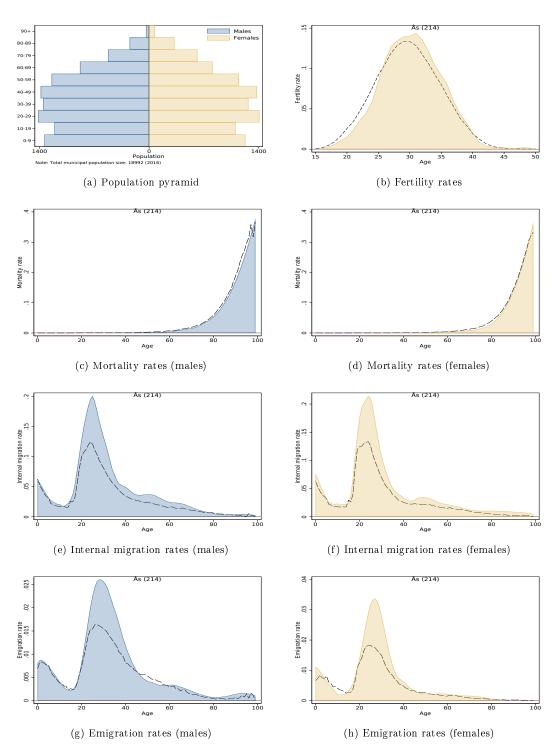


Figure D21: Municipal demographic characteristics

Frogn (215)

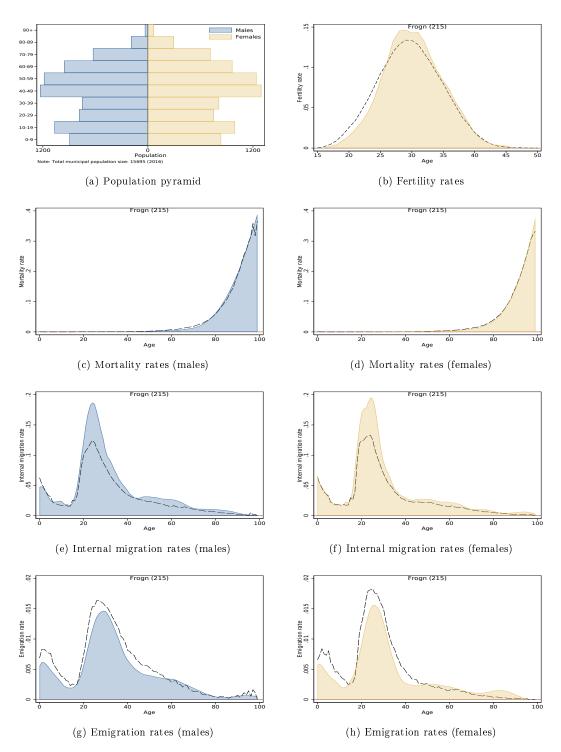


Figure D22: Municipal demographic characteristics

Nesodden (216)

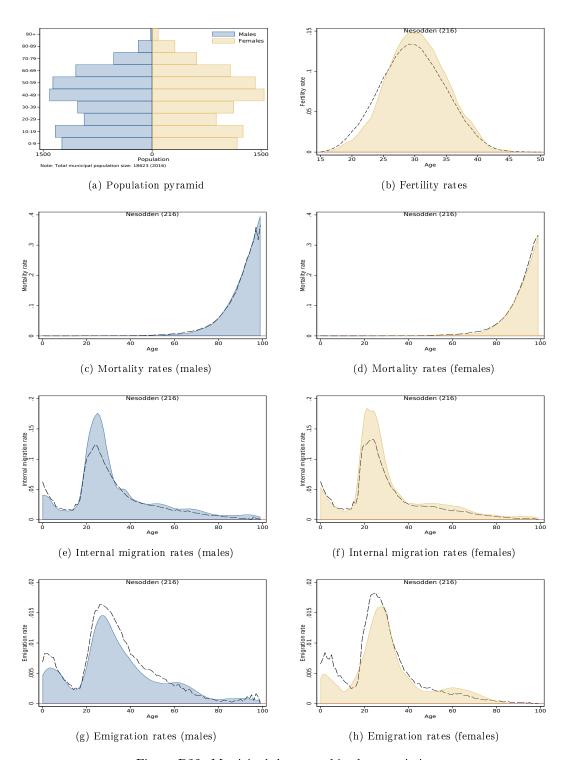


Figure D23: Municipal demographic characteristics

Oppegård (217)

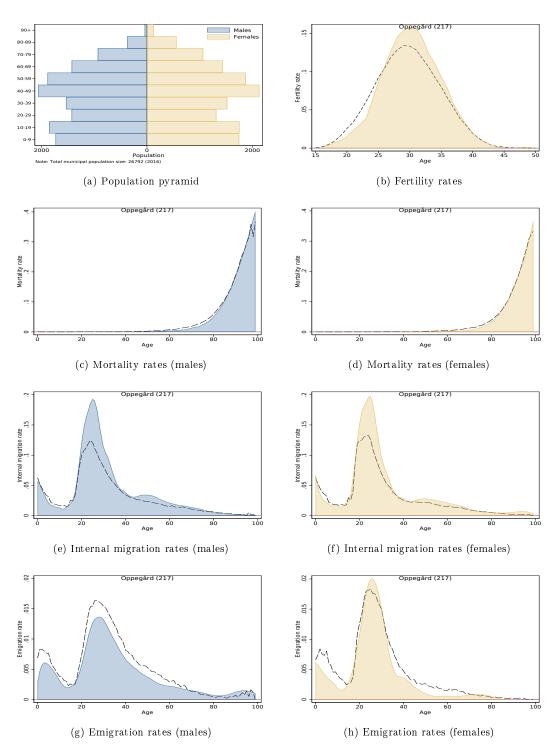


Figure D24: Municipal demographic characteristics

Bærum (219)

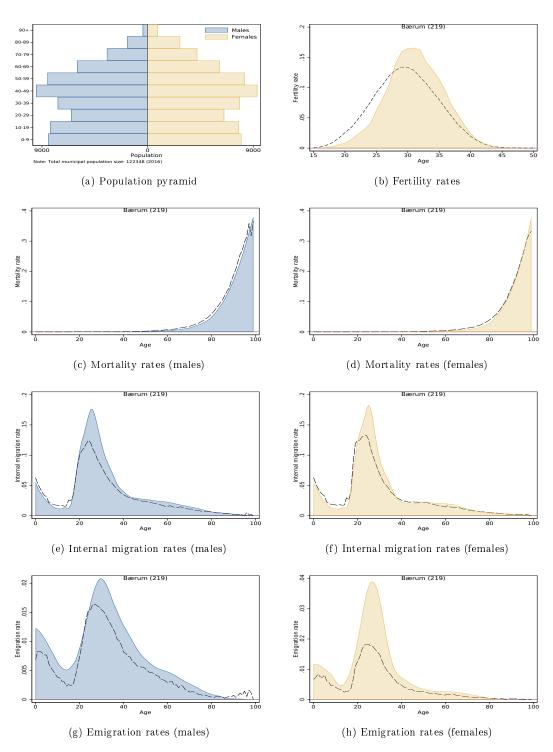


Figure D25: Municipal demographic characteristics

Asker (220)

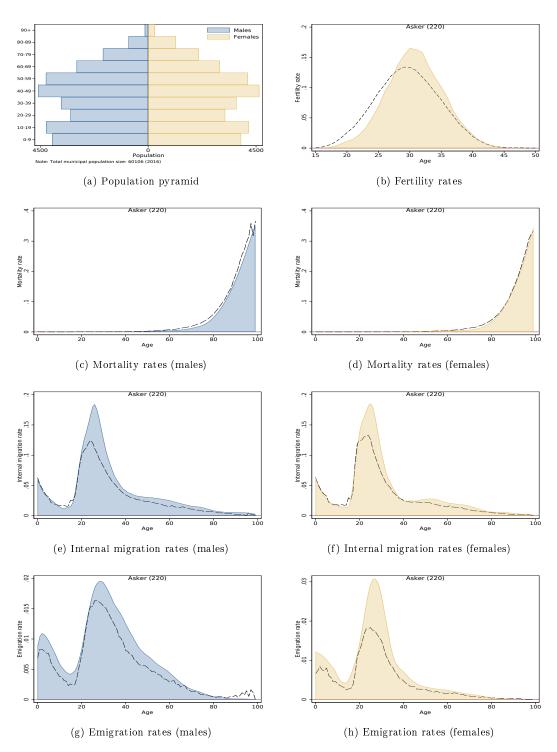


Figure D26: Municipal demographic characteristics

Aurskog-Høland (221)

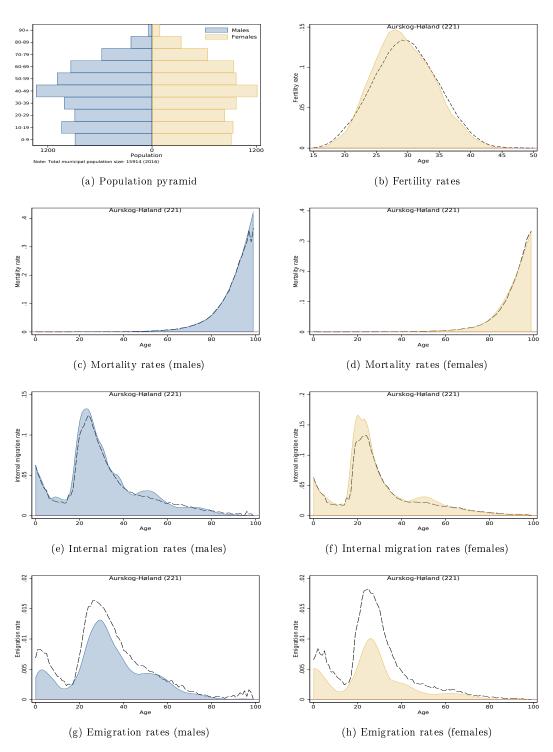


Figure D27: Municipal demographic characteristics

Sørum (226)

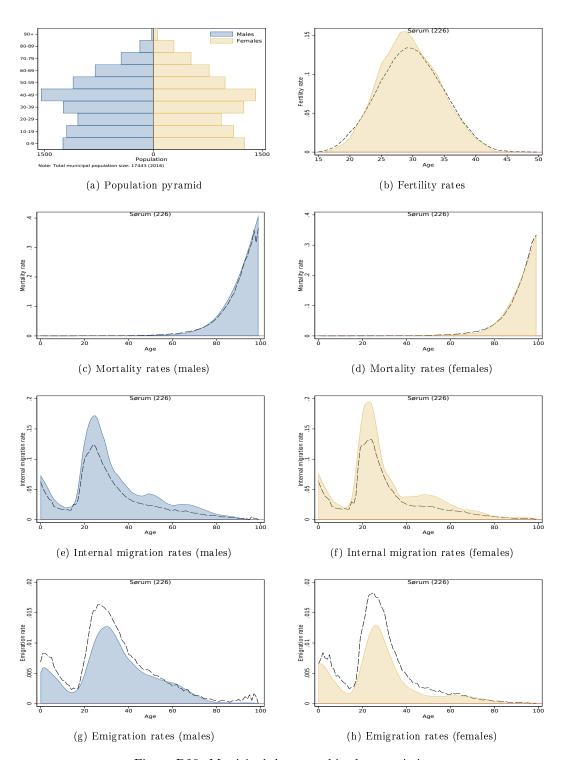


Figure D28: Municipal demographic characteristics

Fet (227)

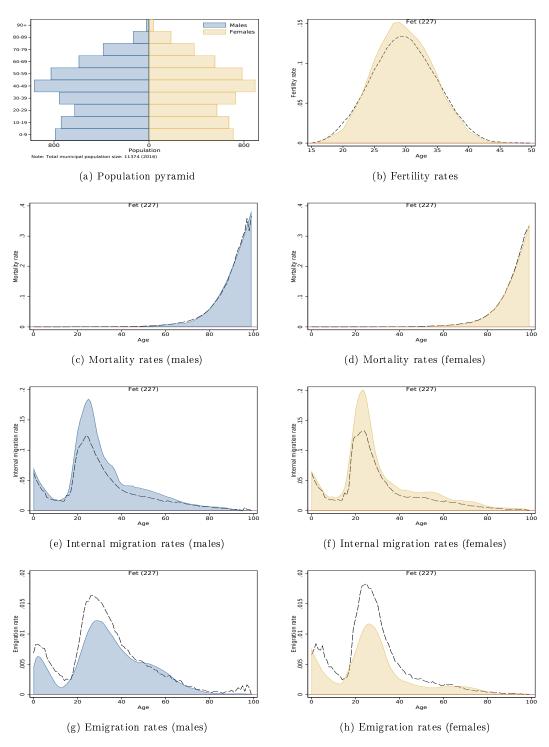


Figure D29: Municipal demographic characteristics

Rælingen (228)

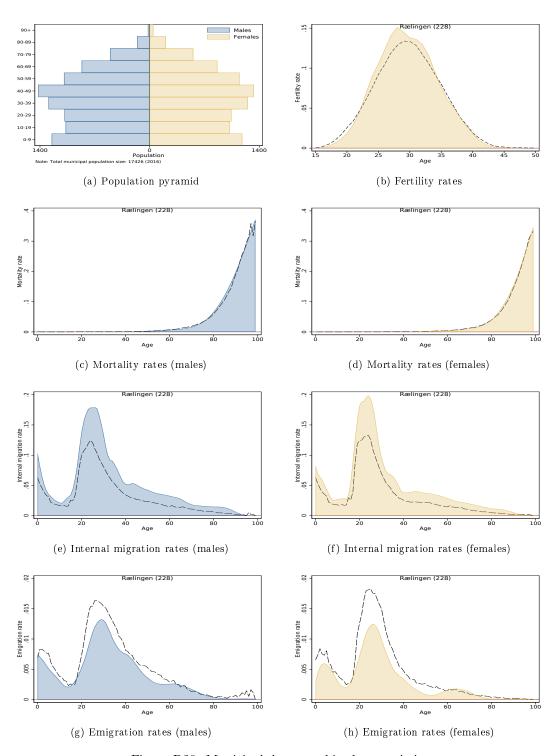


Figure D30: Municipal demographic characteristics

Enebakk (229)

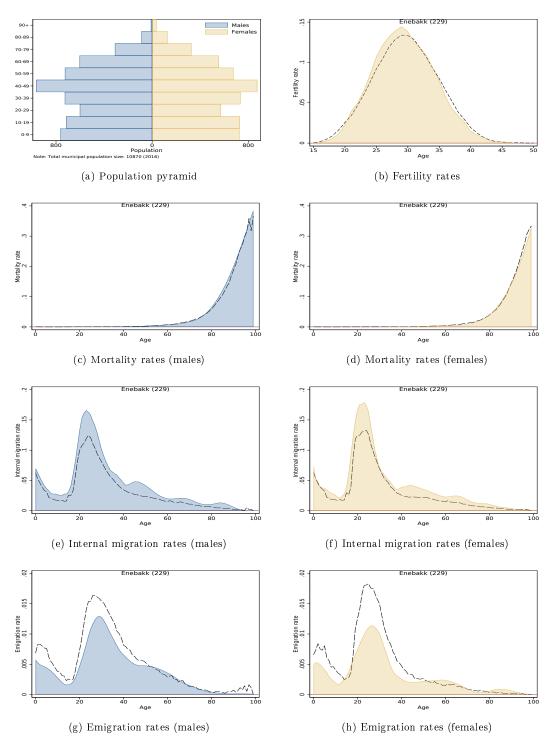


Figure D31: Municipal demographic characteristics

Lørenskog (230)

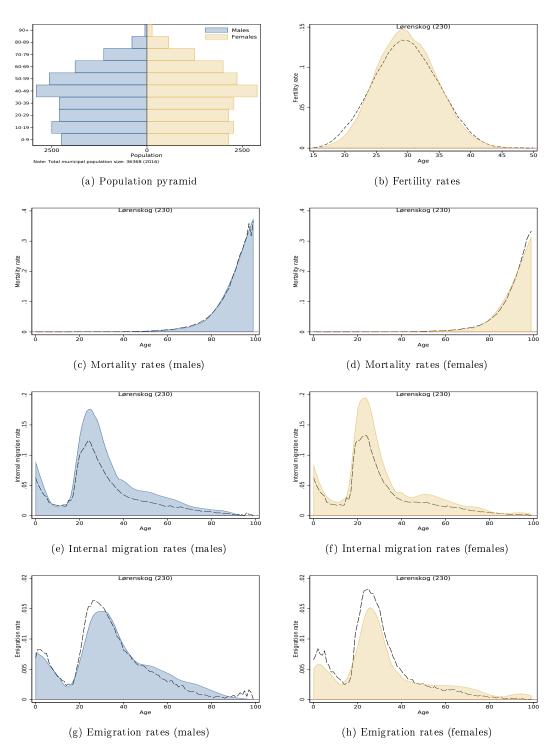


Figure D32: Municipal demographic characteristics

Skedsmo (231)

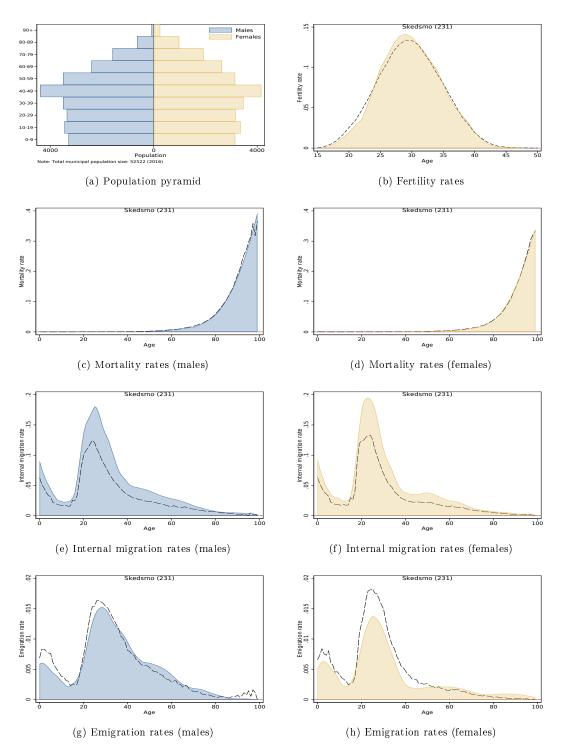


Figure D33: Municipal demographic characteristics

Nittedal (233)

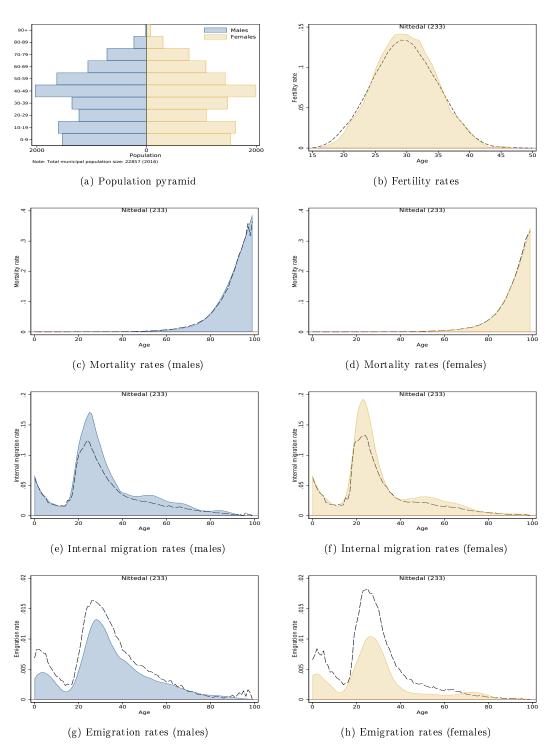


Figure D34: Municipal demographic characteristics

Gjerdrum (234)

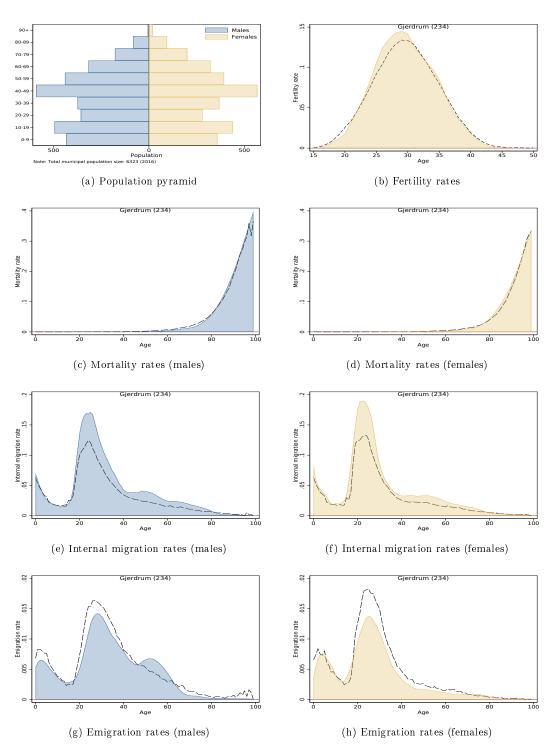


Figure D35: Municipal demographic characteristics

Ullensaker (235)

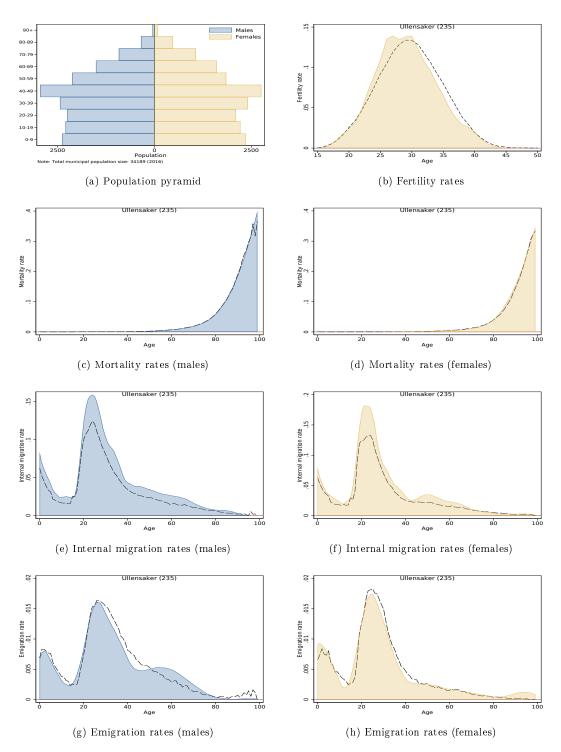


Figure D36: Municipal demographic characteristics

Nes (236)

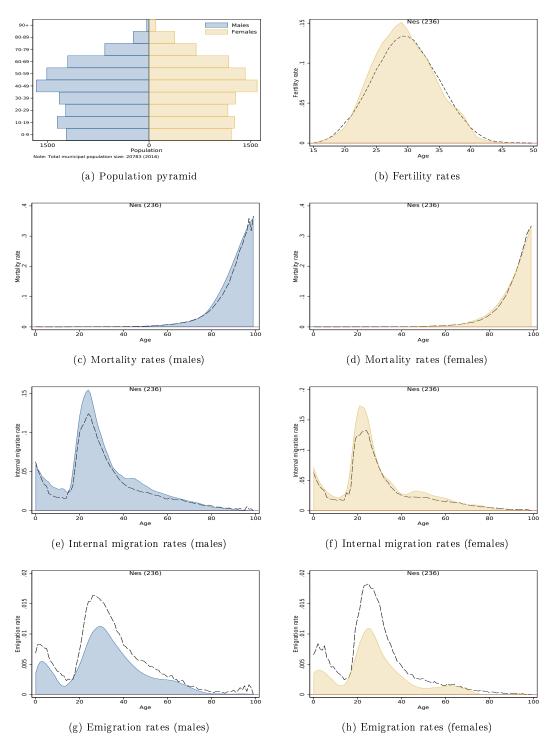


Figure D37: Municipal demographic characteristics

Eidsvoll (237)

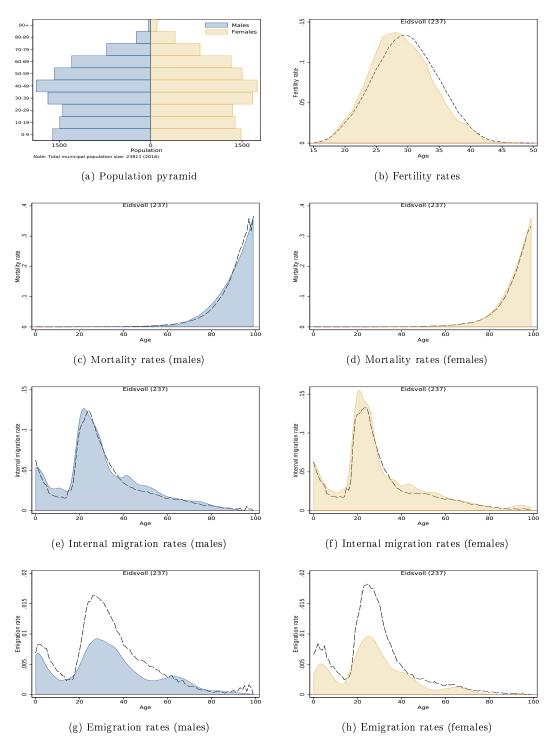


Figure D38: Municipal demographic characteristics

Nannestad (238)

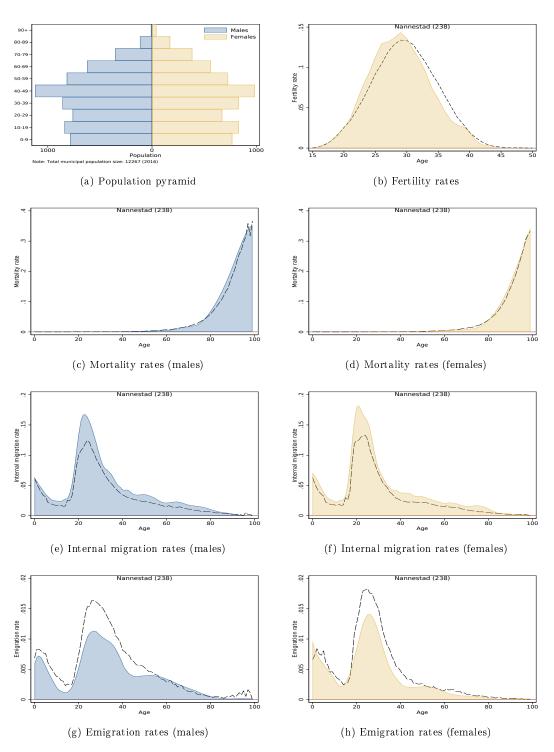


Figure D39: Municipal demographic characteristics

Hurdal (239)

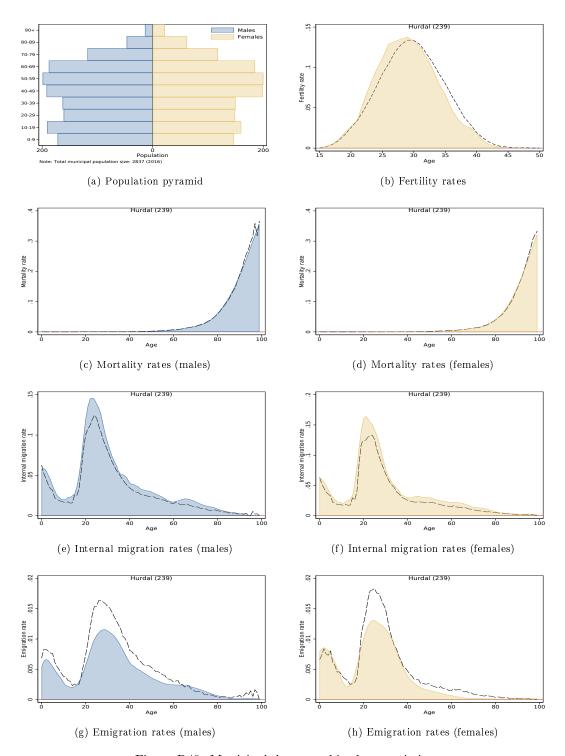


Figure D40: Municipal demographic characteristics

Oslo (301)

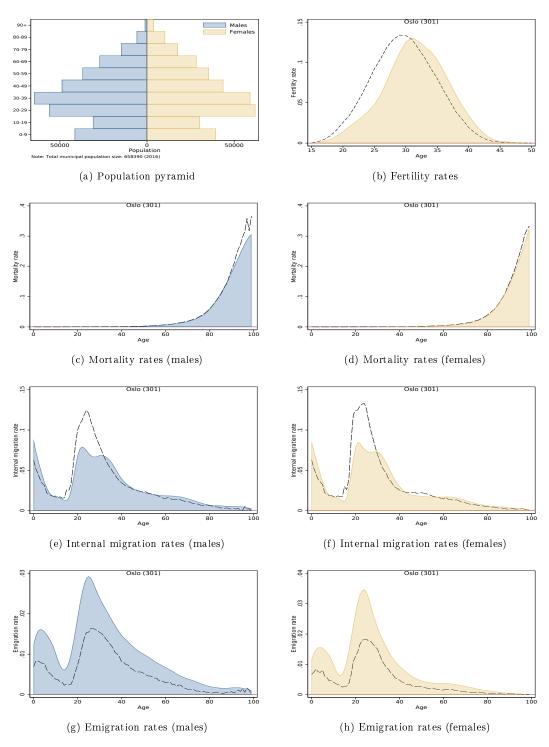


Figure D41: Municipal demographic characteristics

Kongsvinger (402)

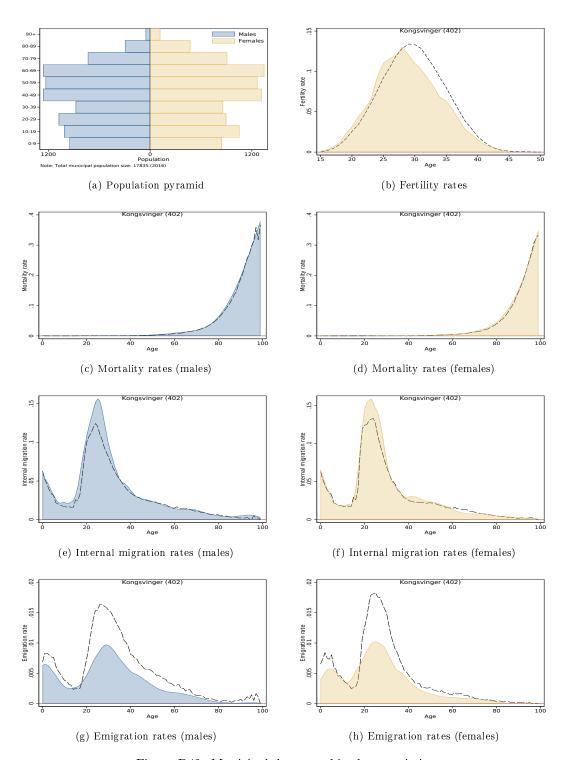


Figure D42: Municipal demographic characteristics

Hamar (403)

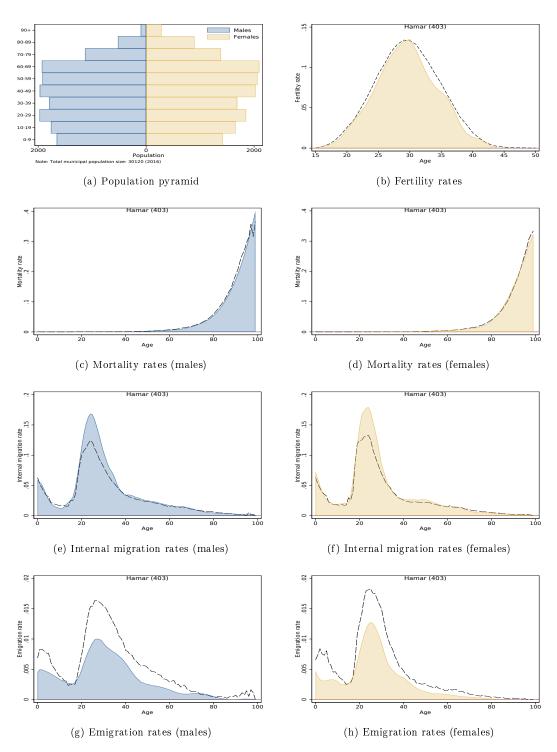


Figure D43: Municipal demographic characteristics

Ringsaker (412)

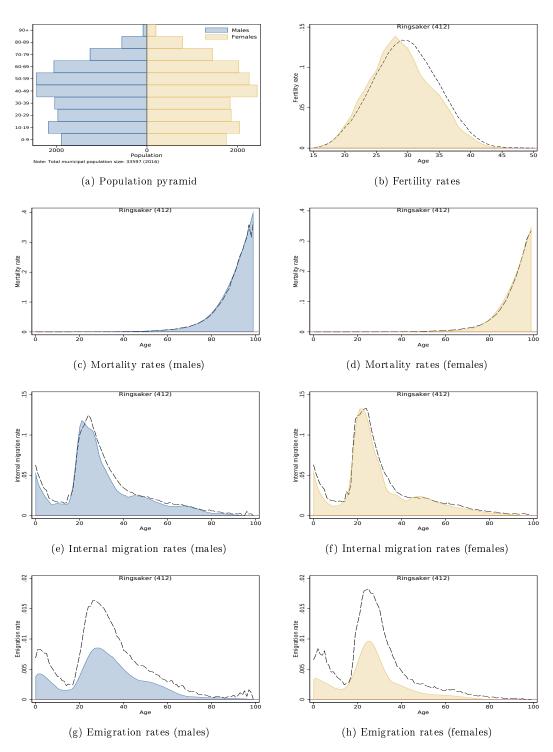


Figure D44: Municipal demographic characteristics

Løten (415)

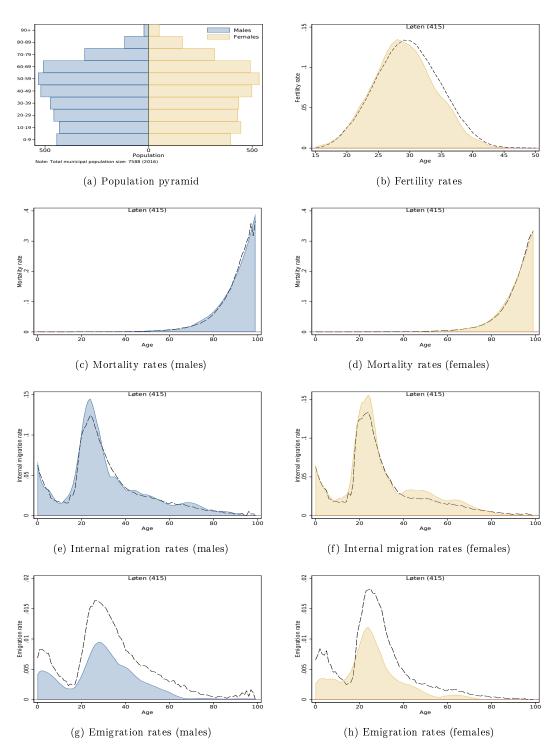


Figure D45: Municipal demographic characteristics

Stange (417)

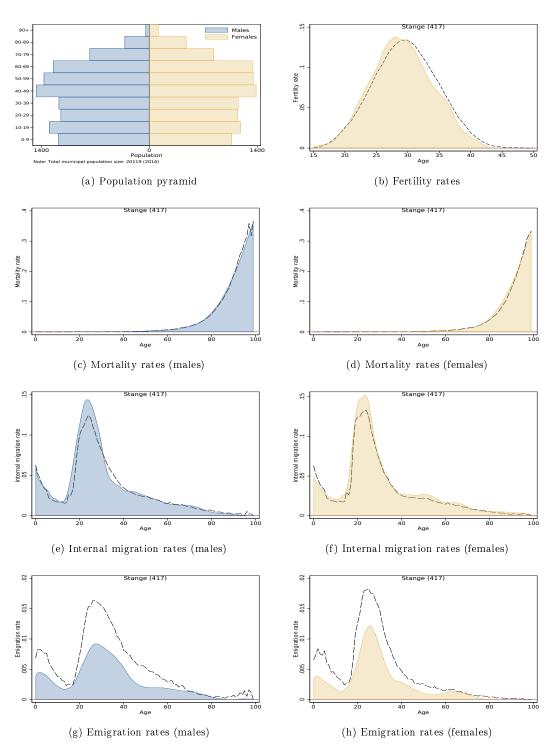


Figure D46: Municipal demographic characteristics

Nord-Odal (418)

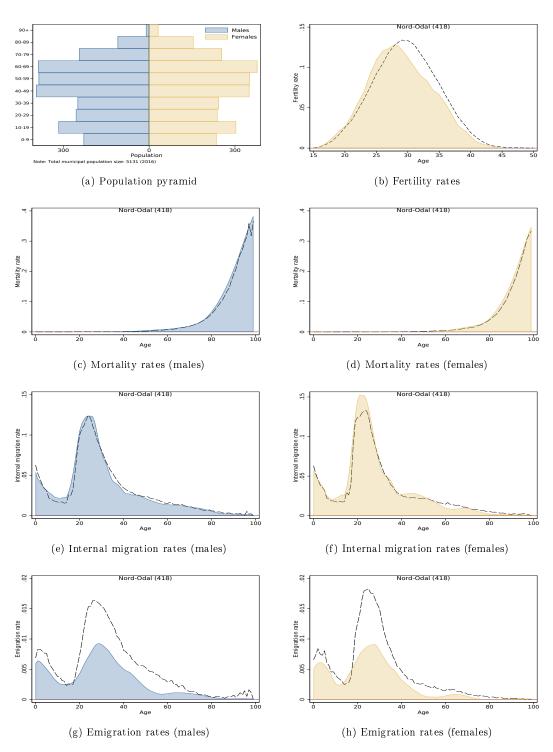


Figure D47: Municipal demographic characteristics

Sør-Odal (419)

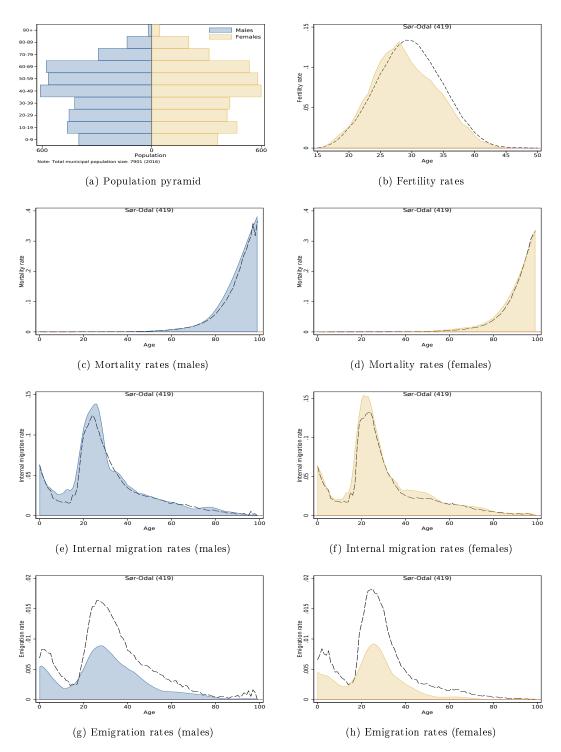


Figure D48: Municipal demographic characteristics

Eidskog (420)

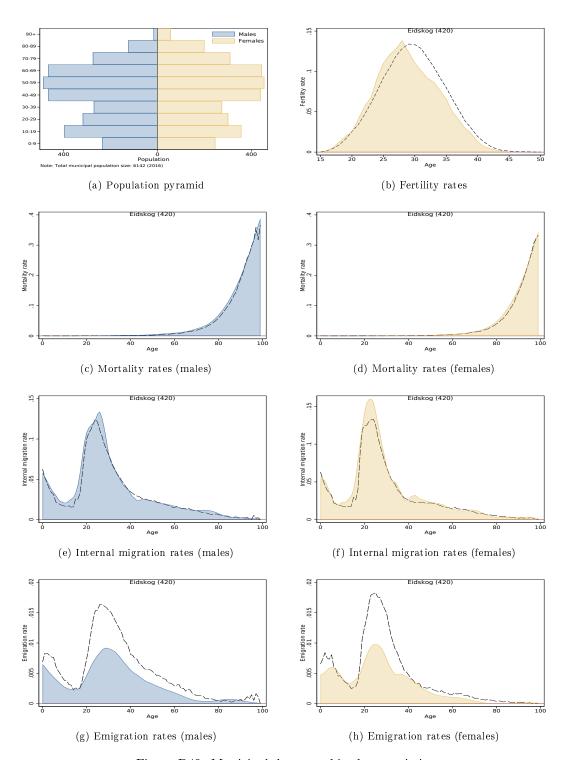


Figure D49: Municipal demographic characteristics

Grue (423)

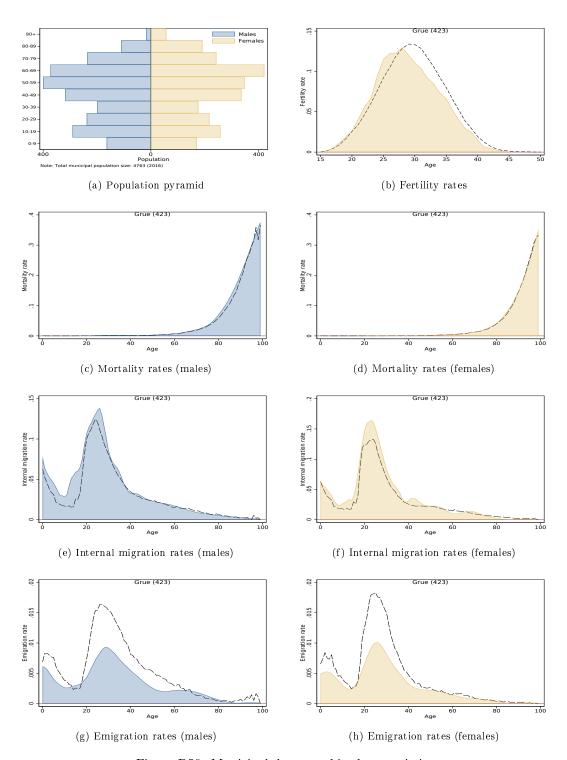


Figure D50: Municipal demographic characteristics

Åsnes (425)

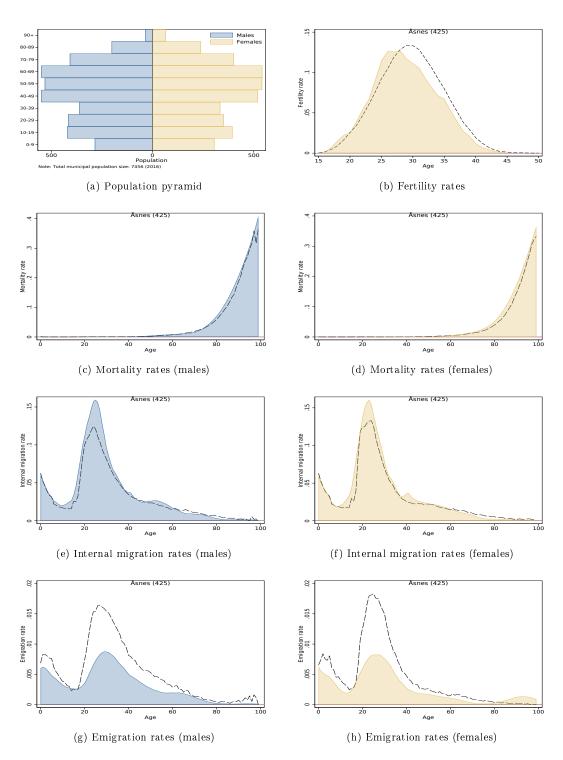


Figure D51: Municipal demographic characteristics

Våler (426)

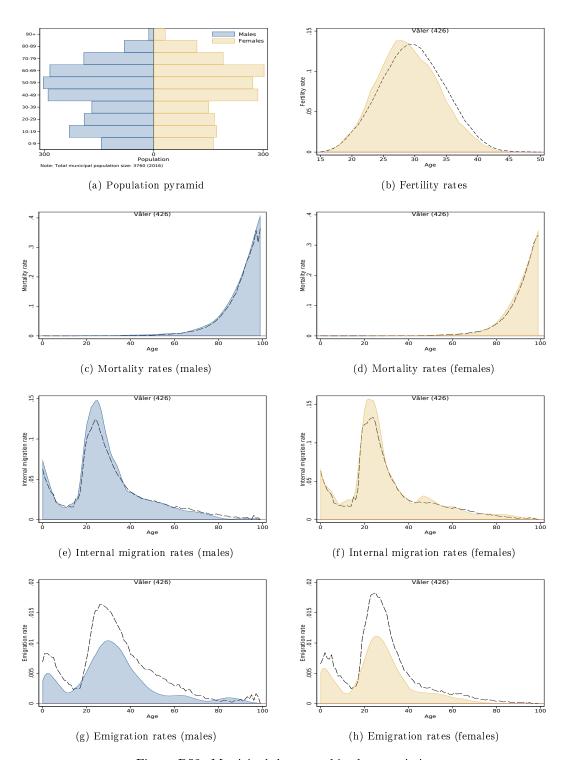


Figure D52: Municipal demographic characteristics

Elverum (427)

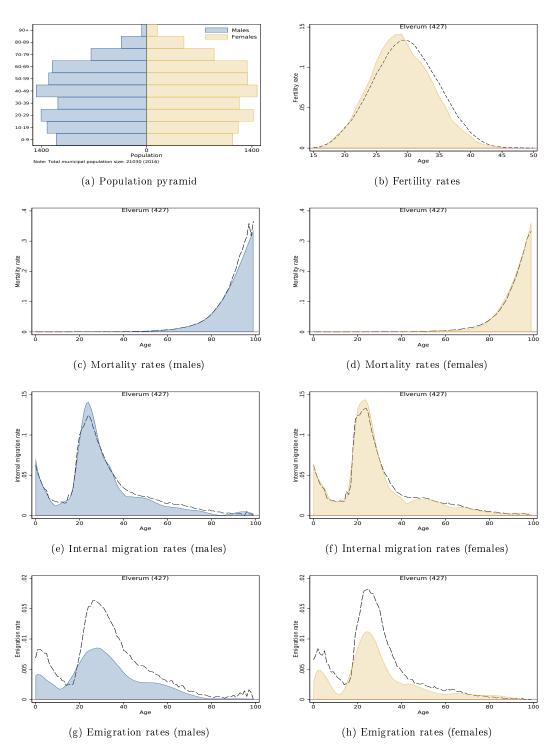


Figure D53: Municipal demographic characteristics

Trysil (428)

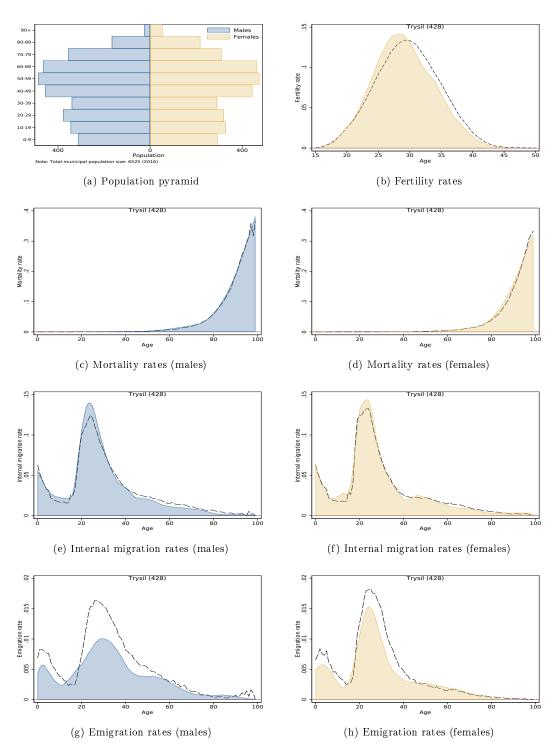


Figure D54: Municipal demographic characteristics

Åmot (429)

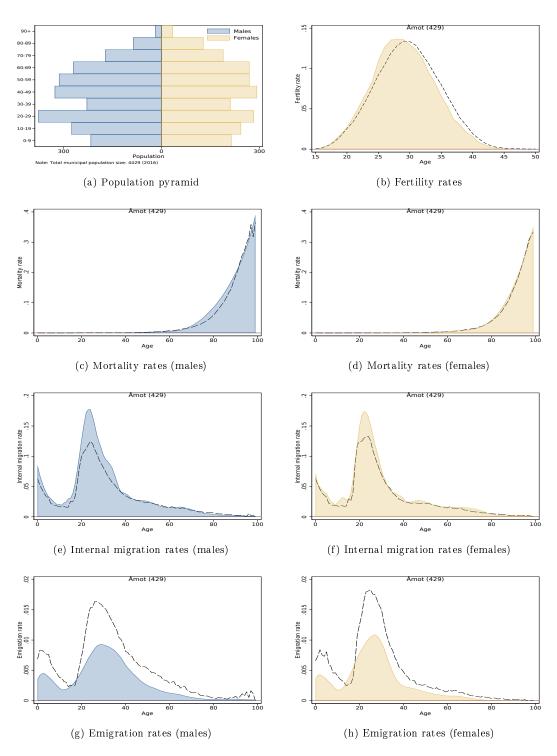


Figure D55: Municipal demographic characteristics

Stor-Elvdal (430)

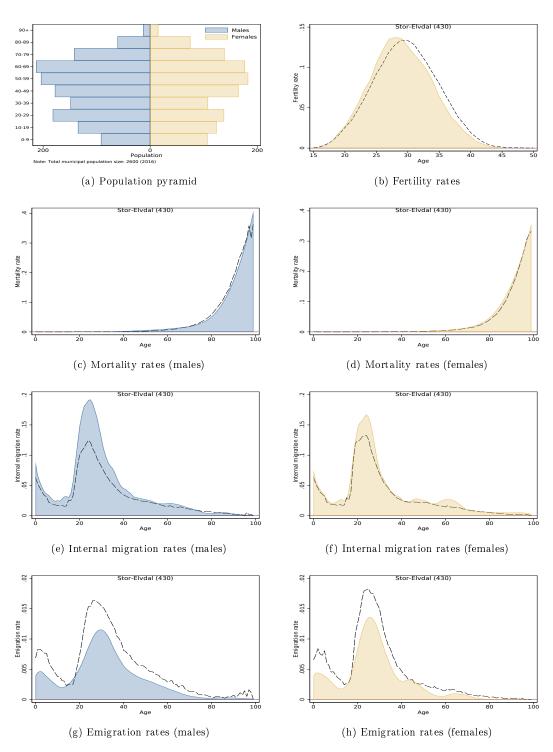


Figure D56: Municipal demographic characteristics

Rendalen (432)

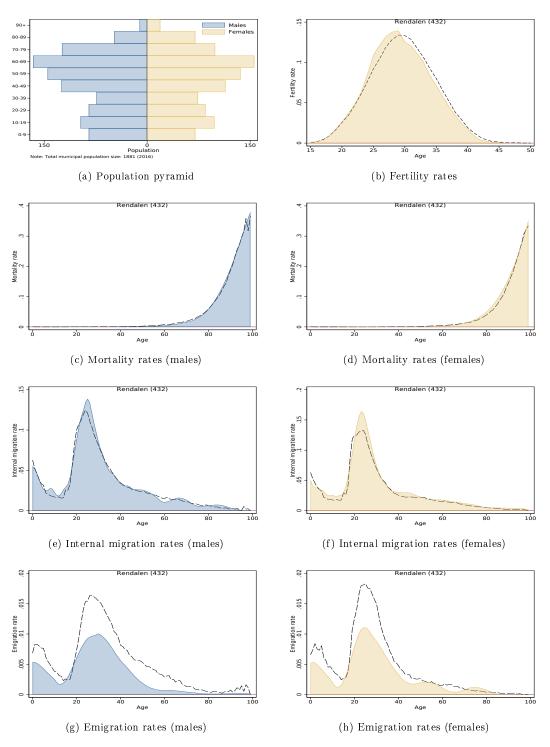


Figure D57: Municipal demographic characteristics

Engerdal (434)

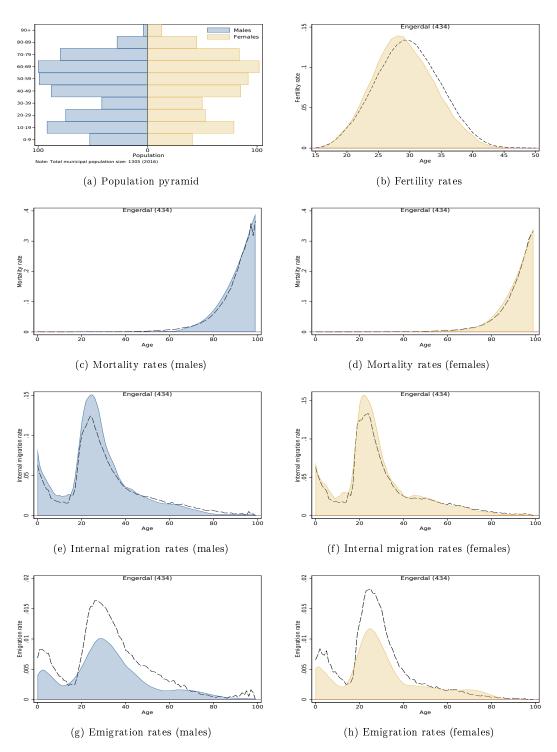
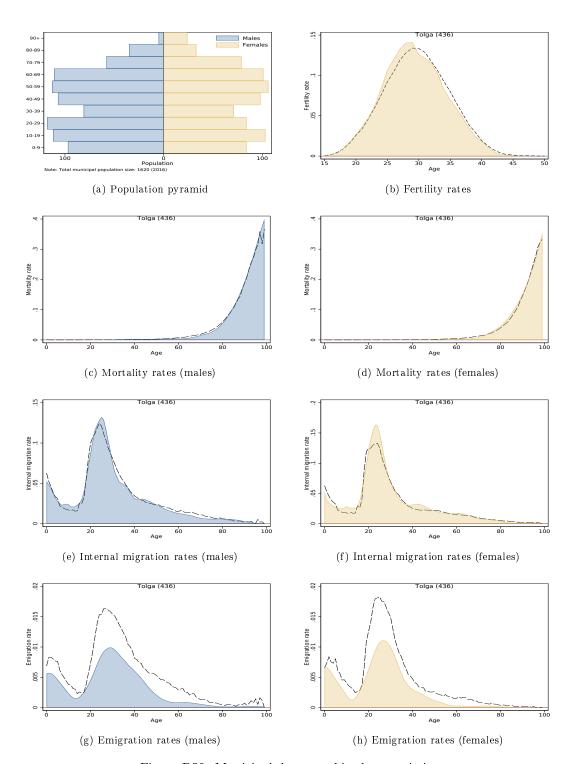


Figure D58: Municipal demographic characteristics

Tolga (436)



 $Figure\ D59:\ Municipal\ demographic\ characteristics$

Tynset (437)

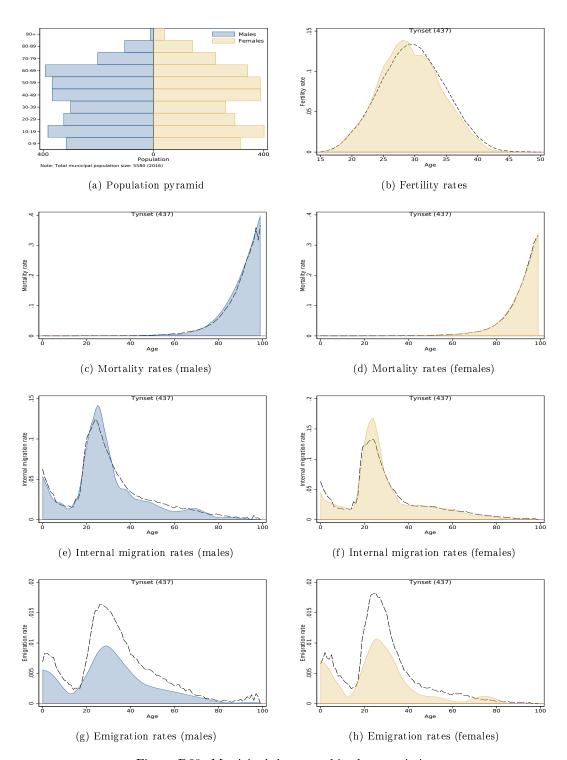


Figure D60: Municipal demographic characteristics

Alvdal (438)

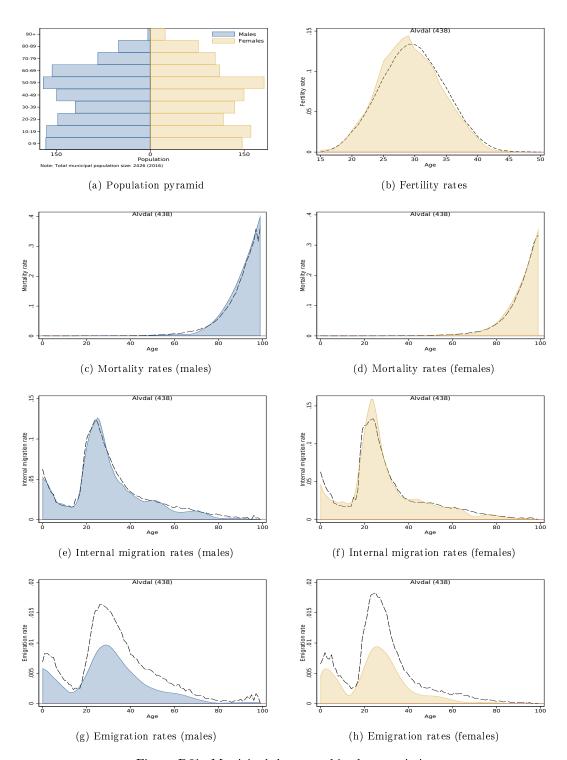


Figure D61: Municipal demographic characteristics

Folldal (439)

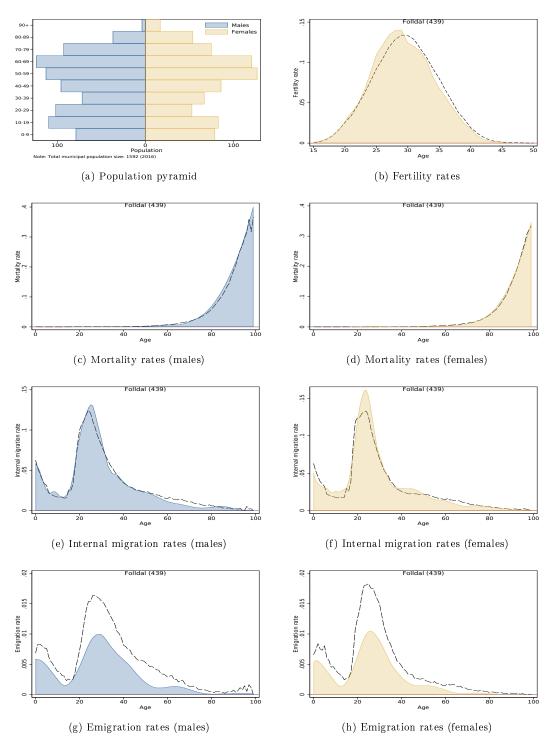


Figure D62: Municipal demographic characteristics

Os (441)

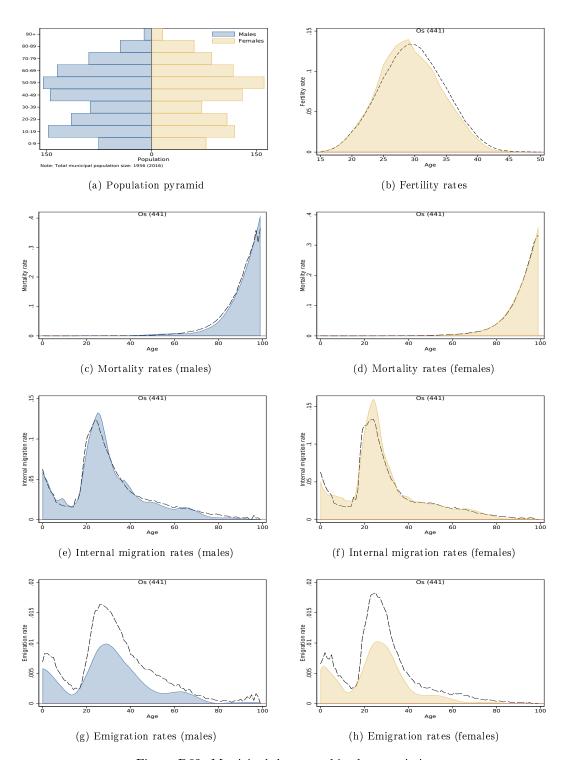


Figure D63: Municipal demographic characteristics

Lillehammer (501)

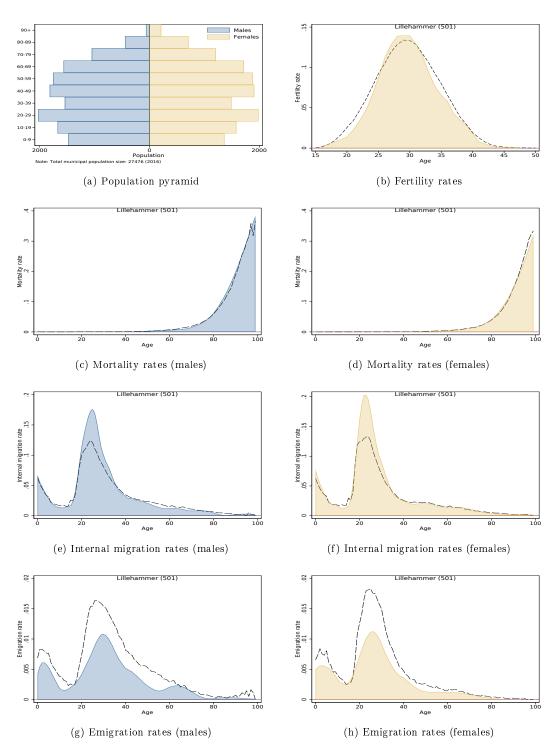


Figure D64: Municipal demographic characteristics

Gjøvik (502)

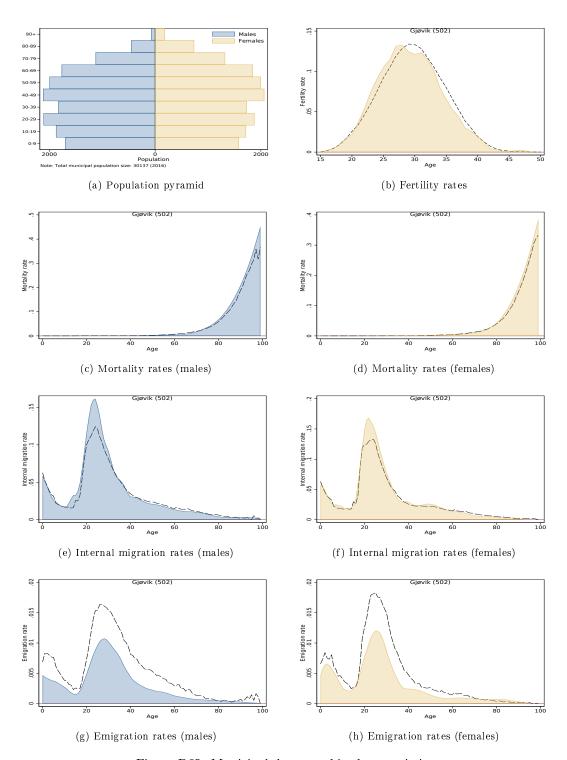


Figure D65: Municipal demographic characteristics

Dovre (511)

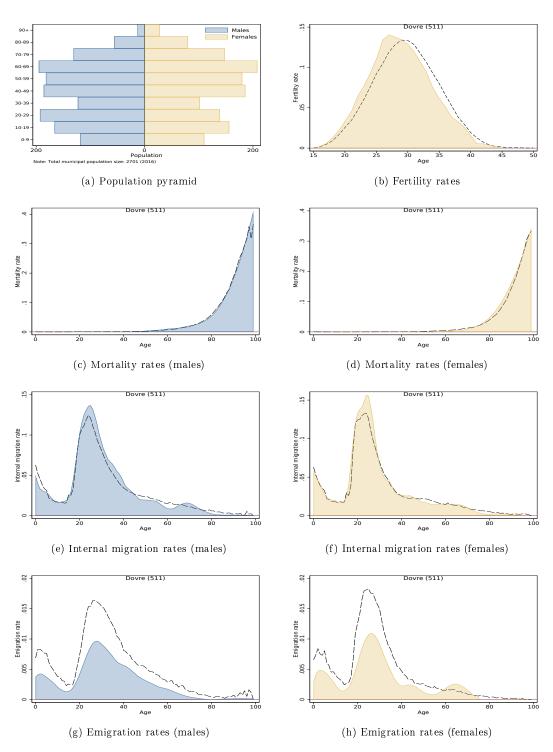


Figure D66: Municipal demographic characteristics

Lesja (512)

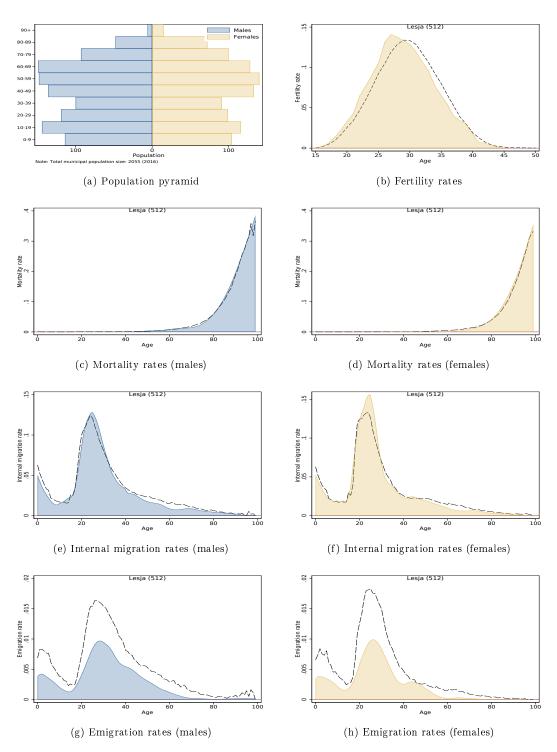


Figure D67: Municipal demographic characteristics

Skjåk (513)

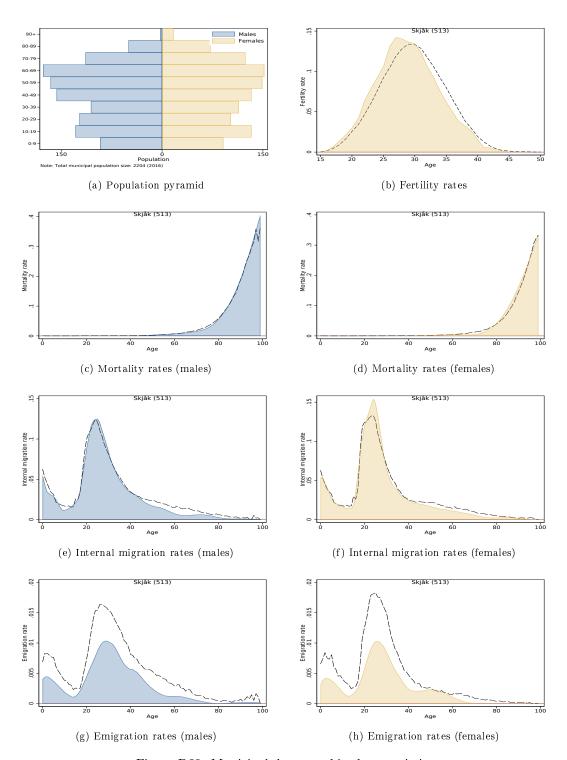


Figure D68: Municipal demographic characteristics

Lom (514)

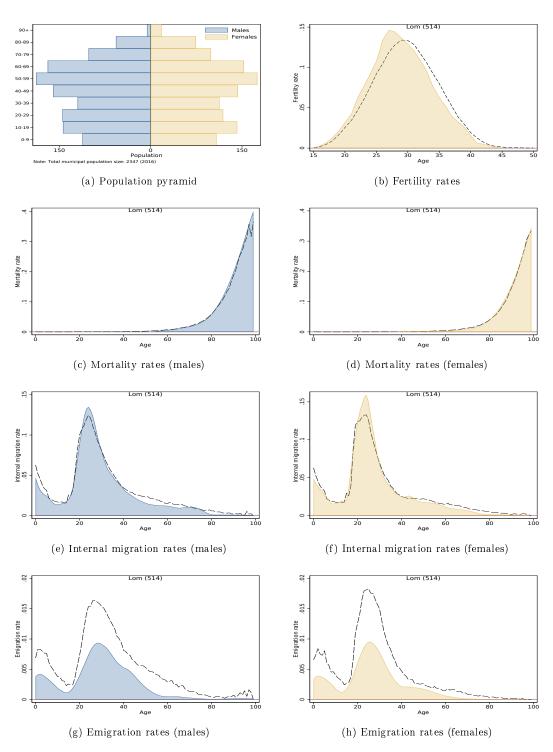


Figure D69: Municipal demographic characteristics

Vågå(515)

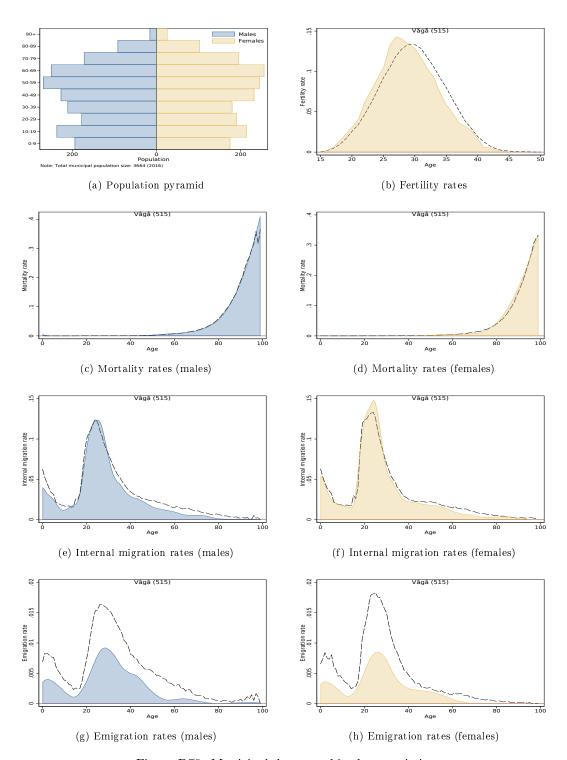


Figure D70: Municipal demographic characteristics

Nord-Fron (516)

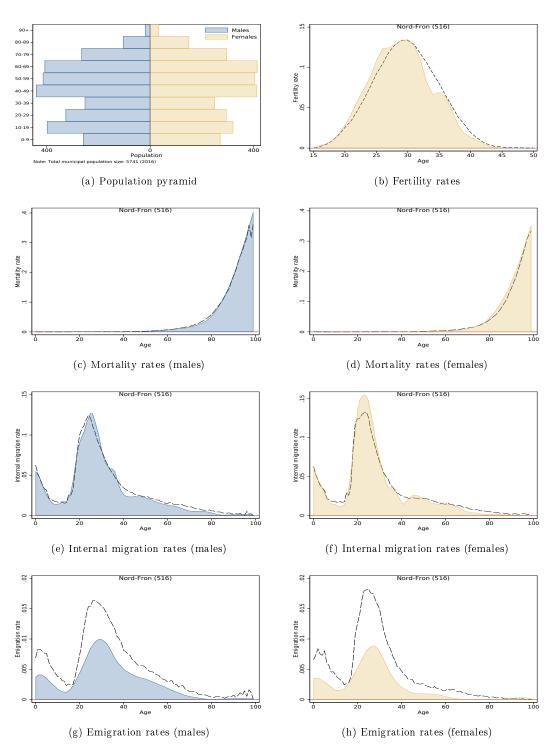


Figure D71: Municipal demographic characteristics

Sel (517)

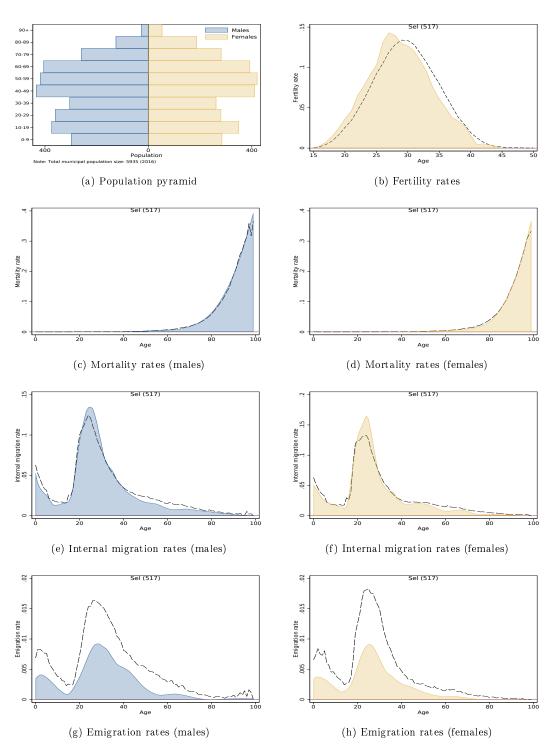


Figure D72: Municipal demographic characteristics

Sør-Fron (519)

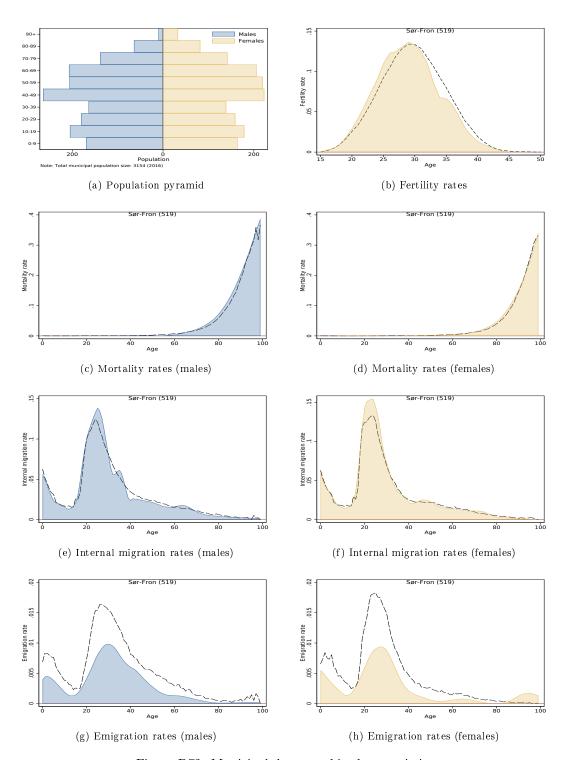


Figure D73: Municipal demographic characteristics

Ringebu (520)

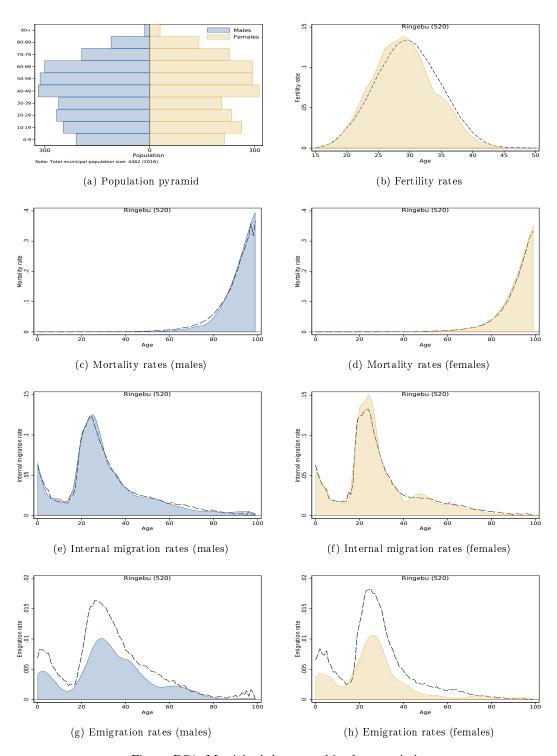


Figure D74: Municipal demographic characteristics

Øyer (521)

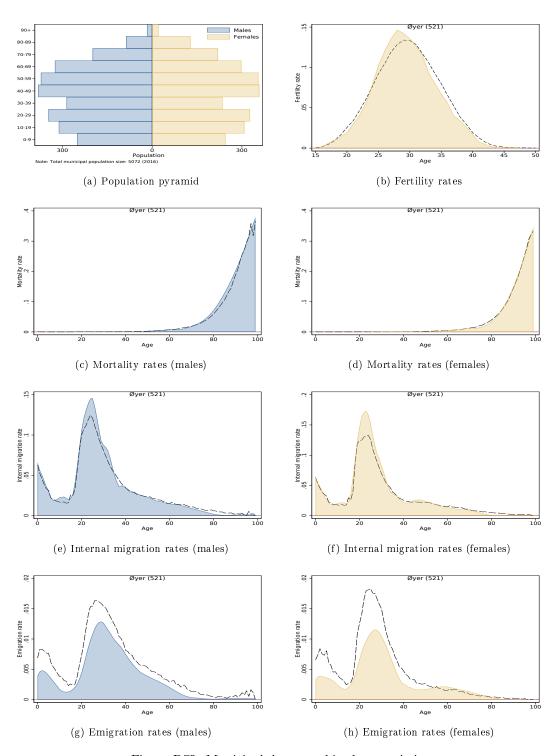


Figure D75: Municipal demographic characteristics

Gausdal (522)

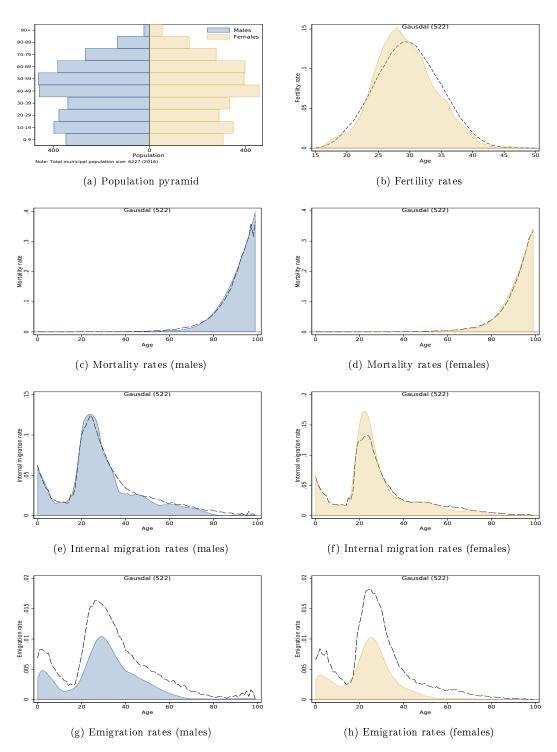


Figure D76: Municipal demographic characteristics

Østre Toten (528)

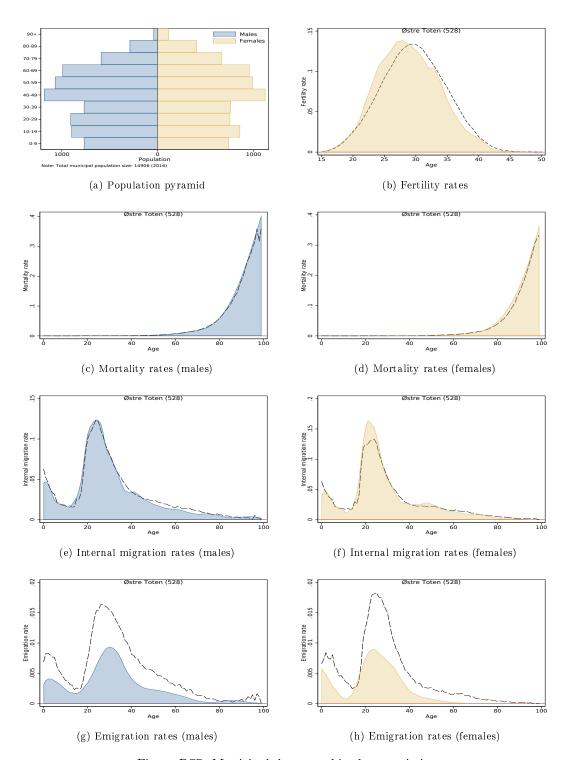


Figure D77: Municipal demographic characteristics

Vestre Toten (529)

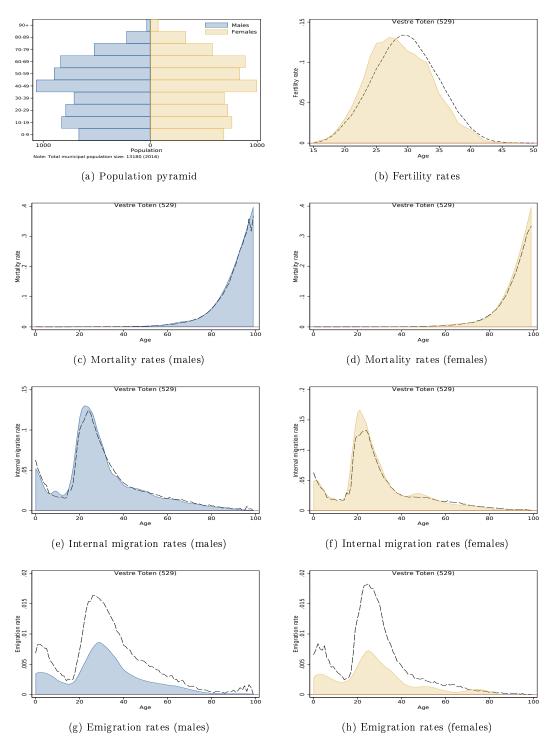


Figure D78: Municipal demographic characteristics

Jevnaker (532)

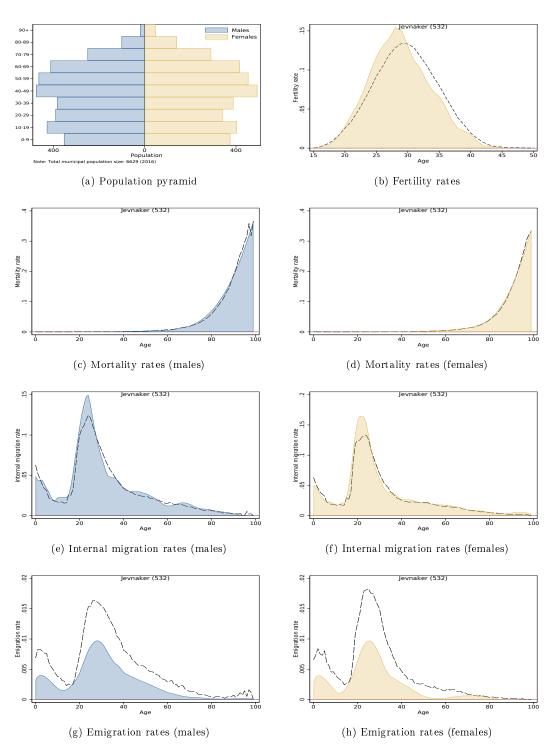


Figure D79: Municipal demographic characteristics

Lunner (533)

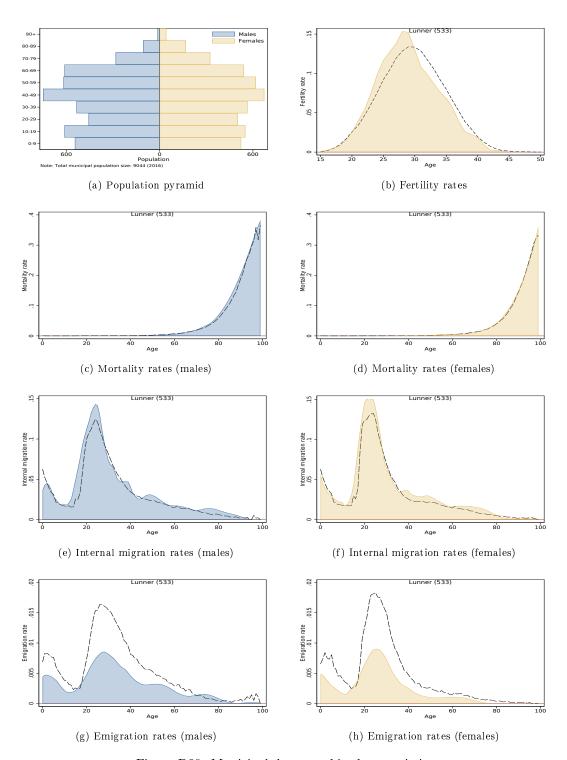


Figure D80: Municipal demographic characteristics

Gran (534)

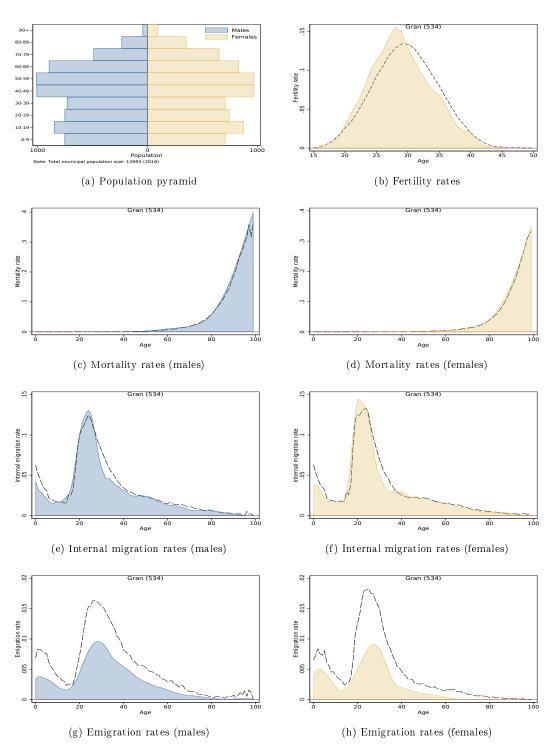


Figure D81: Municipal demographic characteristics

Søndre Land (536)

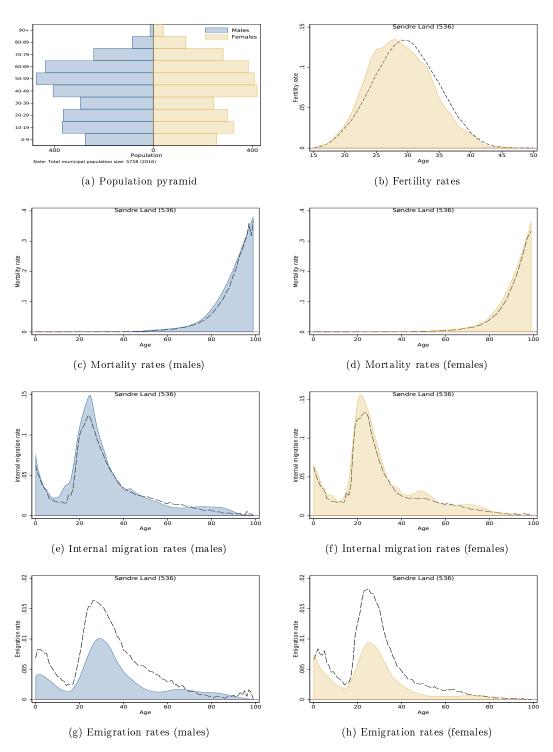


Figure D82: Municipal demographic characteristics

Nordre Land (538)

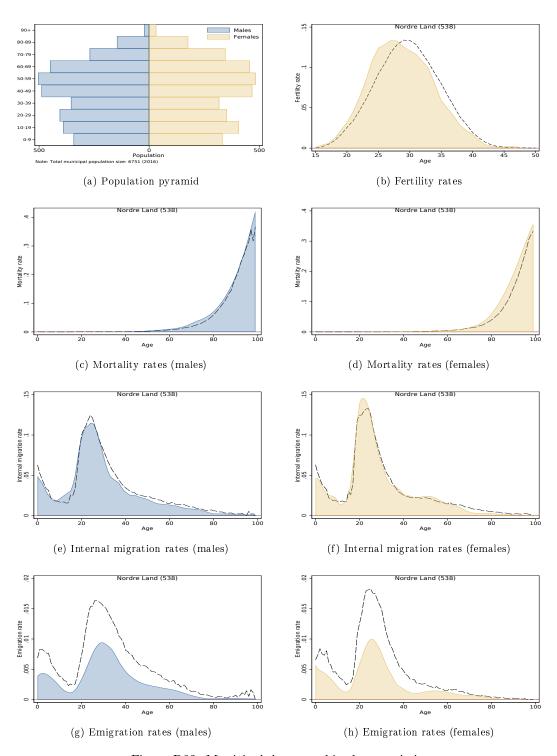


Figure D83: Municipal demographic characteristics

Sør-Aurdal (540)

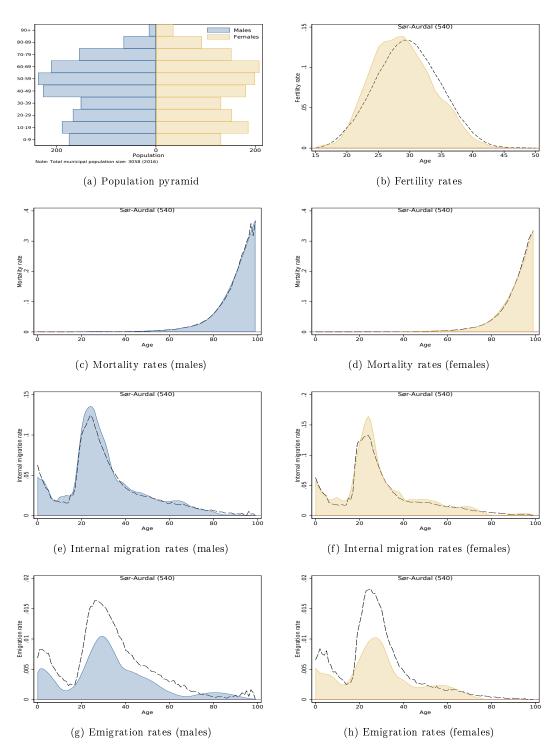


Figure D84: Municipal demographic characteristics

Etnedal (541)

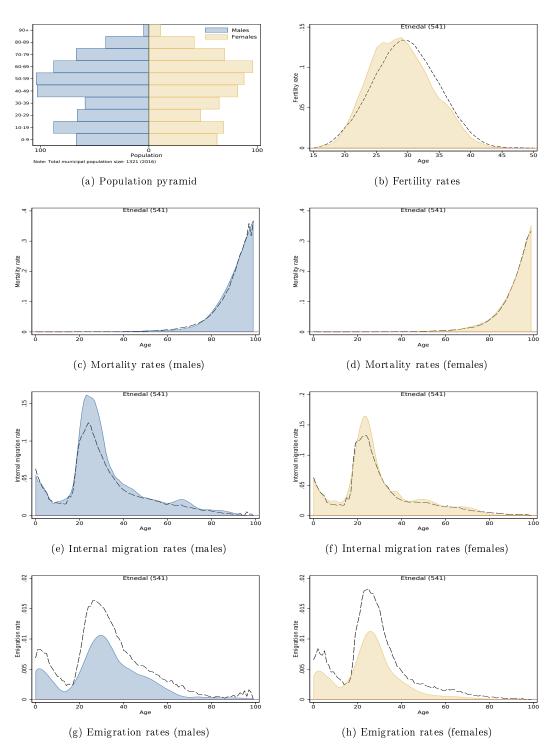


Figure D85: Municipal demographic characteristics

Nord-Aurdal (542)

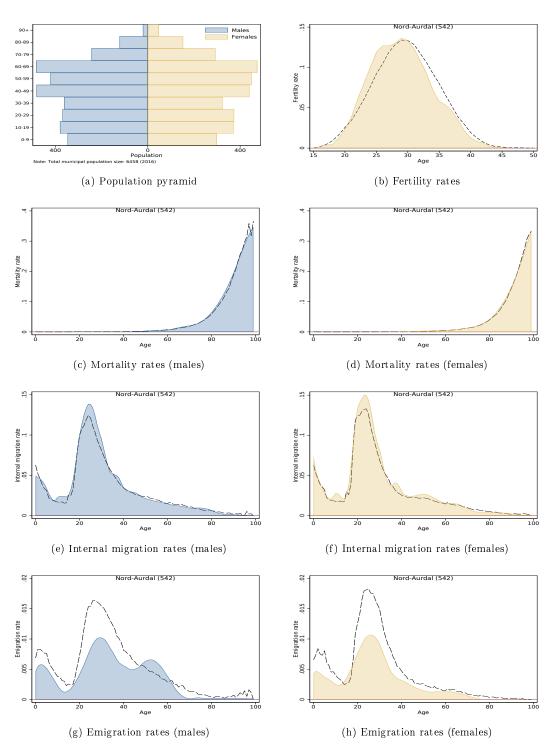


Figure D86: Municipal demographic characteristics

Vestre Slidre (543)

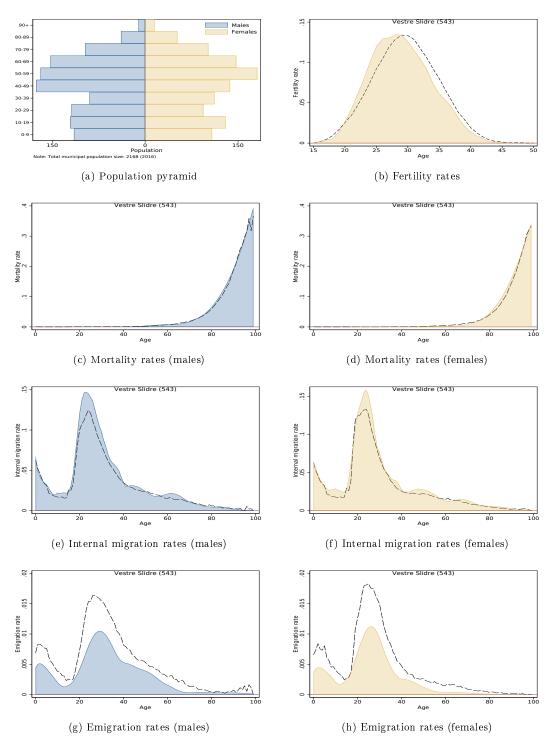


Figure D87: Municipal demographic characteristics

Øystre Slidre (544)

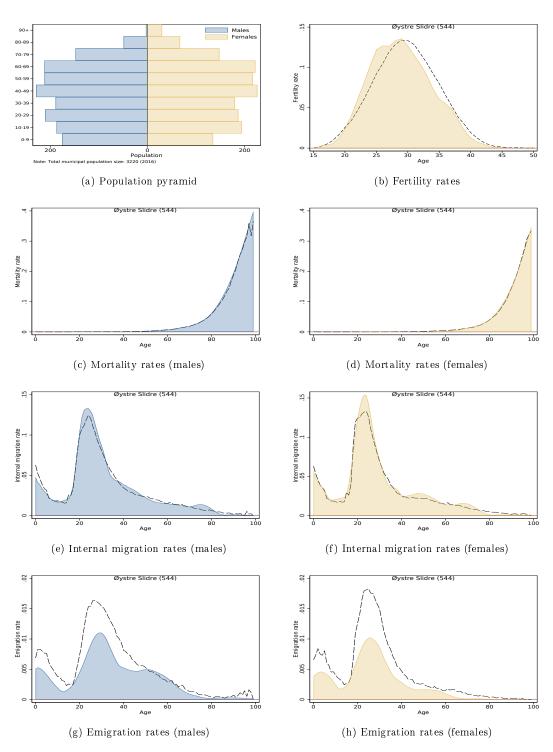


Figure D88: Municipal demographic characteristics

Vang (545)

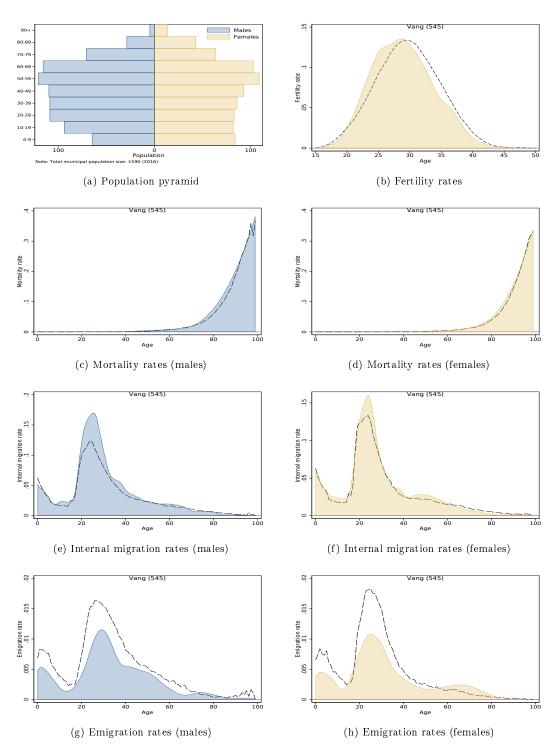


Figure D89: Municipal demographic characteristics

Drammen (602)

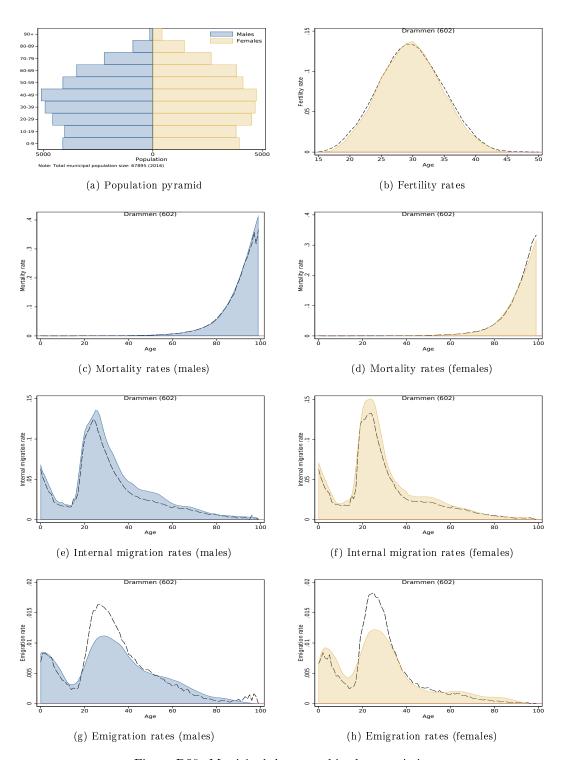


Figure D90: Municipal demographic characteristics

Kongsberg (604)

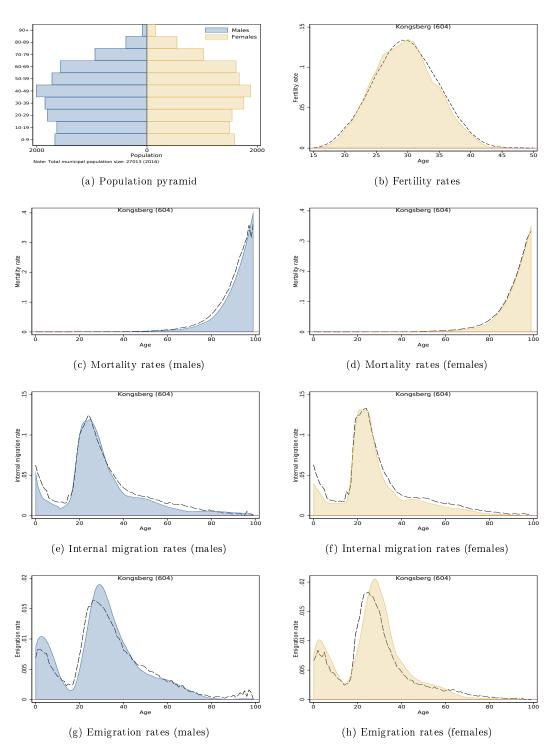


Figure D91: Municipal demographic characteristics

Ringerike (605)

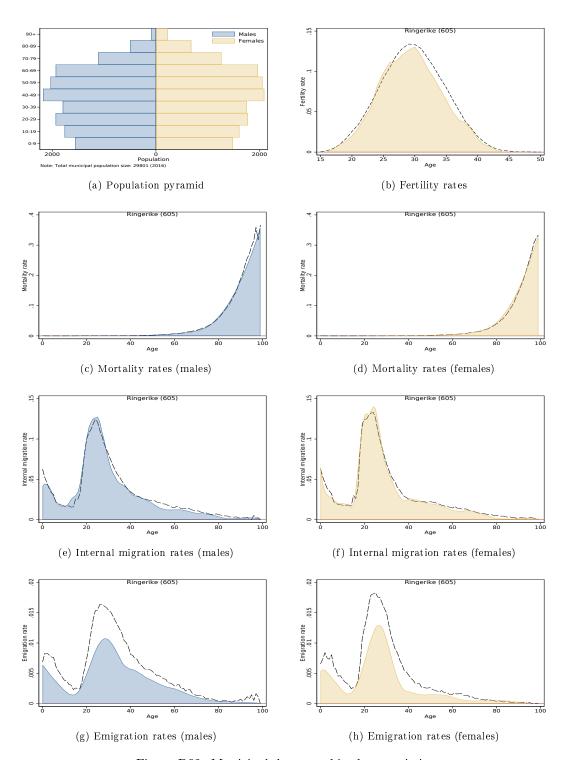


Figure D92: Municipal demographic characteristics

Hole (612)

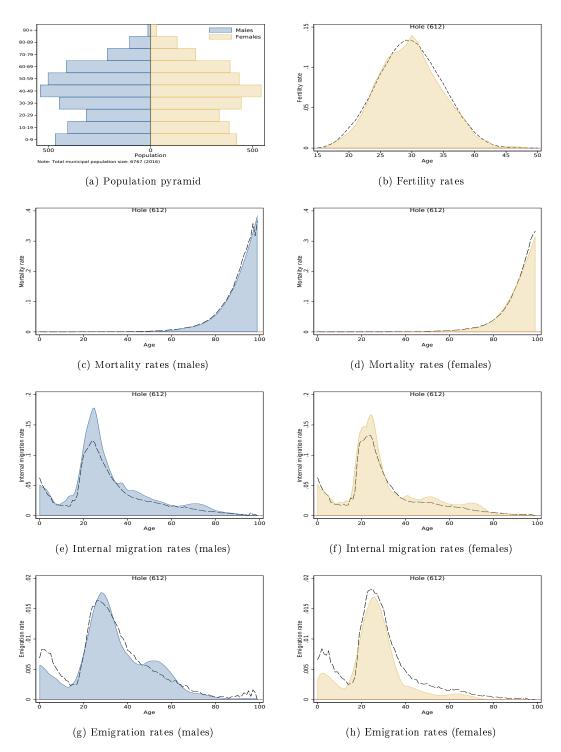


Figure D93: Municipal demographic characteristics

Flå(615)

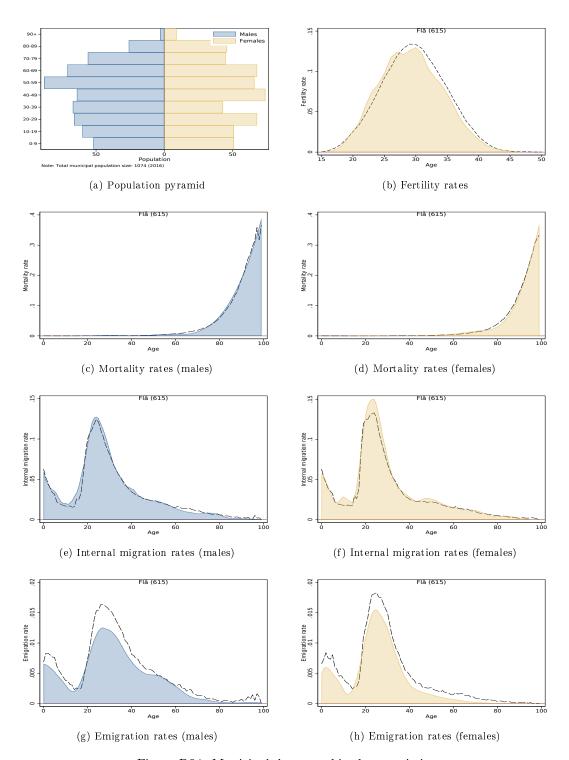


Figure D94: Municipal demographic characteristics

Nes (616)

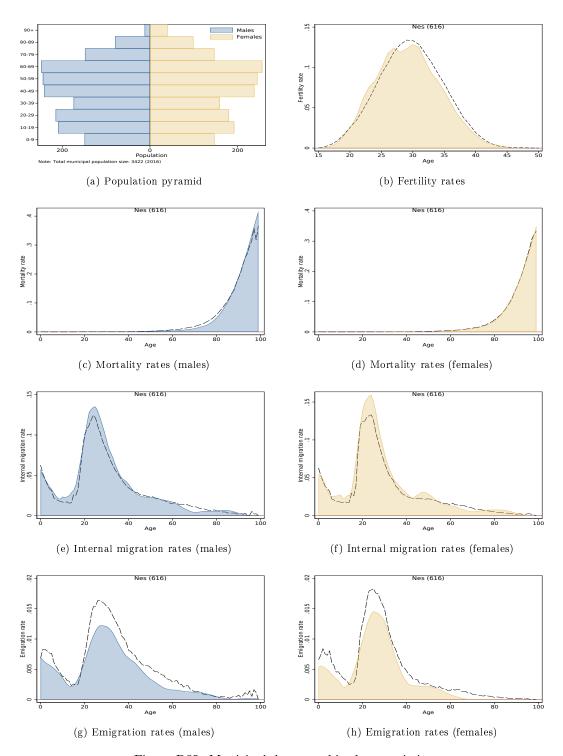


Figure D95: Municipal demographic characteristics

Gol (617)

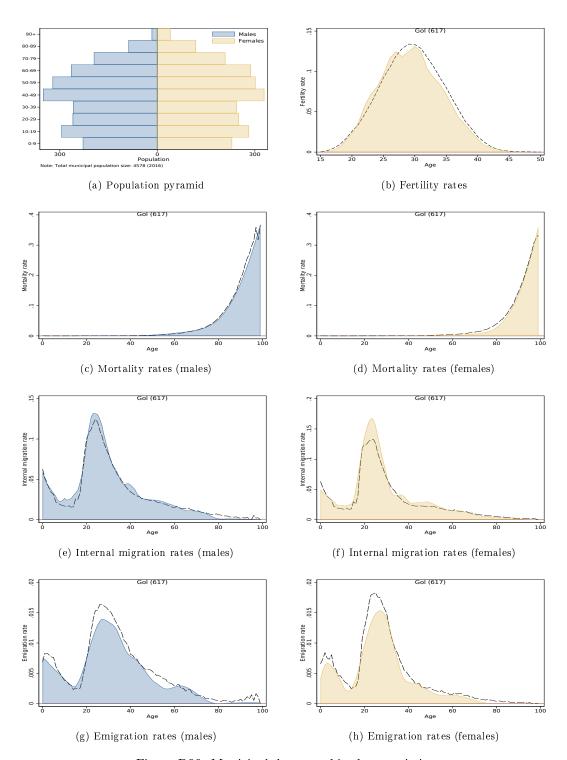


Figure D96: Municipal demographic characteristics

Hemsedal (618)

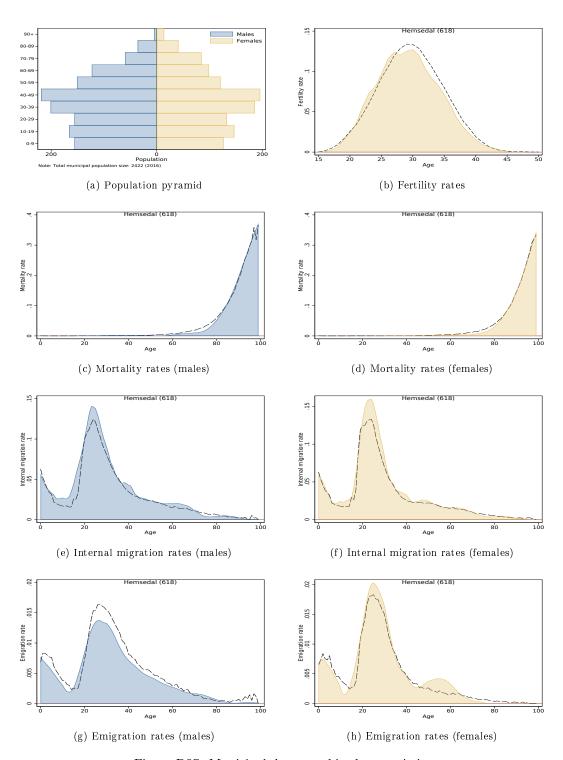


Figure D97: Municipal demographic characteristics

Ål (619)

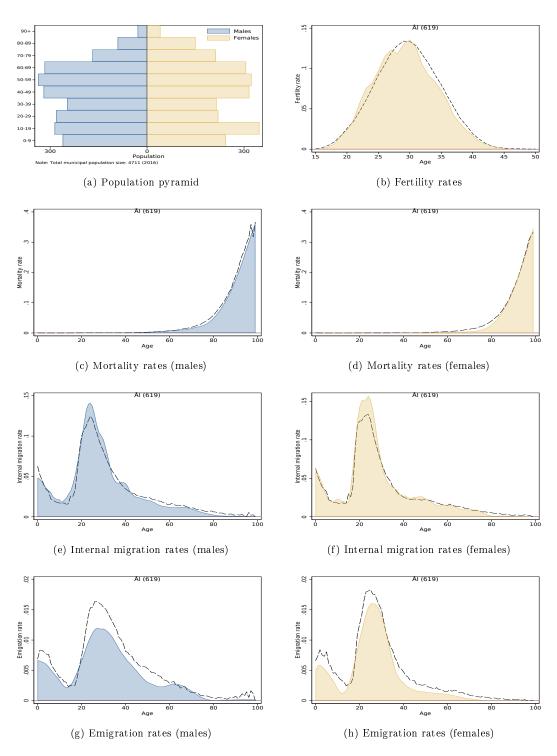


Figure D98: Municipal demographic characteristics

Hol (620)

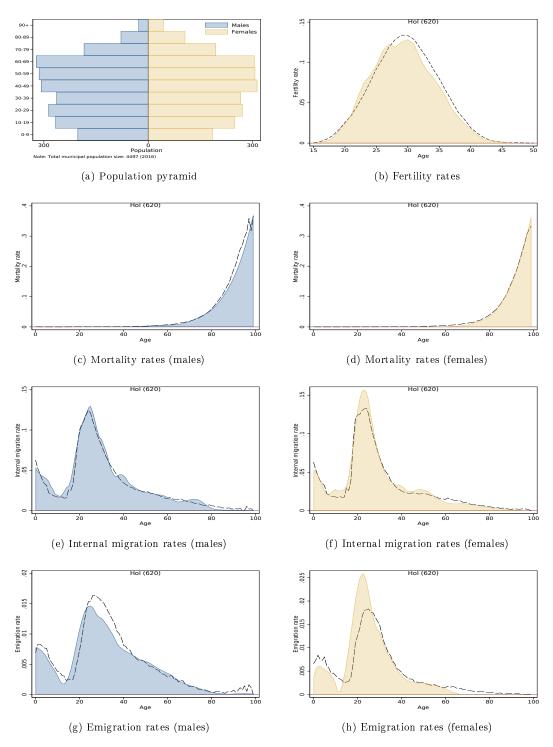


Figure D99: Municipal demographic characteristics

Sigdal (621)

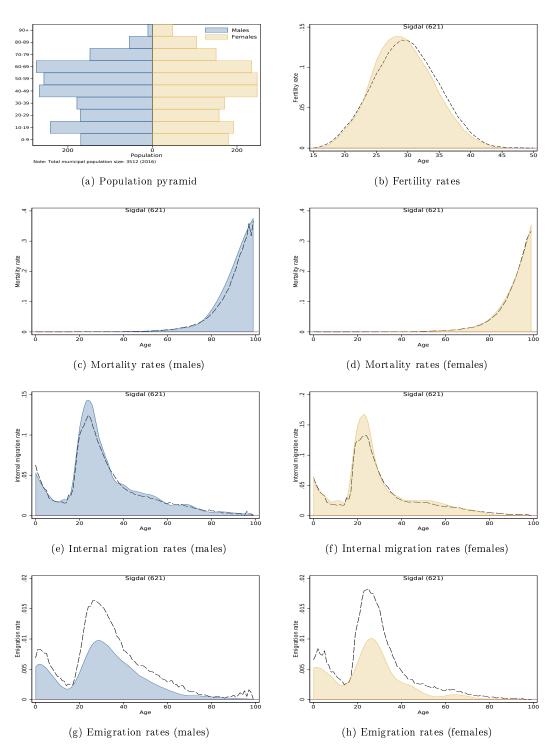


Figure D100: Municipal demographic characteristics

Krødsherad (622)

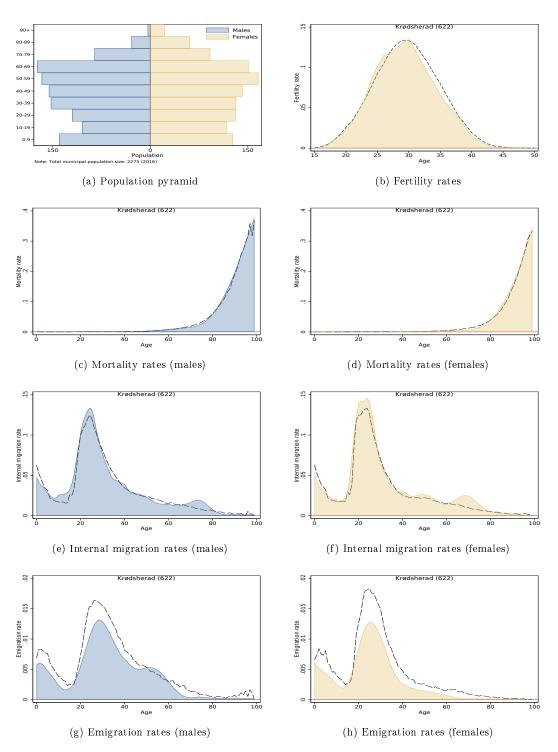


Figure D101: Municipal demographic characteristics

Modum (623)

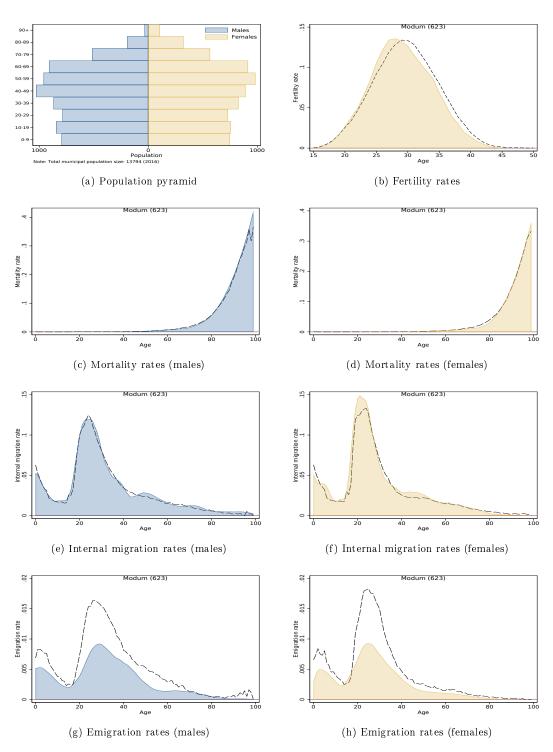


Figure D102: Municipal demographic characteristics

Øvre Eiker (624)

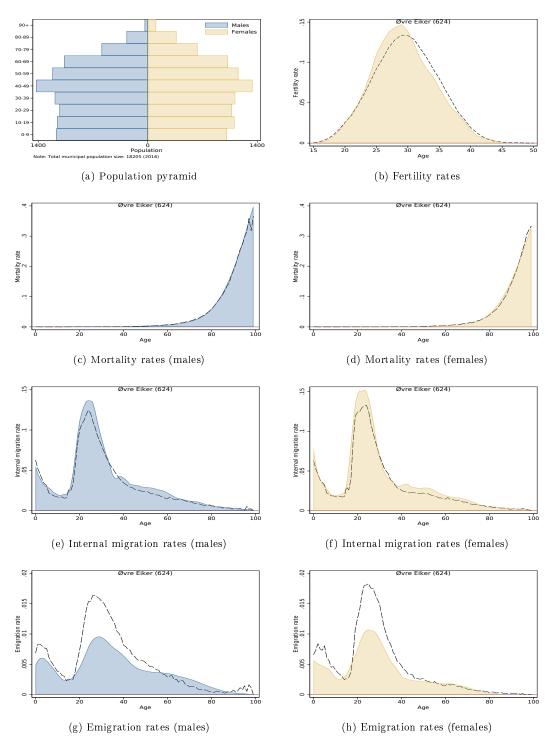


Figure D103: Municipal demographic characteristics

Nedre Eiker (625)

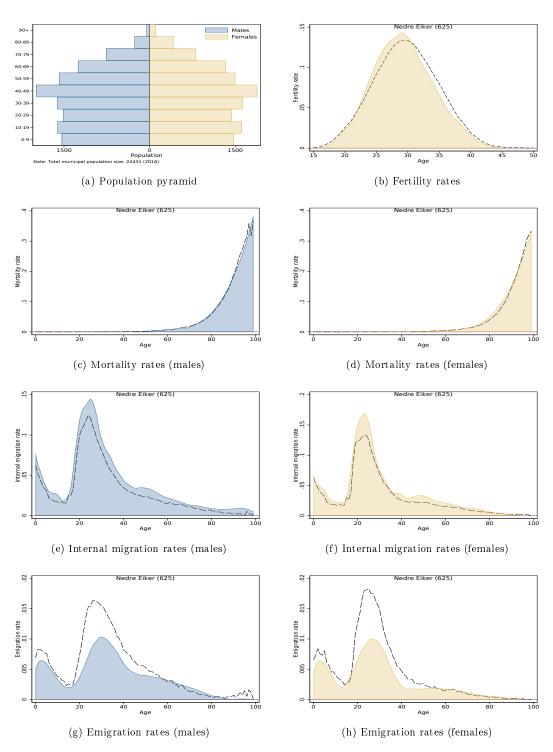


Figure D104: Municipal demographic characteristics

Lier (626)

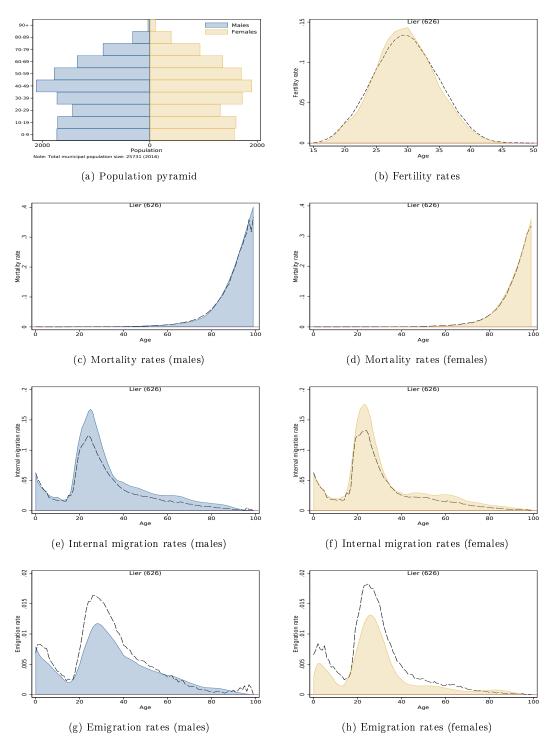


Figure D105: Municipal demographic characteristics

Røyken (627)

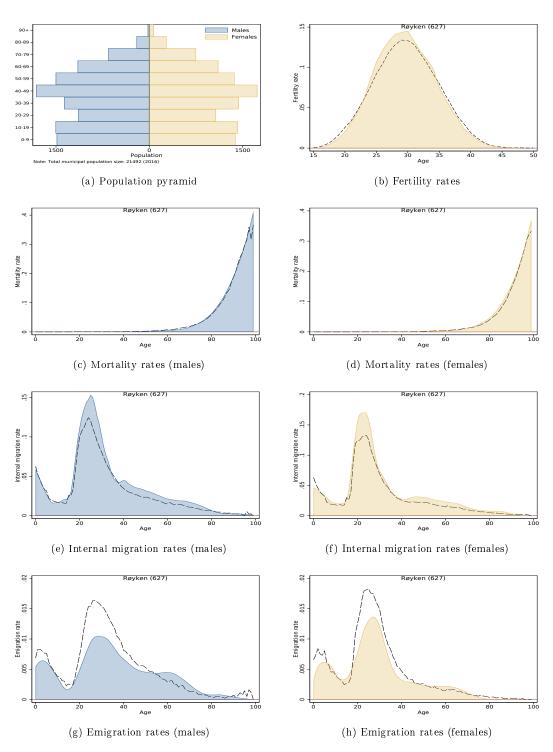


Figure D106: Municipal demographic characteristics

Hurum (628)

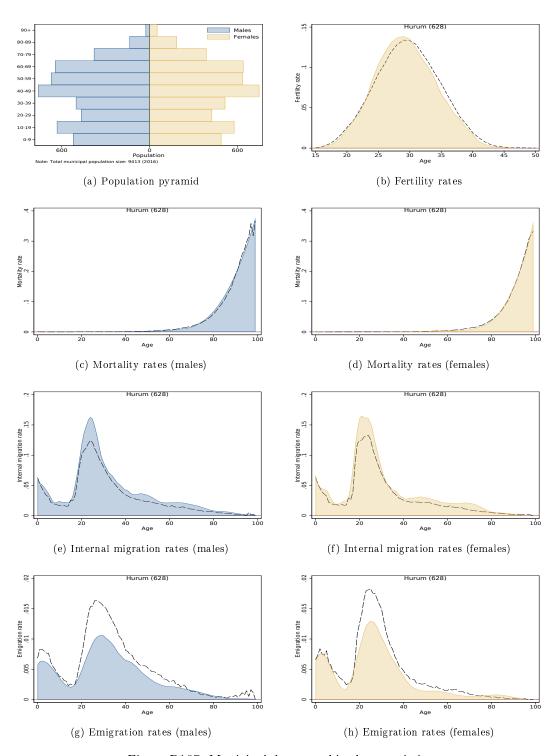


Figure D107: Municipal demographic characteristics

Flesberg (631)

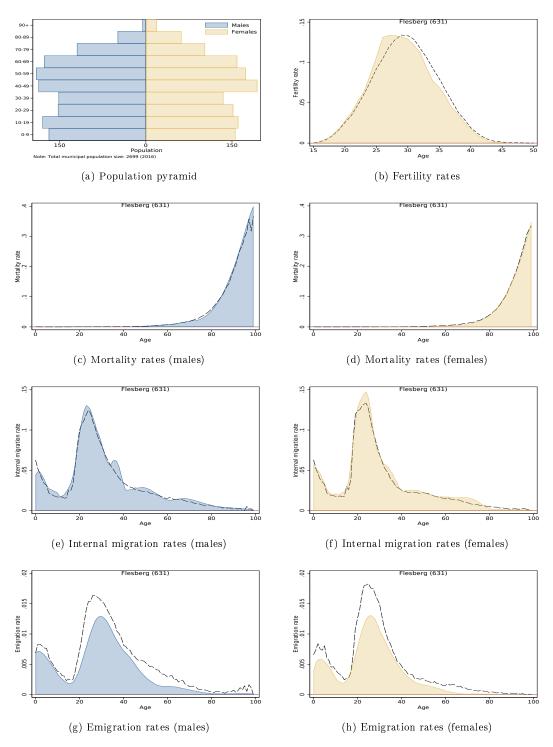


Figure D108: Municipal demographic characteristics

Rollag (632)

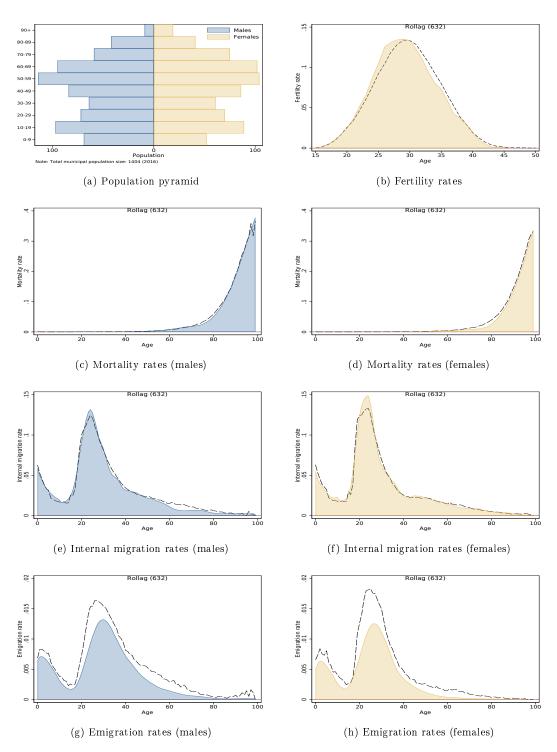
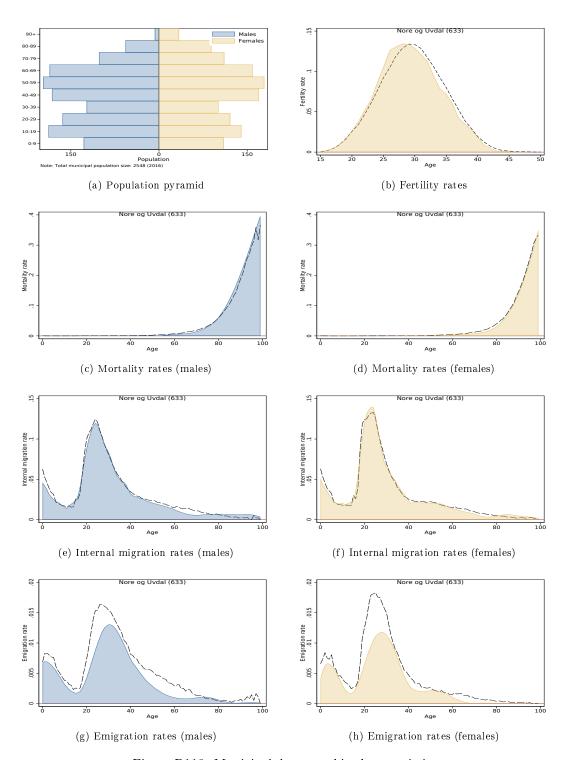


Figure D109: Municipal demographic characteristics

Nore og Uvdal (633)



 $Figure\ D110:\ Municipal\ demographic\ characteristics$

Horten (701)

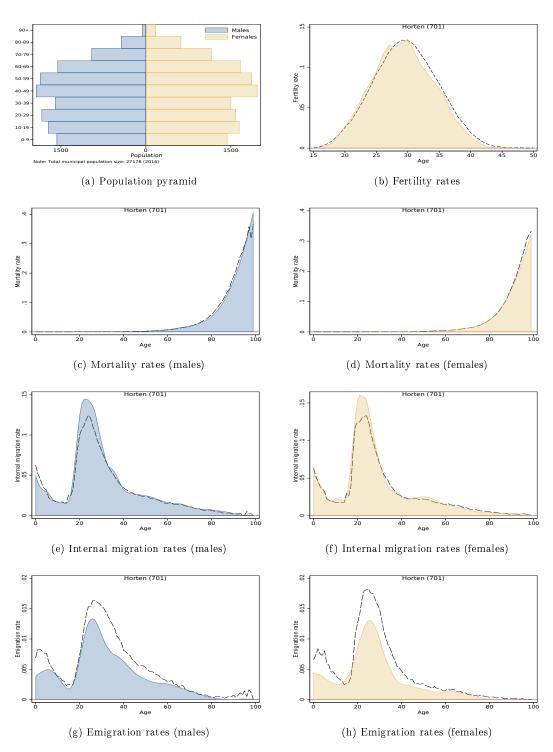


Figure D111: Municipal demographic characteristics

Tønsberg (704)

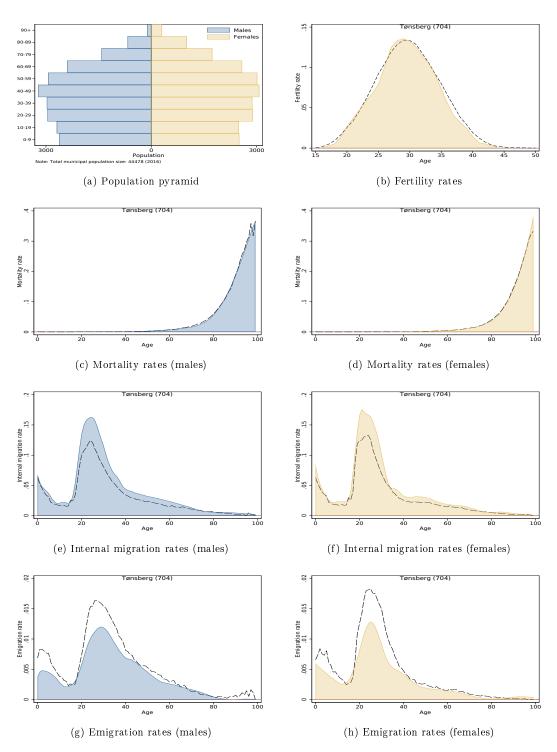
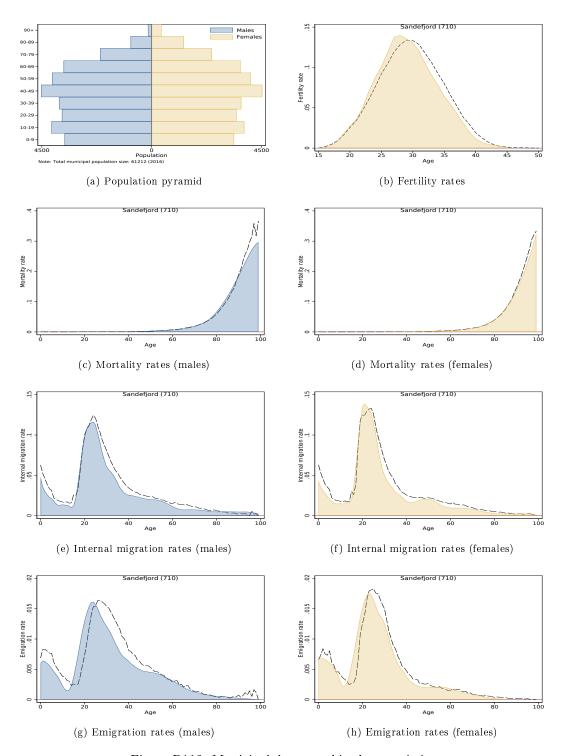


Figure D112: Municipal demographic characteristics

Sandefjord (710)



 $Figure\ D113:\ Municipal\ demographic\ characteristics$

Svelvik (711)

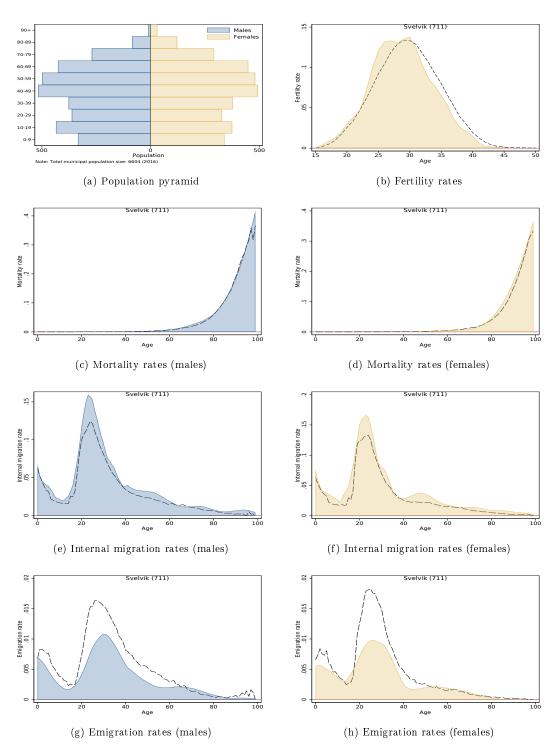


Figure D114: Municipal demographic characteristics

Larvik (712)

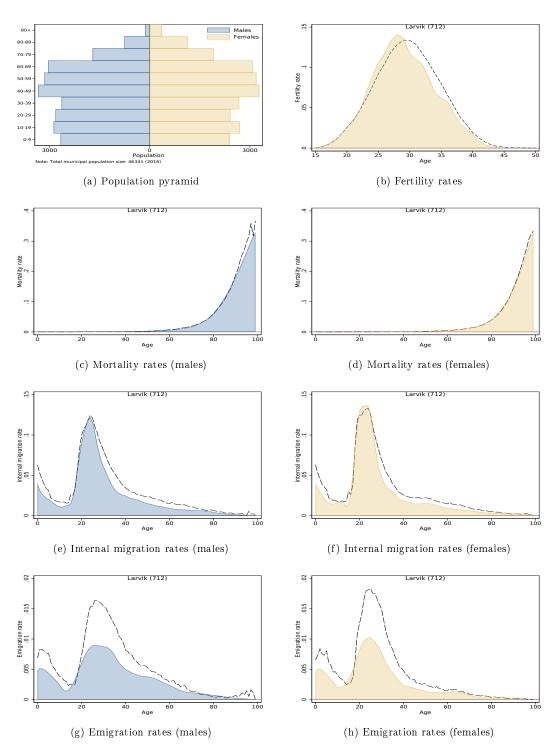


Figure D115: Municipal demographic characteristics

Sande (713)

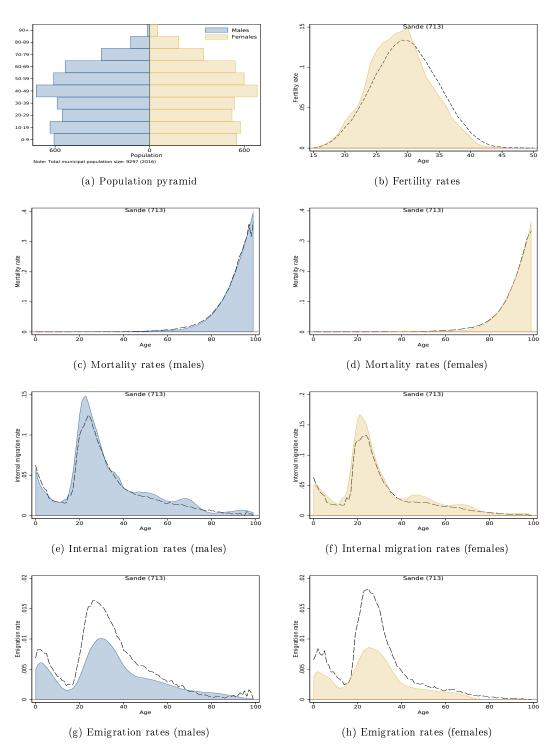


Figure D116: Municipal demographic characteristics

Holmestrand (715)

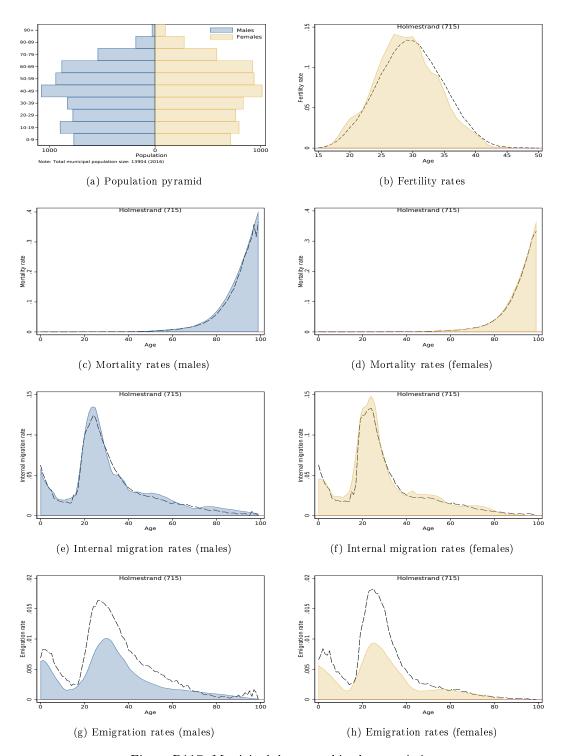


Figure D117: Municipal demographic characteristics

Re (716)

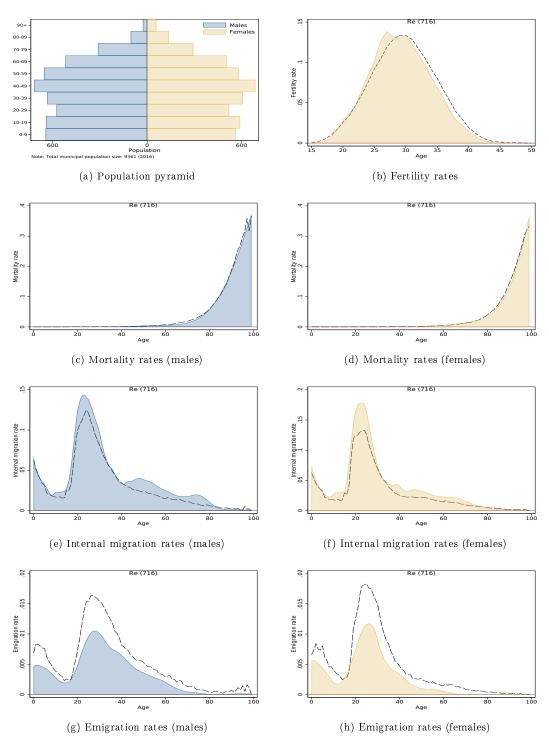
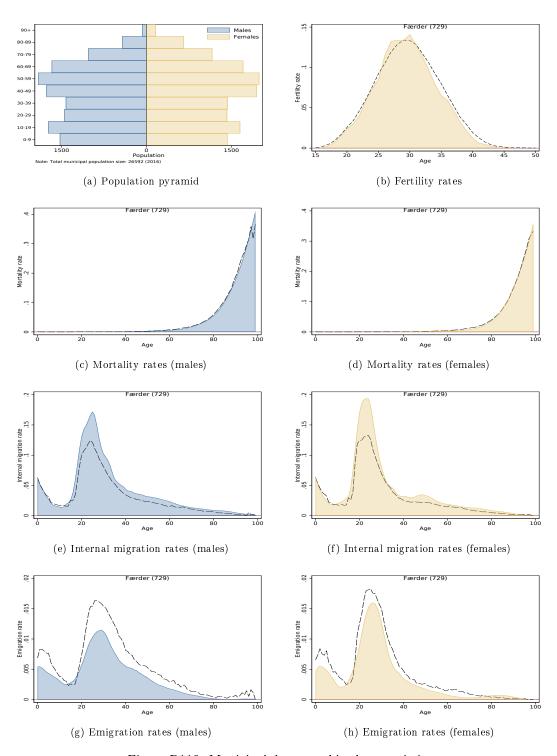


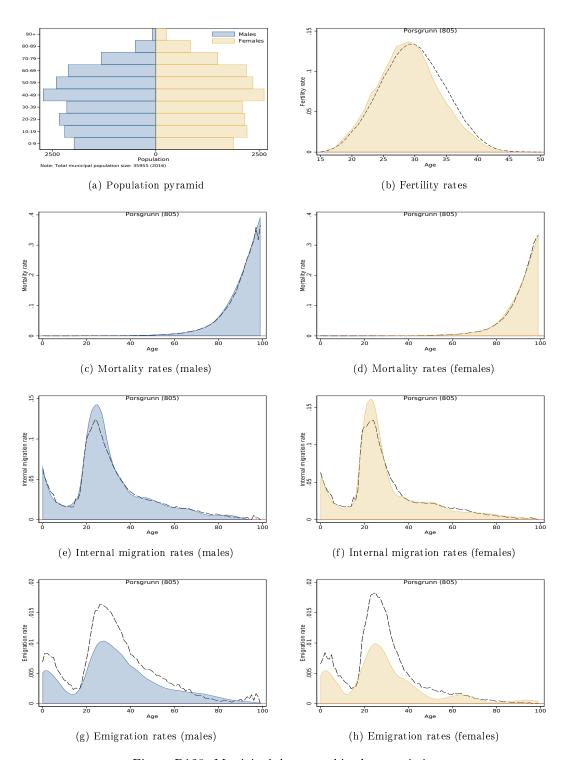
Figure D118: Municipal demographic characteristics

Færder (729)



 $Figure\ D119:\ Municipal\ demographic\ characteristics$

Porsgrunn (805)



 $Figure\ D120:\ Municipal\ demographic\ characteristics$

Skien (806)

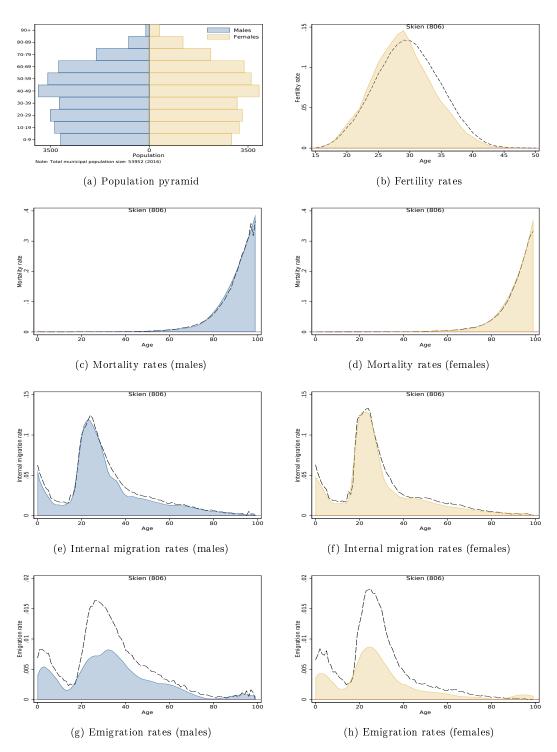


Figure D121: Municipal demographic characteristics

Notodden (807)

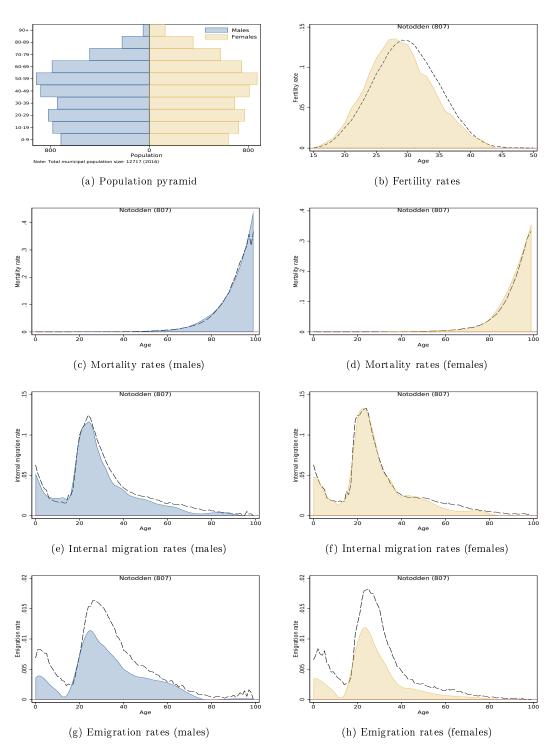


Figure D122: Municipal demographic characteristics

Siljan (811)

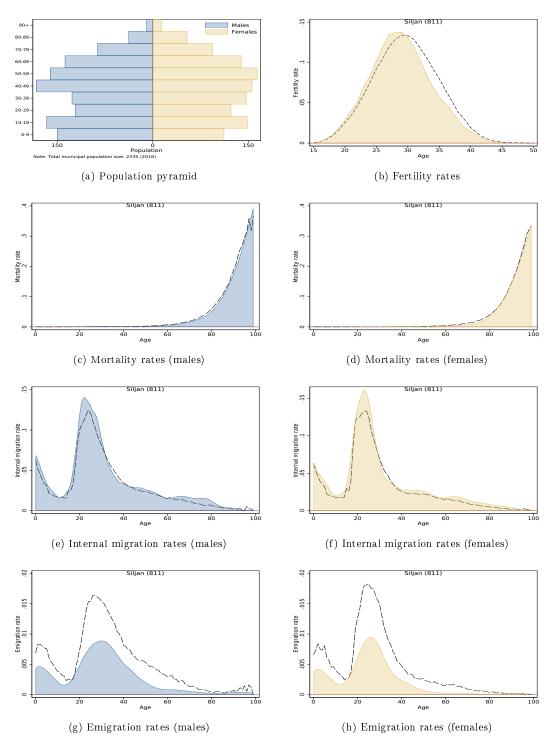


Figure D123: Municipal demographic characteristics

Bamble (814)

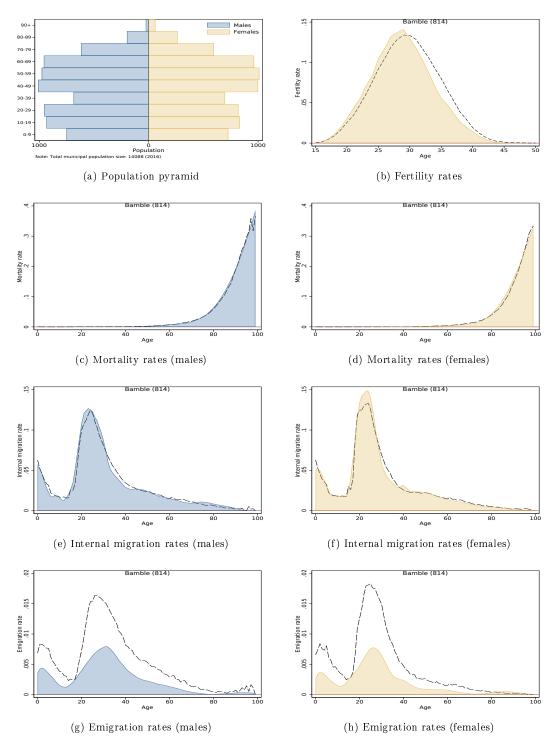


Figure D124: Municipal demographic characteristics

Kragerø(815)

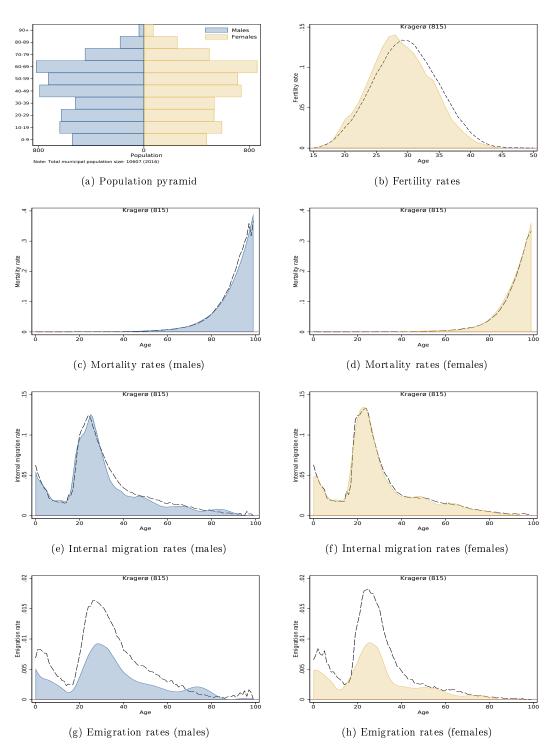


Figure D125: Municipal demographic characteristics

Drangedal (817)

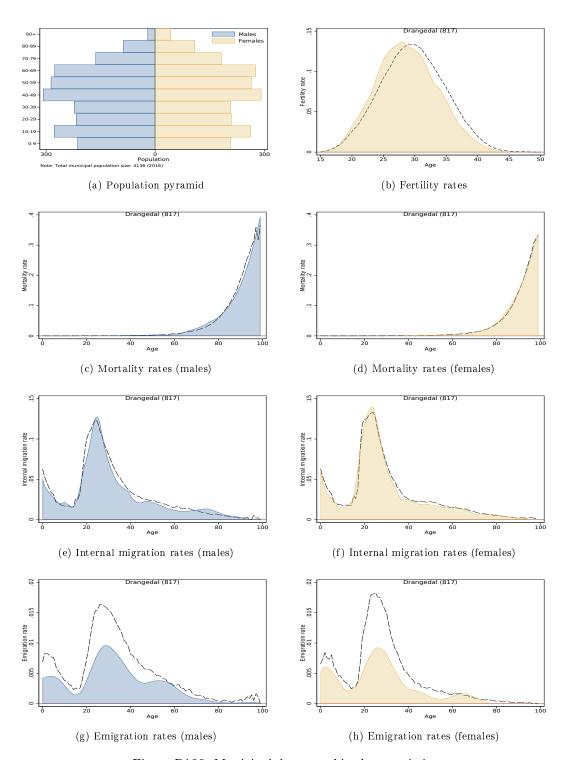


Figure D126: Municipal demographic characteristics

Nome (819)

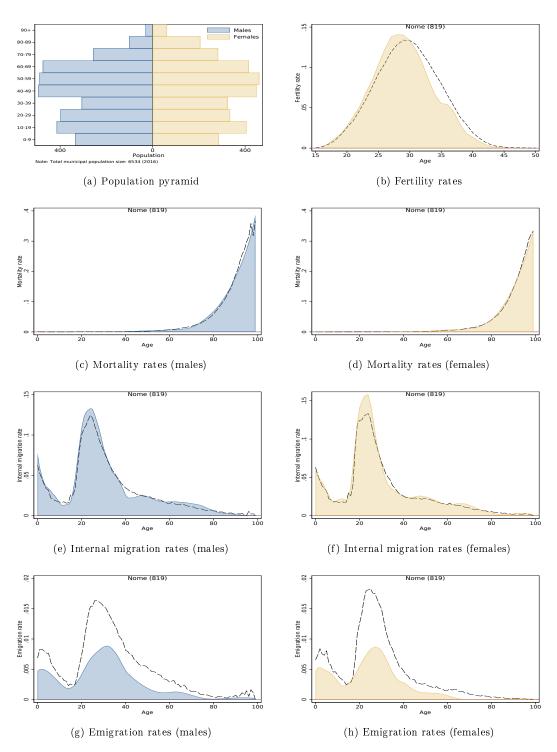
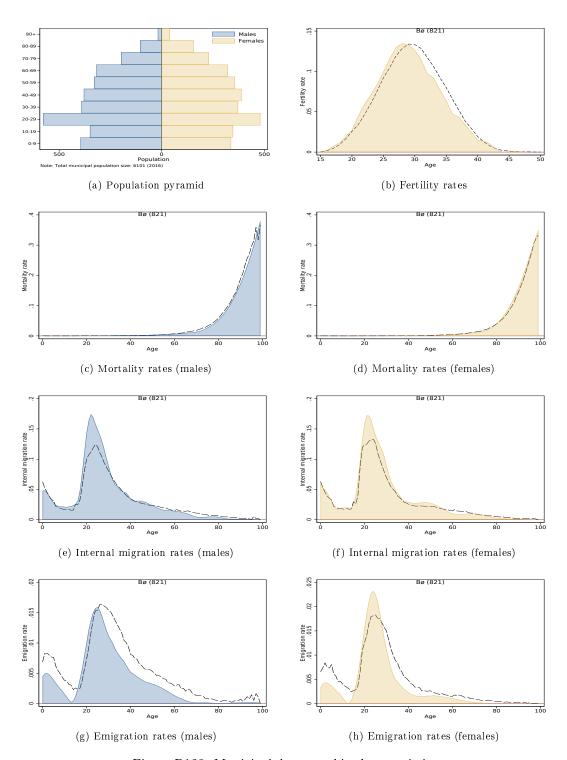


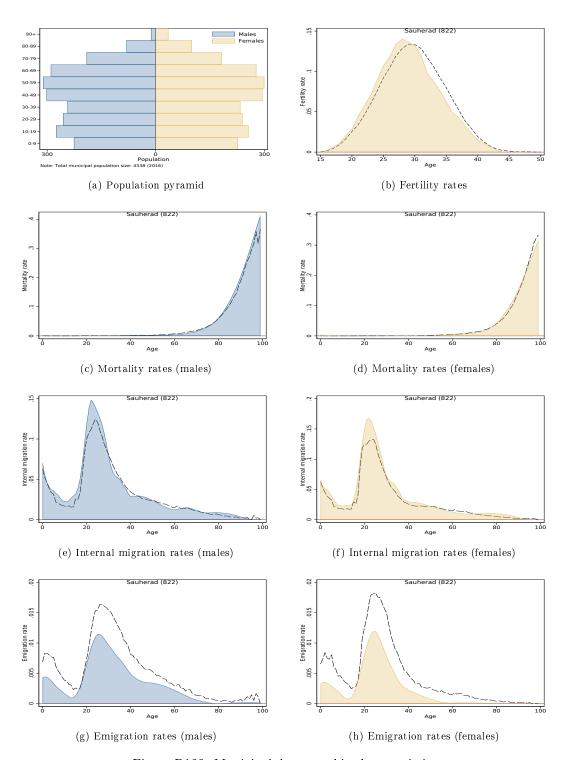
Figure D127: Municipal demographic characteristics

Bø(821)



 $Figure\ D128:\ Municipal\ demographic\ characteristics$

Sauherad (822)



 $Figure\ D129:\ Municipal\ demographic\ characteristics$

Tinn (826)

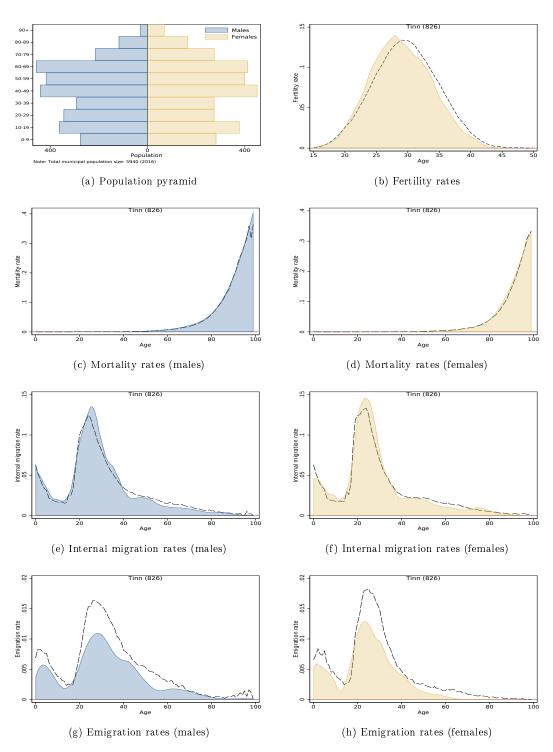


Figure D130: Municipal demographic characteristics

Hjartdal (827)

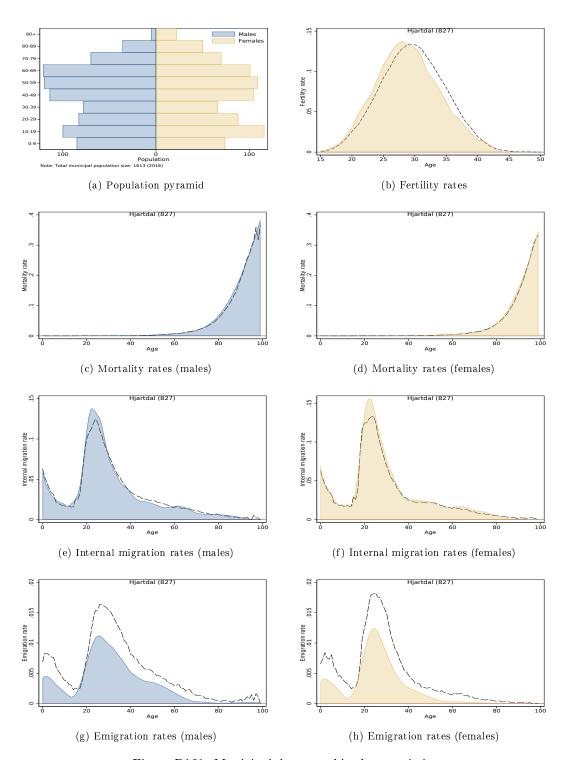


Figure D131: Municipal demographic characteristics

Seljord (828)

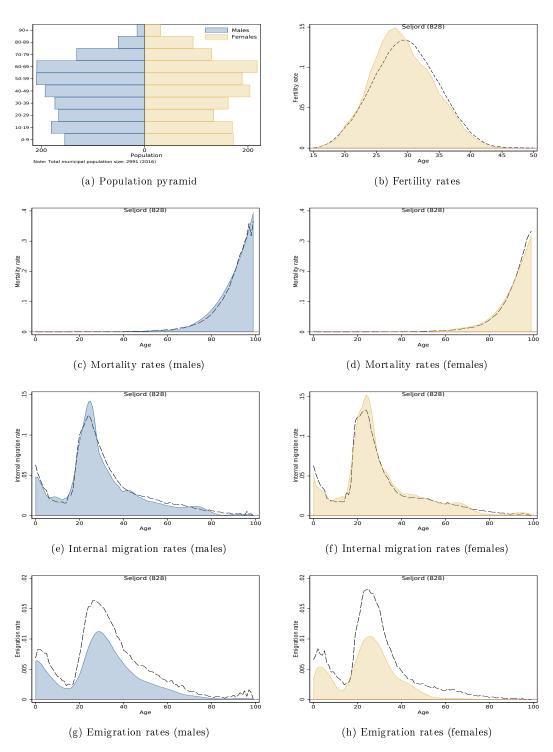


Figure D132: Municipal demographic characteristics

Kviteseid (829)

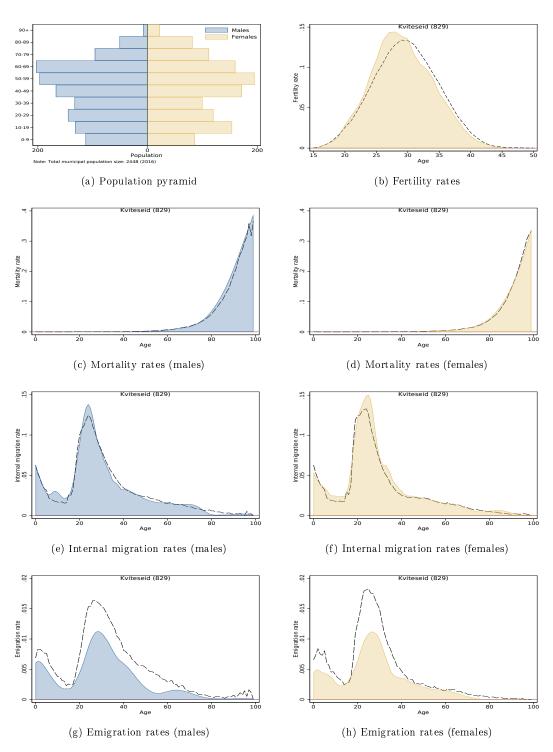


Figure D133: Municipal demographic characteristics

Nissedal (830)

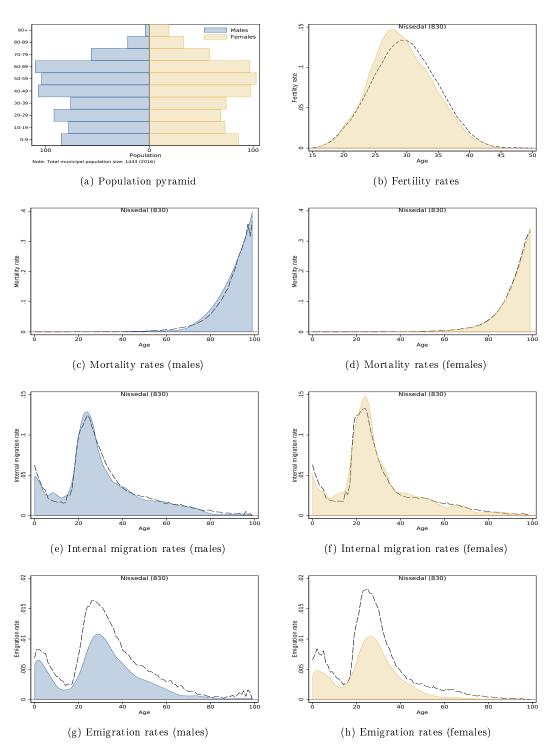


Figure D134: Municipal demographic characteristics

Fyresdal (831)

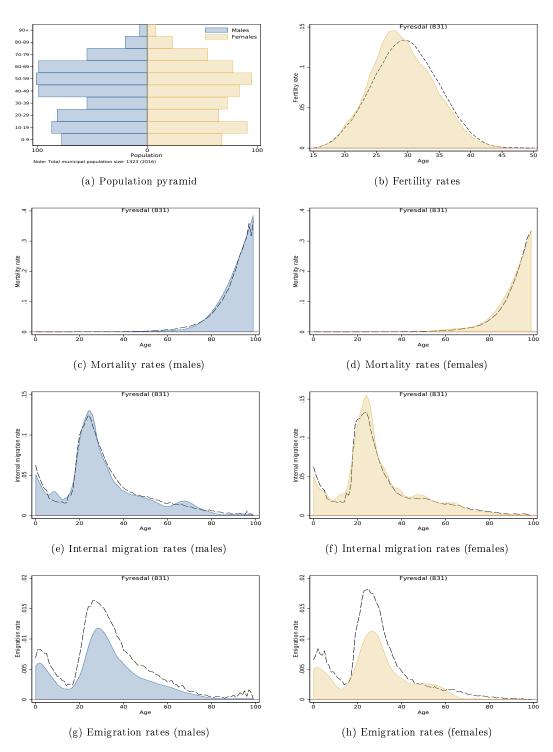


Figure D135: Municipal demographic characteristics

Tokke (833)

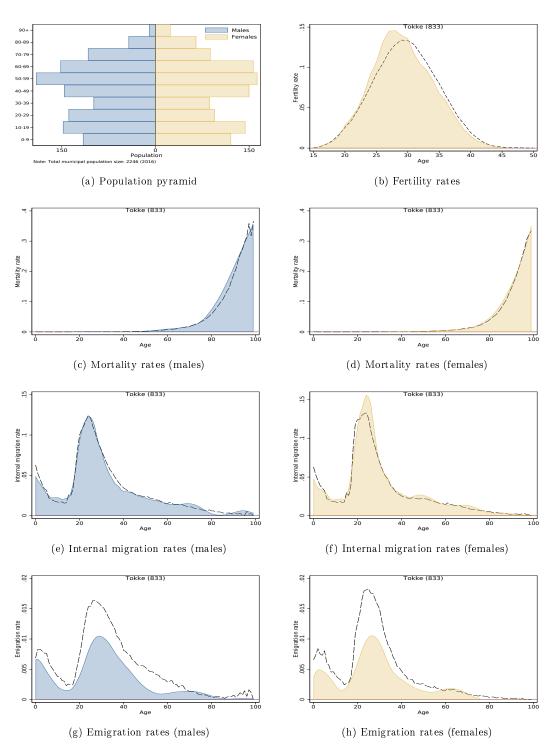
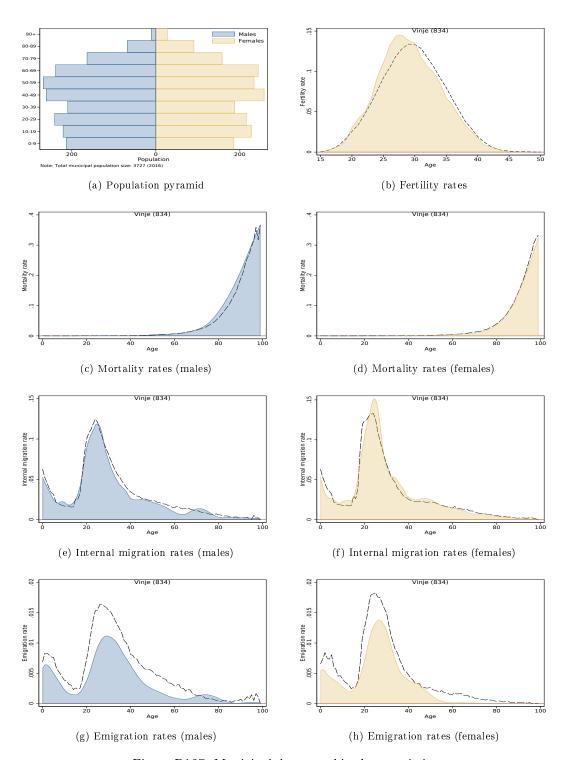


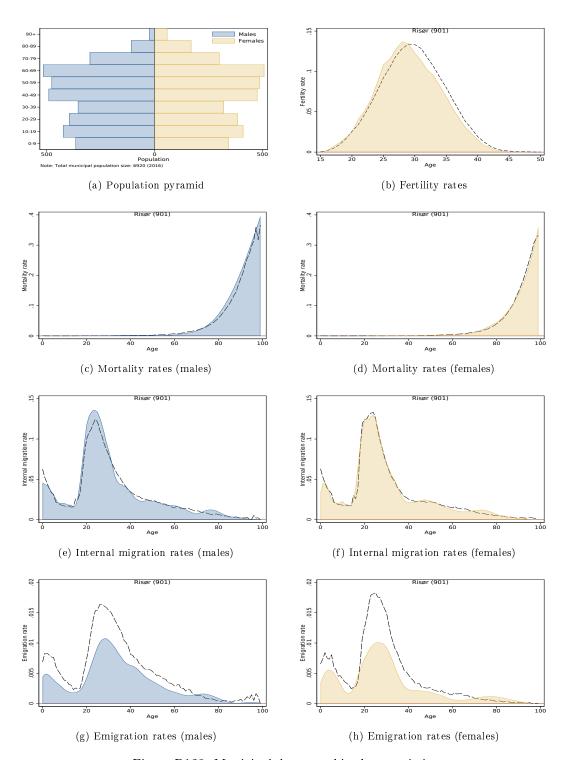
Figure D136: Municipal demographic characteristics

Vinje (834)



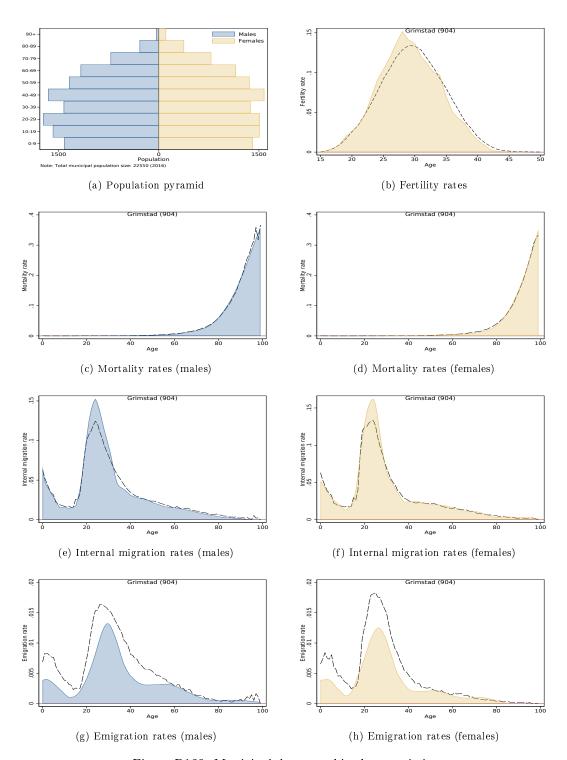
 $Figure\ D137:\ Municipal\ demographic\ characteristics$

Risør (901)



 $Figure\ D138:\ Municipal\ demographic\ characteristics$

Grimstad (904)



 $Figure\ D139:\ Municipal\ demographic\ characteristics$

Arendal (906)

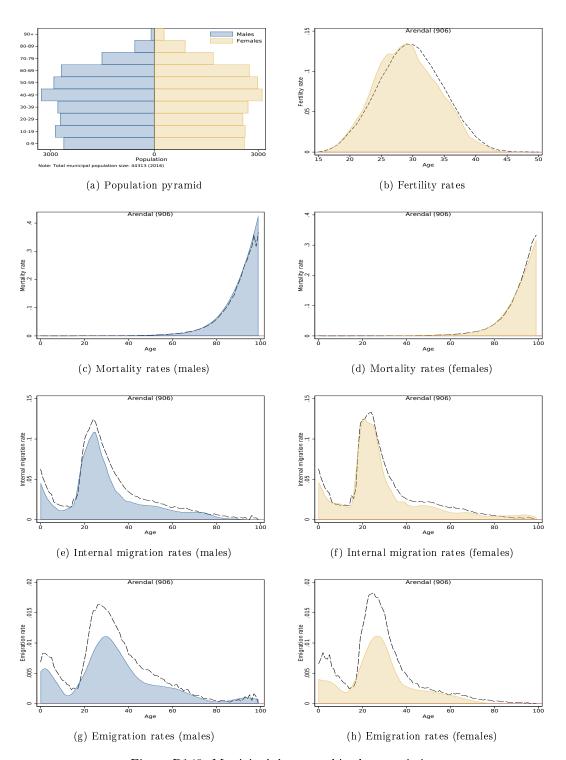


Figure D140: Municipal demographic characteristics

Gjerstad (911)

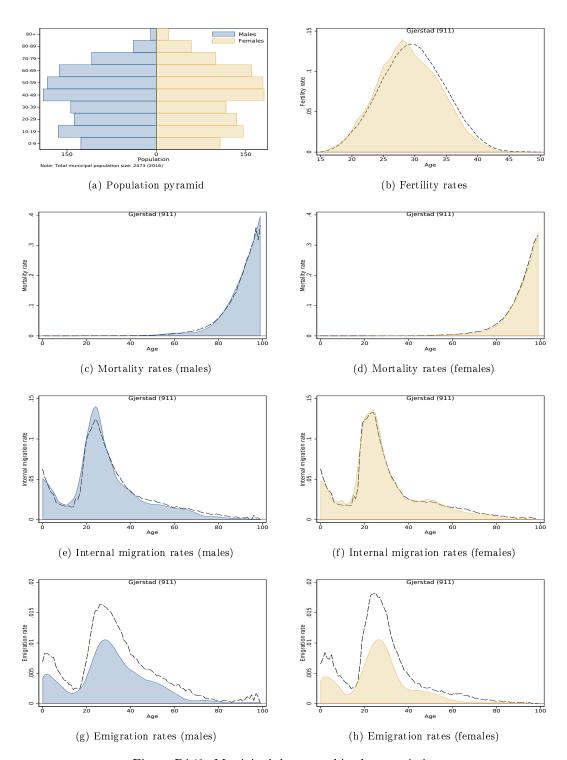


Figure D141: Municipal demographic characteristics

Vegårshei (912)

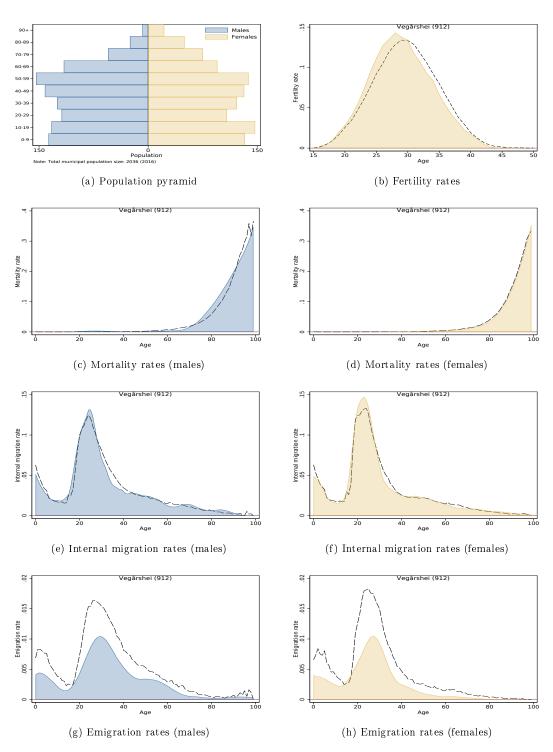


Figure D142: Municipal demographic characteristics

Tvedestrand (914)

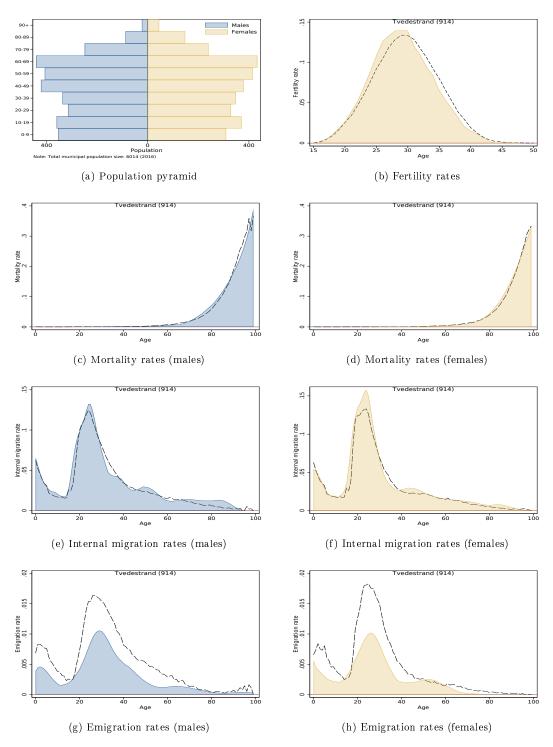


Figure D143: Municipal demographic characteristics

Froland (919)

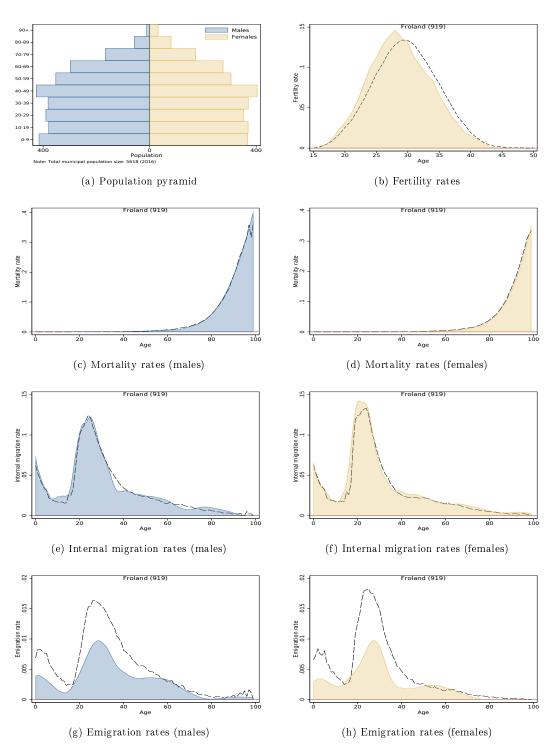


Figure D144: Municipal demographic characteristics

Lillesand (926)

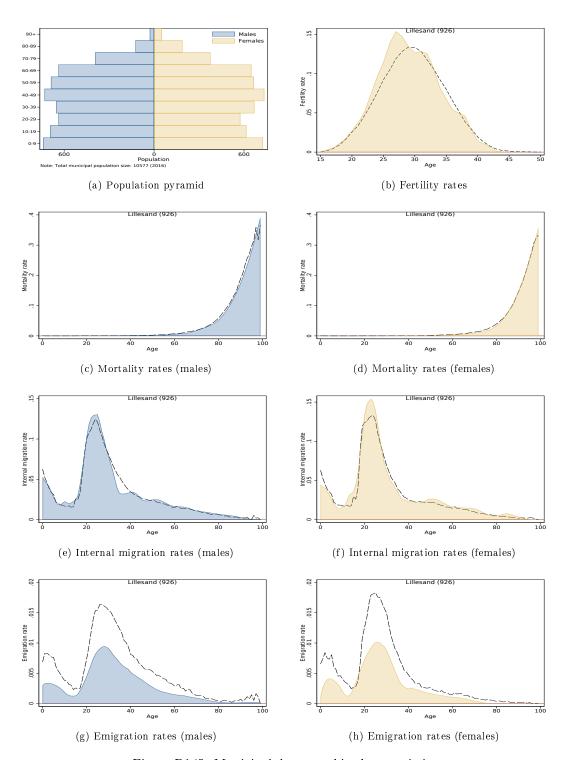


Figure D145: Municipal demographic characteristics

Birkenes (928)

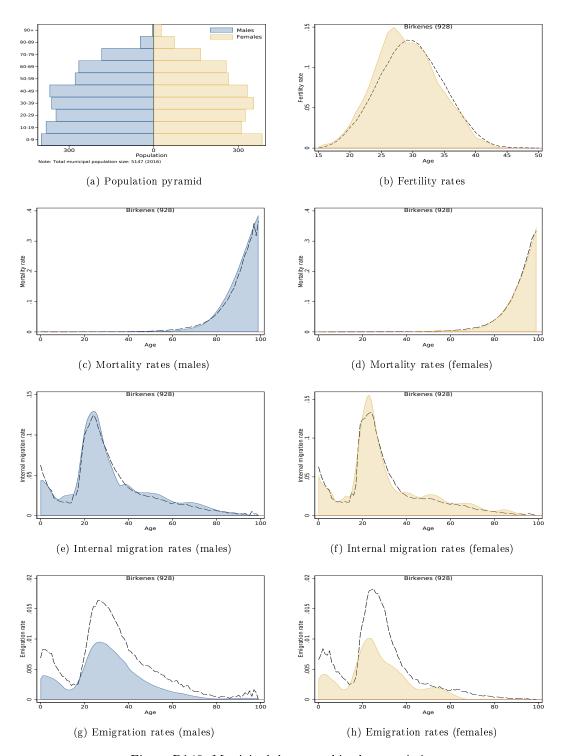


Figure D146: Municipal demographic characteristics

Åmli (929)

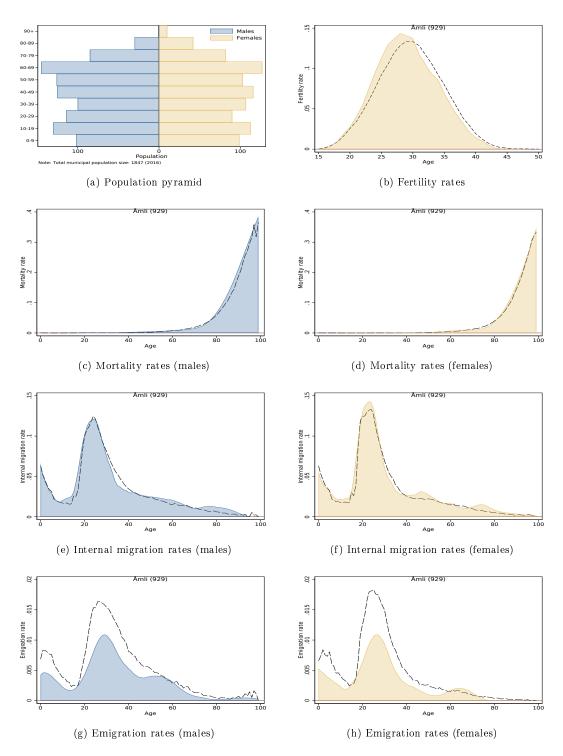


Figure D147: Municipal demographic characteristics

Iveland (935)

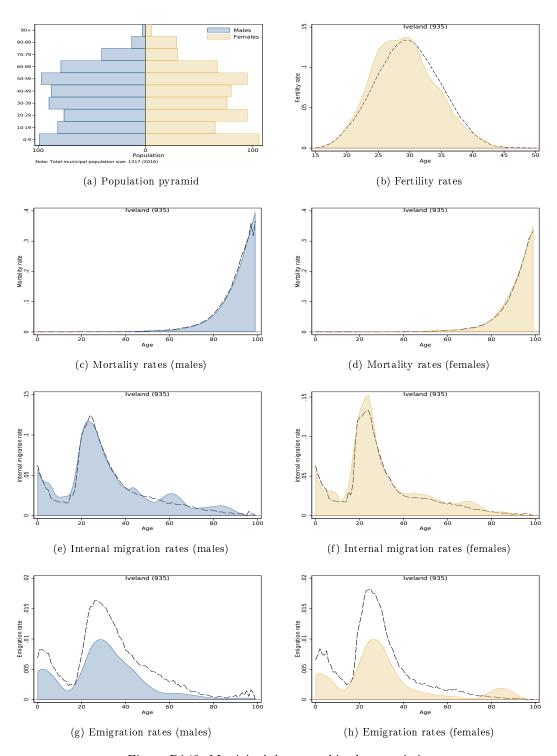


Figure D148: Municipal demographic characteristics

Evje og Hornnes (937)

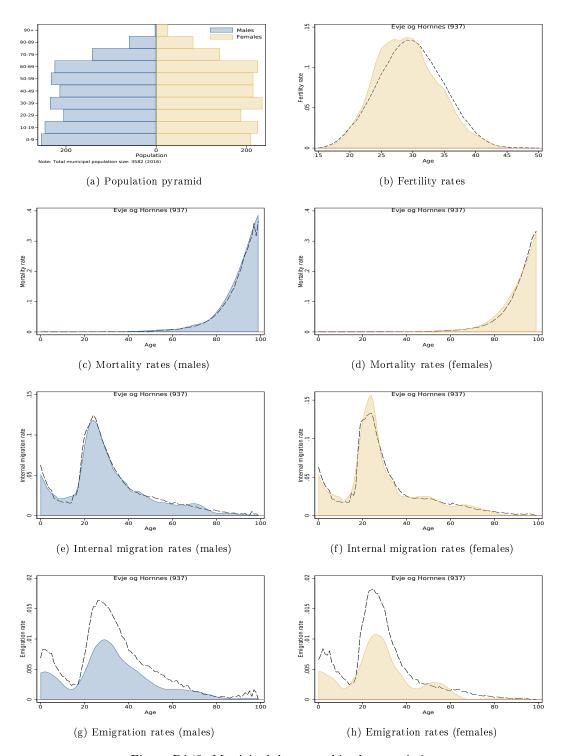


Figure D149: Municipal demographic characteristics

Bygland (938)

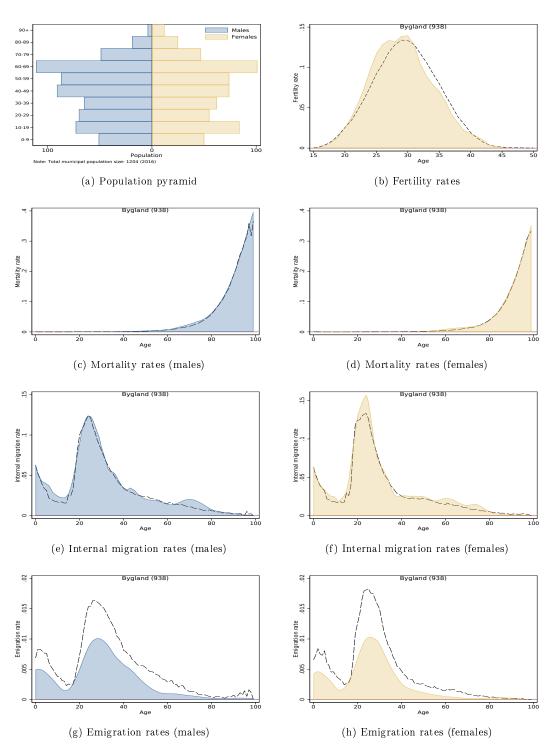


Figure D150: Municipal demographic characteristics

Valle (940)

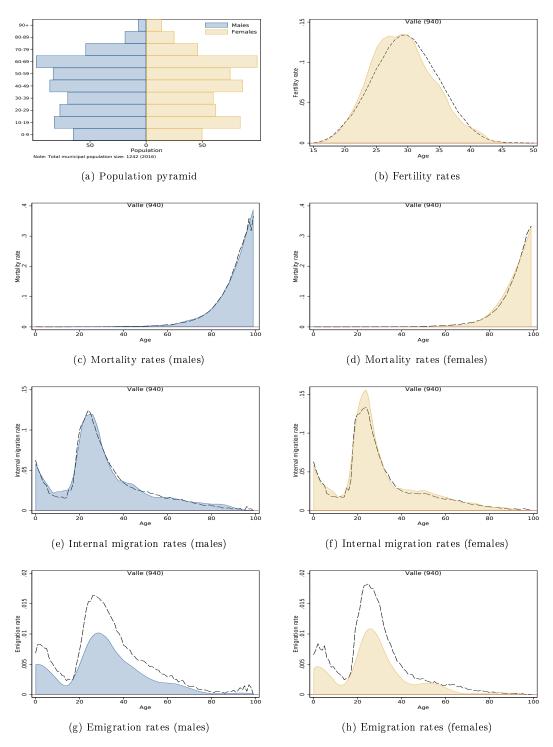


Figure D151: Municipal demographic characteristics

Bykle (941)

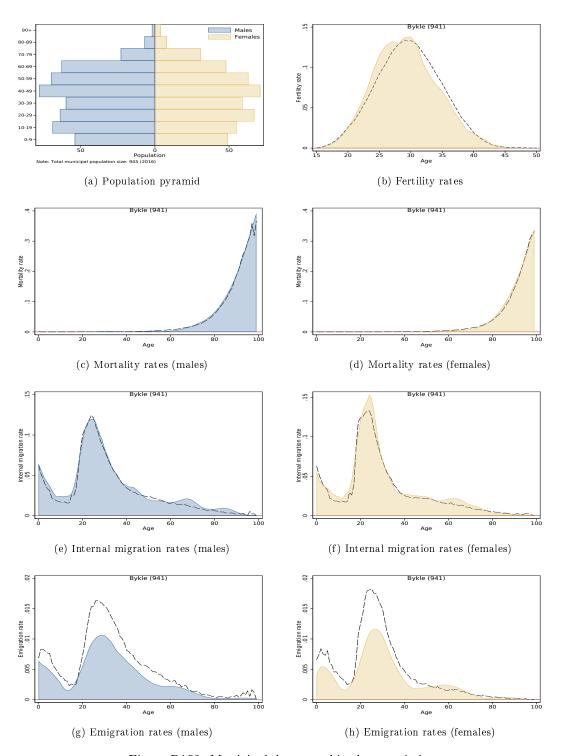
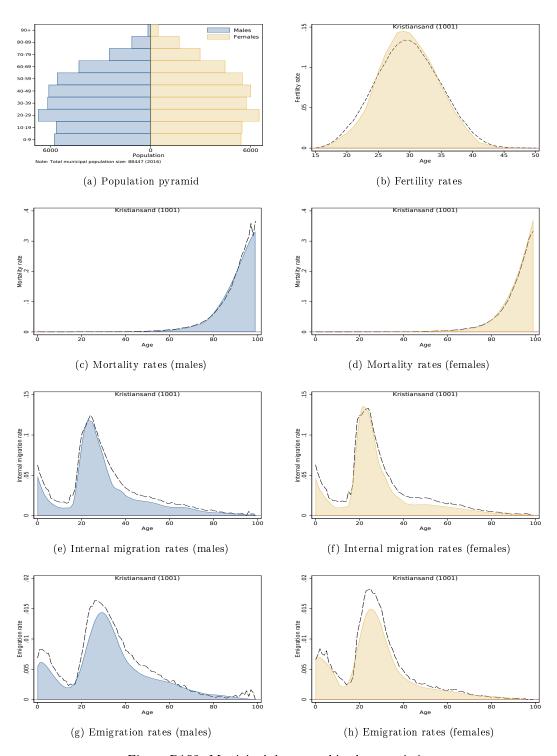


Figure D152: Municipal demographic characteristics

Kristiansand (1001)



 $Figure\ D153:\ Municipal\ demographic\ characteristics$

Mandal (1002)

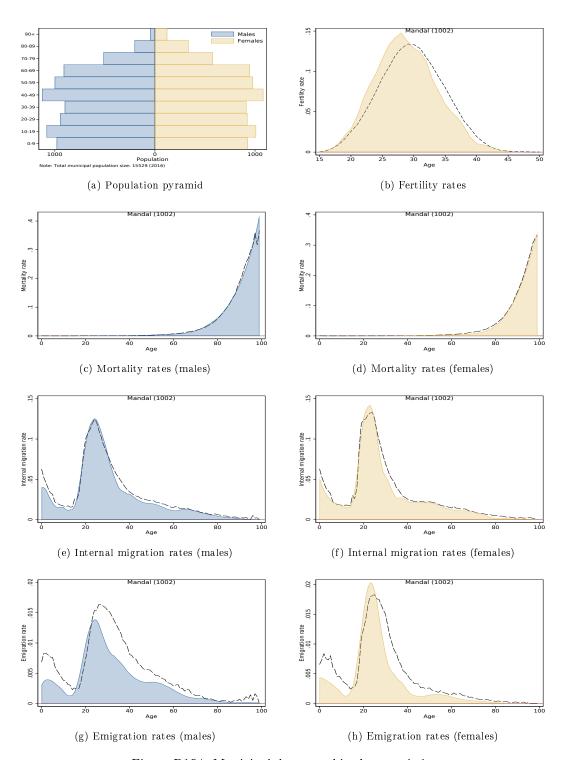


Figure D154: Municipal demographic characteristics

Farsund (1003)

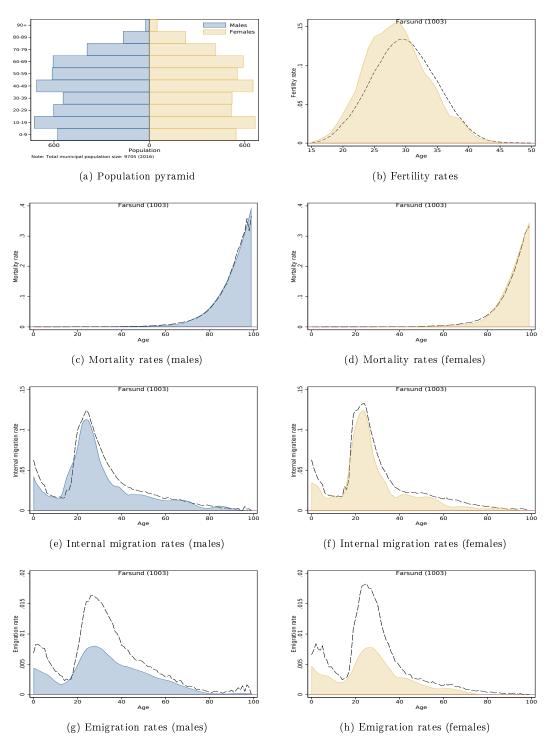
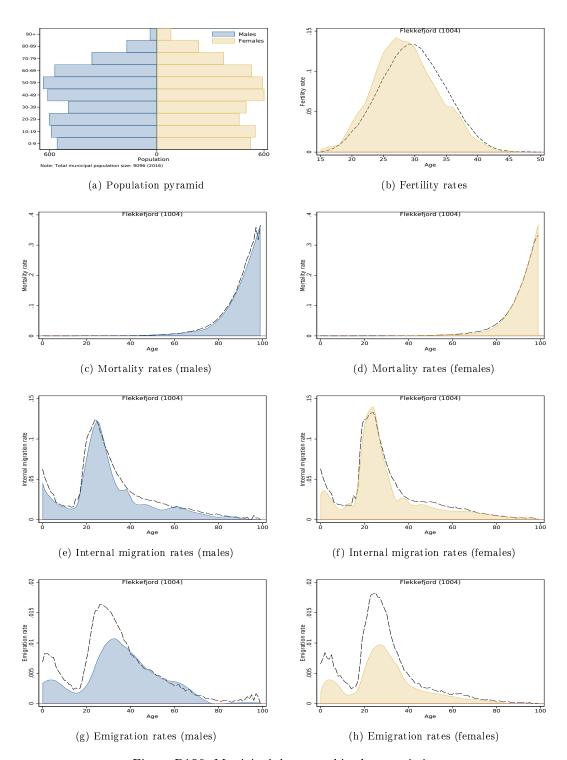


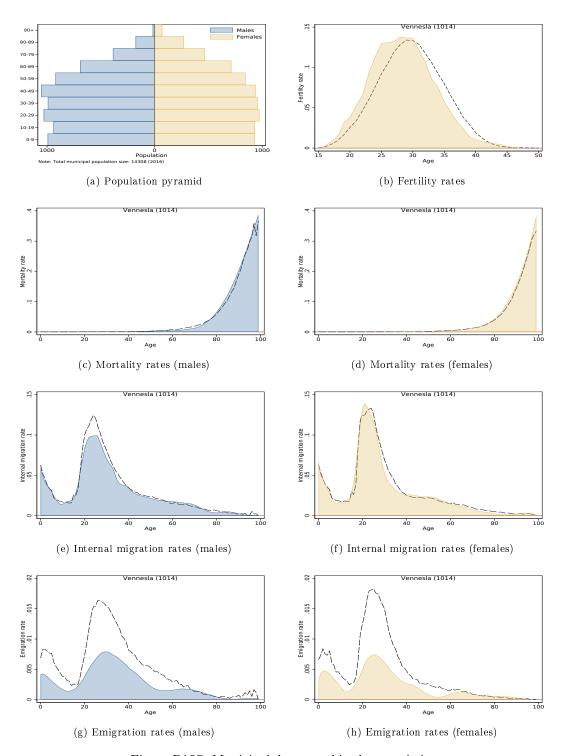
Figure D155: Municipal demographic characteristics

Flekkefjord (1004)



 $Figure\ D156:\ Municipal\ demographic\ characteristics$

Vennesla (1014)



 $Figure\ D157:\ Municipal\ demographic\ characteristics$

Songdalen (1017)

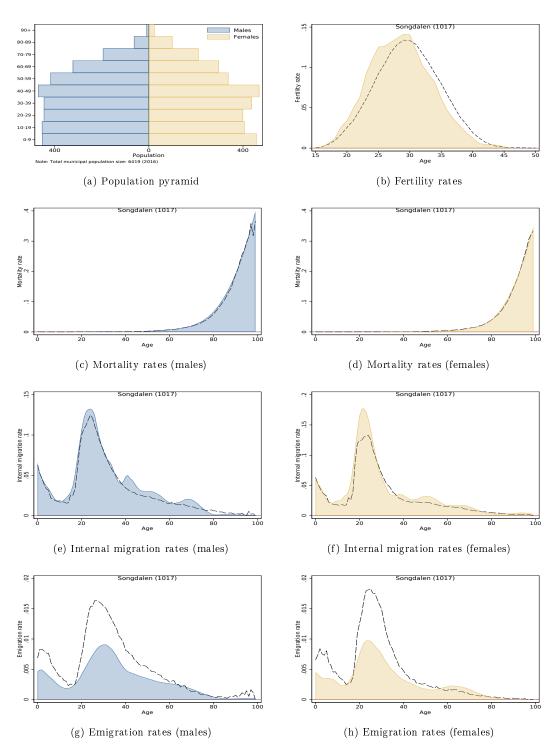


Figure D158: Municipal demographic characteristics

Søgne (1018)

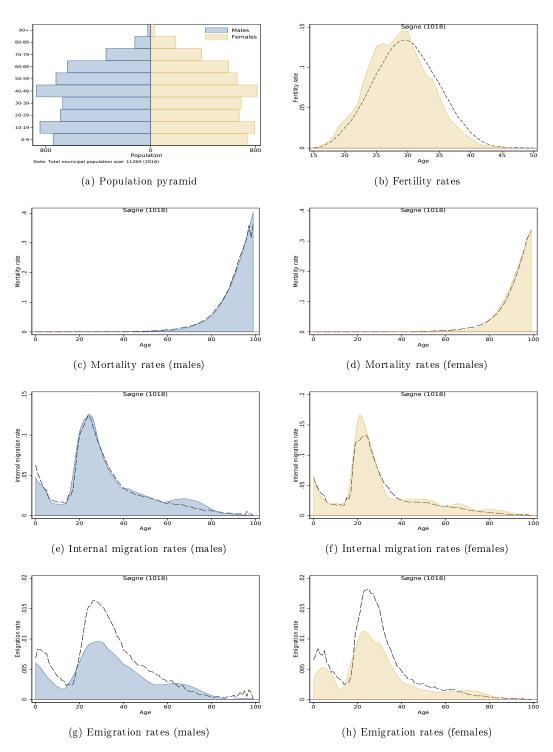


Figure D159: Municipal demographic characteristics

Marnardal (1021)

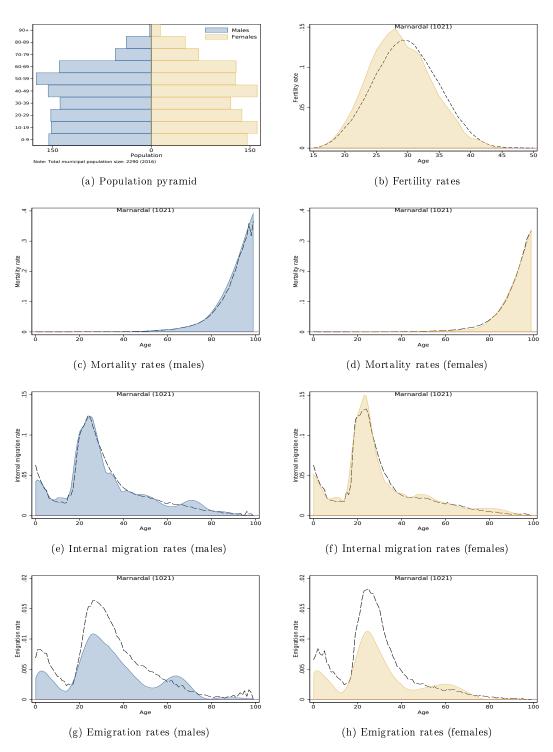


Figure D160: Municipal demographic characteristics

Åseral (1026)

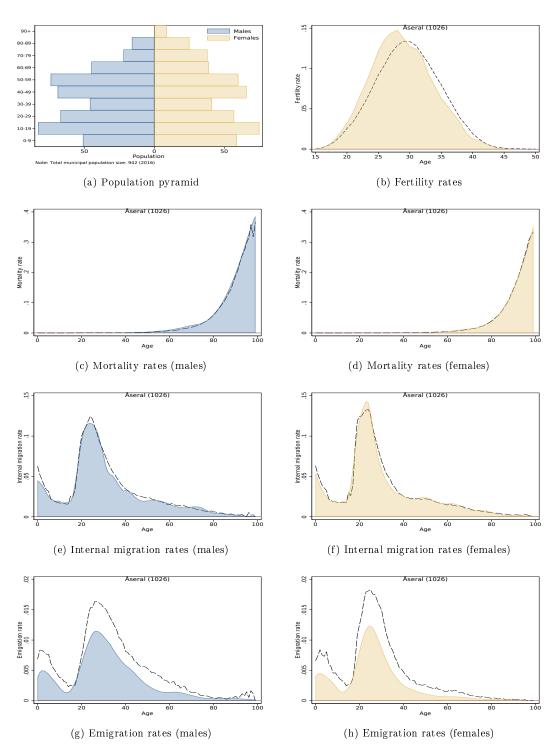


Figure D161: Municipal demographic characteristics

Audnedal (1027)

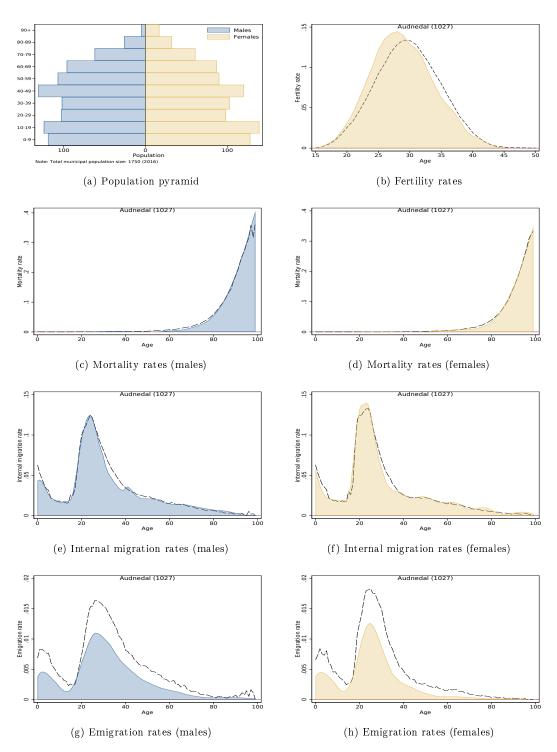


Figure D162: Municipal demographic characteristics

Lindesnes (1029)

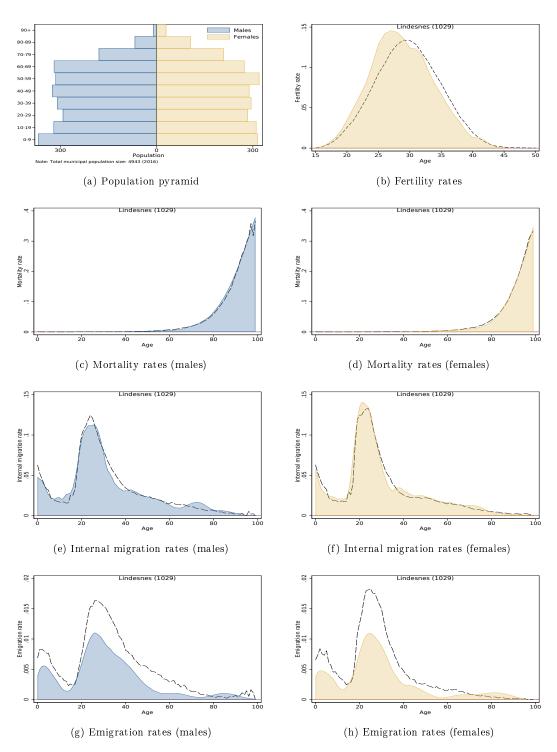


Figure D163: Municipal demographic characteristics

Lyngdal (1032)

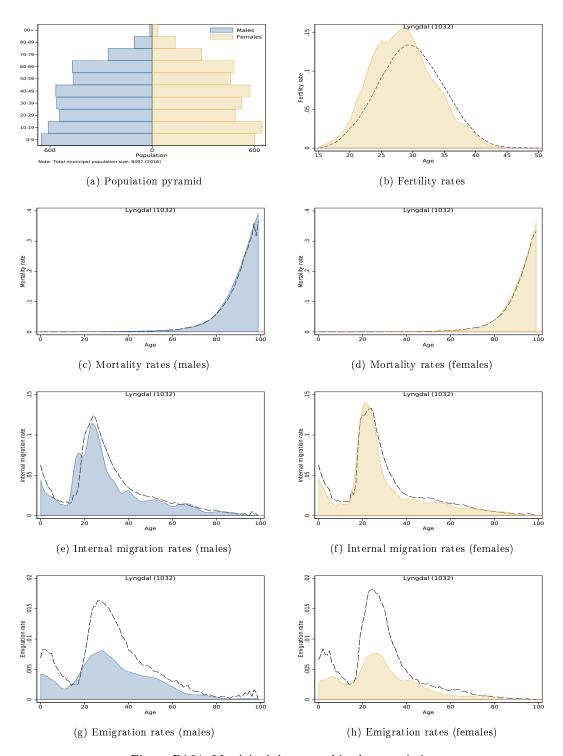


Figure D164: Municipal demographic characteristics

Hægebostad (1034)

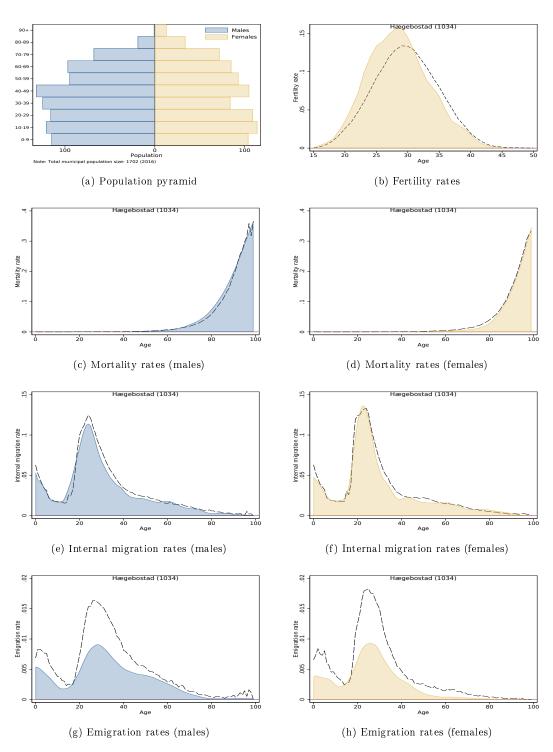


Figure D165: Municipal demographic characteristics

Kvinesdal (1037)

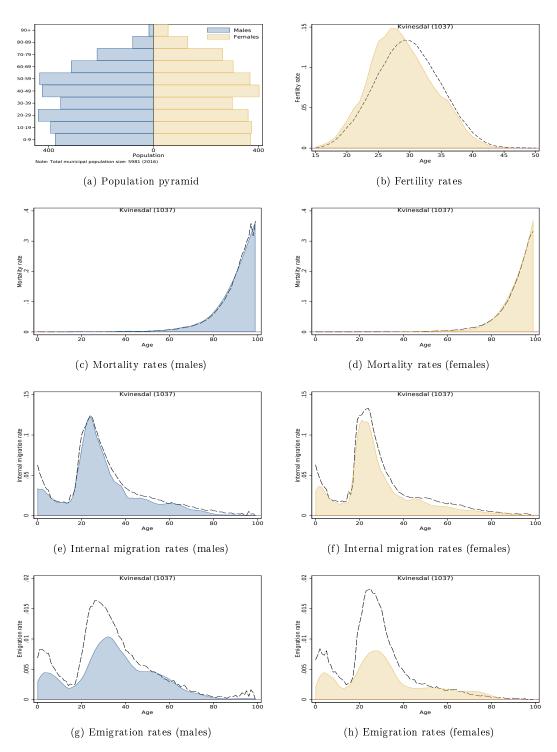


Figure D166: Municipal demographic characteristics

Sirdal (1046)

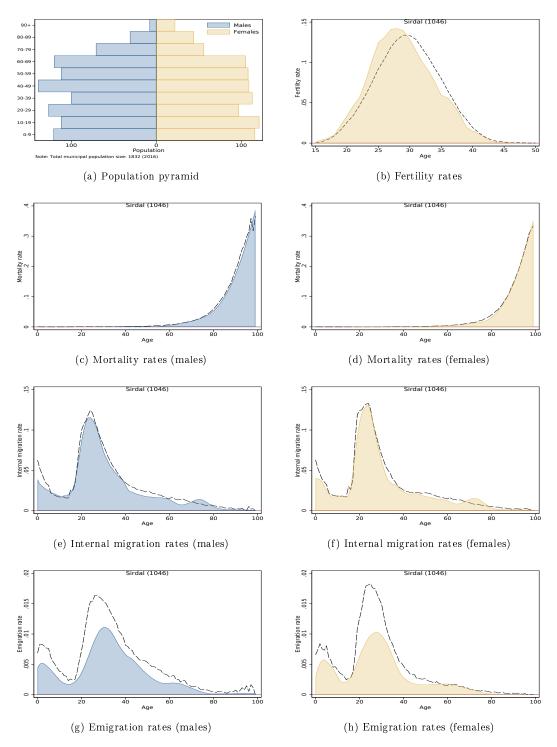


Figure D167: Municipal demographic characteristics

Eigersund (1101)

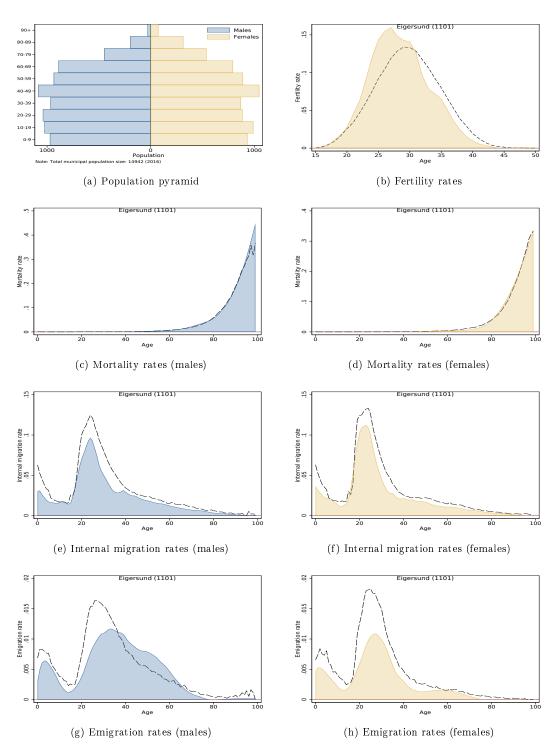
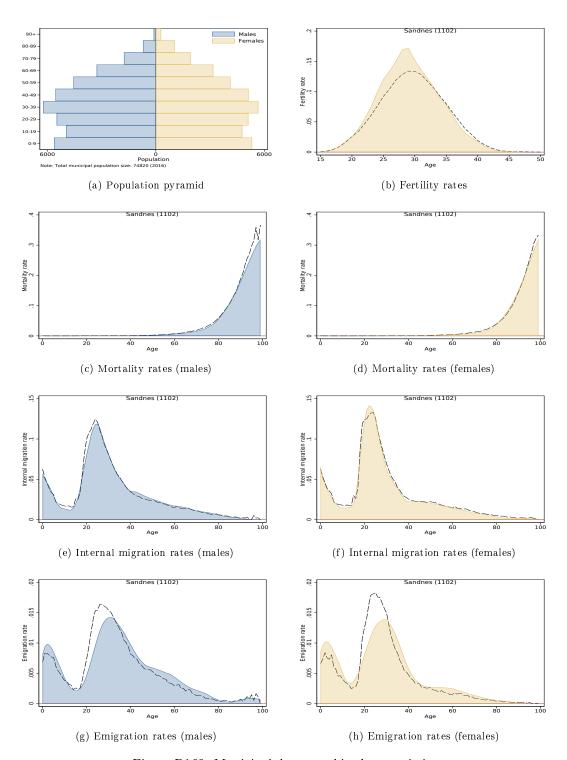


Figure D168: Municipal demographic characteristics

Sandnes (1102)



 $Figure\ D169:\ Municipal\ demographic\ characteristics$

Stavanger (1103)

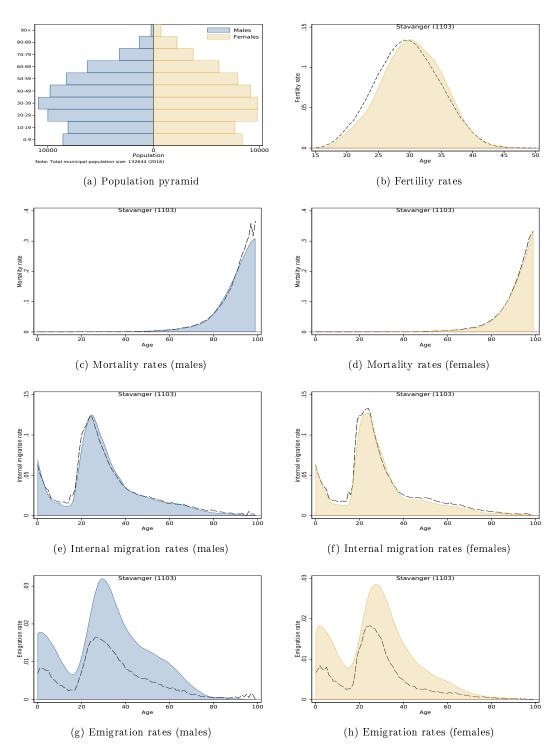


Figure D170: Municipal demographic characteristics

Haugesund (1106)

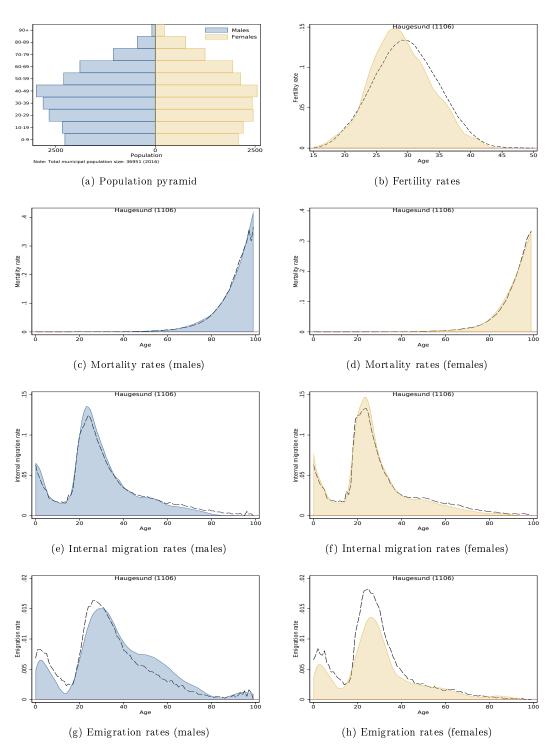


Figure D171: Municipal demographic characteristics

Sokndal (1111)

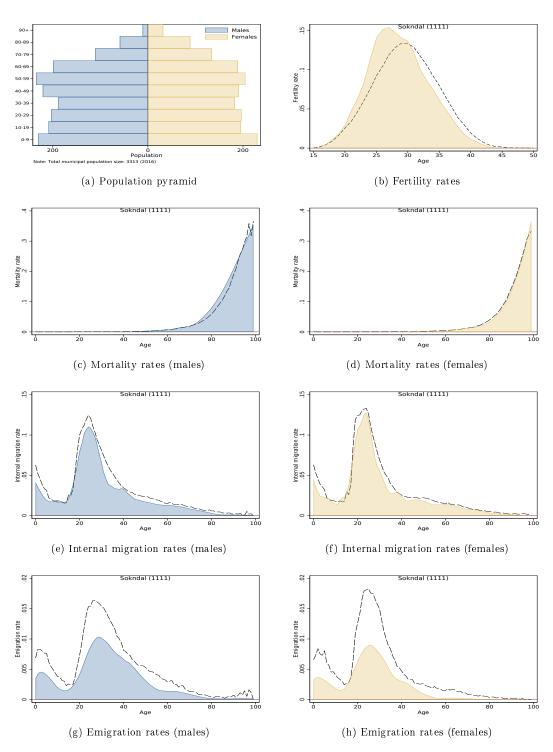


Figure D172: Municipal demographic characteristics

Lund (1112)

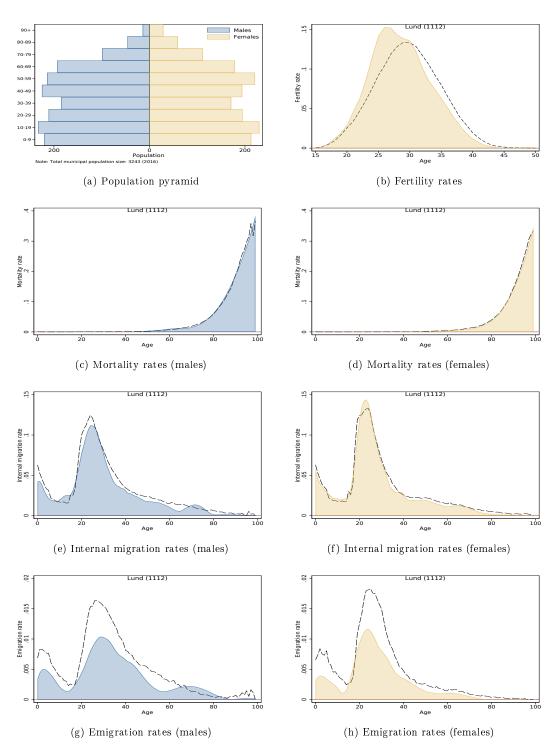


Figure D173: Municipal demographic characteristics

Bjerkreim (1114)

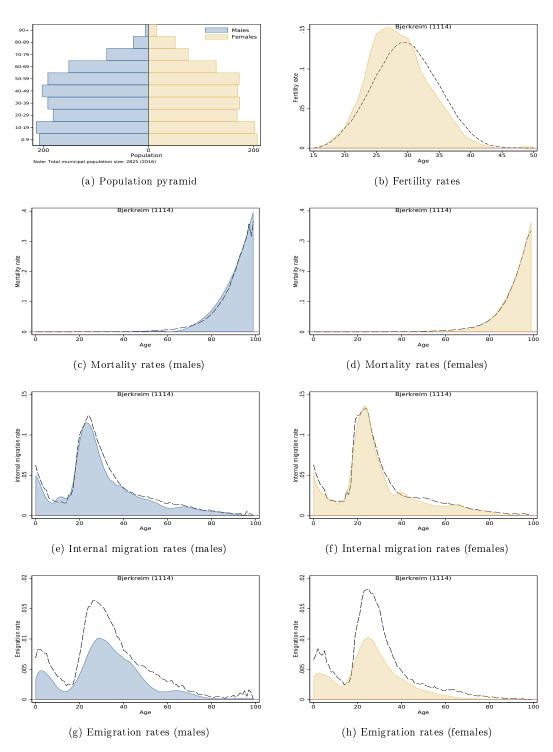


Figure D174: Municipal demographic characteristics

Hå(1119)

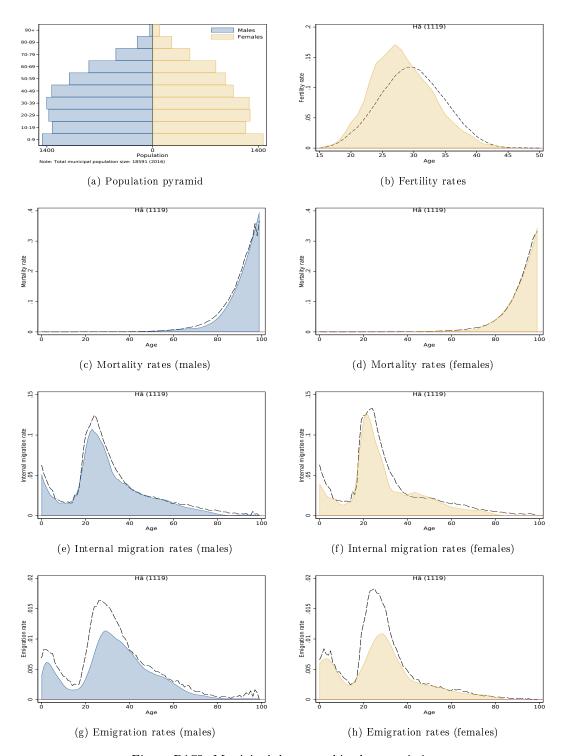


Figure D175: Municipal demographic characteristics

Klepp (1120)

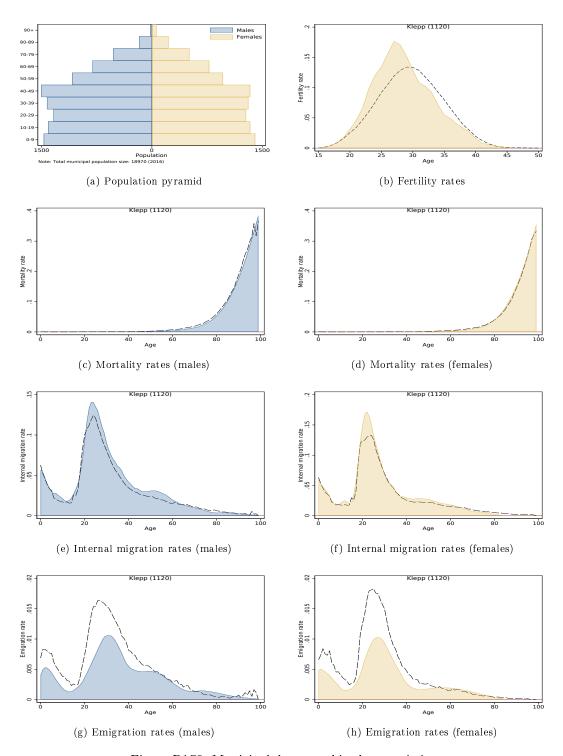


Figure D176: Municipal demographic characteristics

Time (1121)

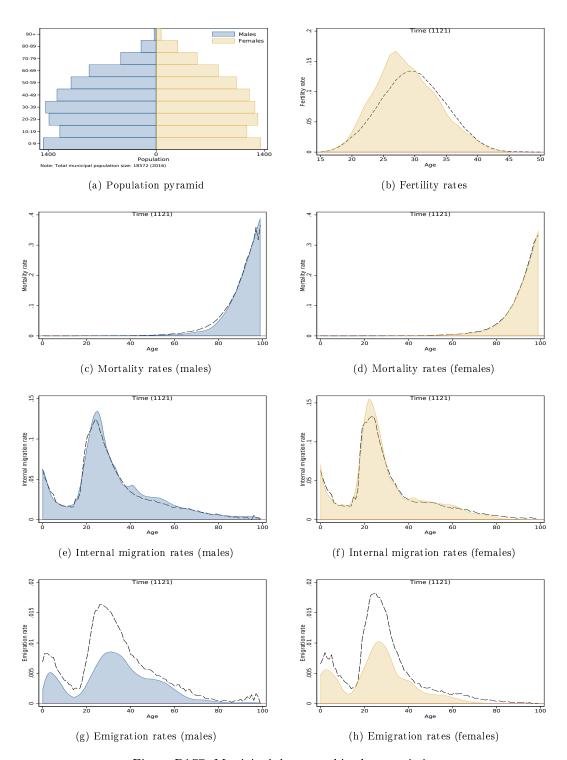


Figure D177: Municipal demographic characteristics

Gjesdal (1122)

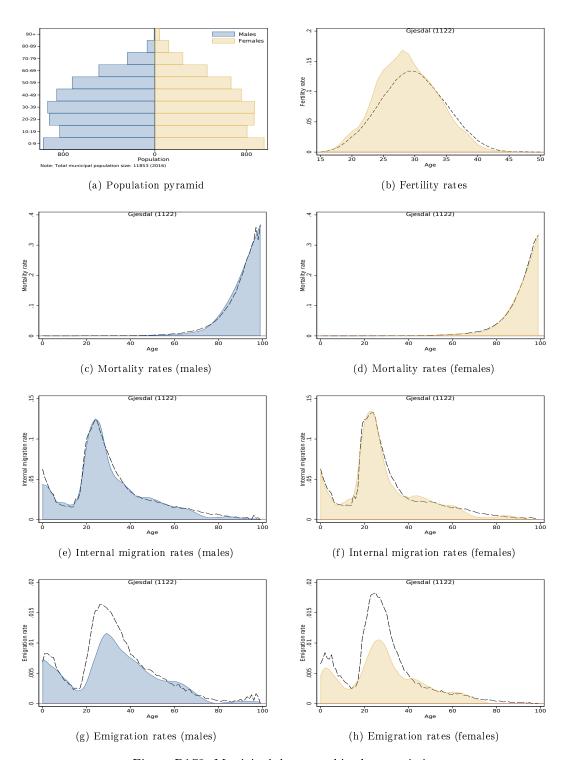


Figure D178: Municipal demographic characteristics

Sola (1124)

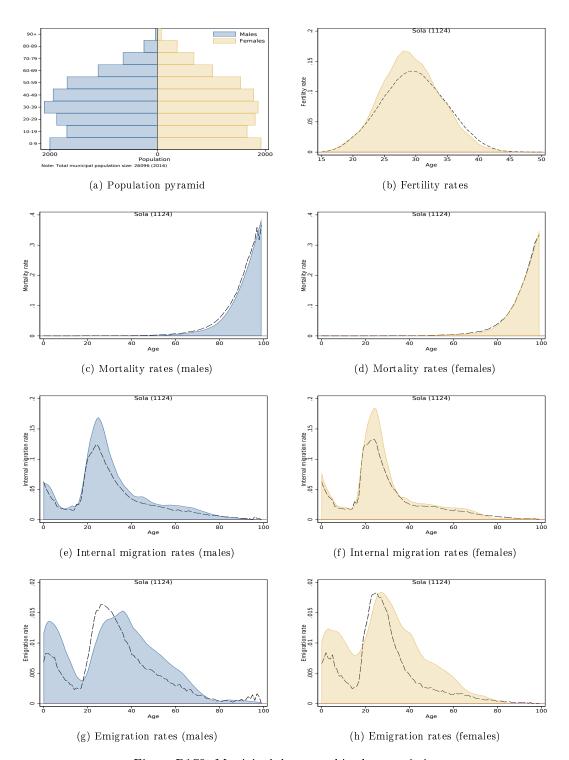
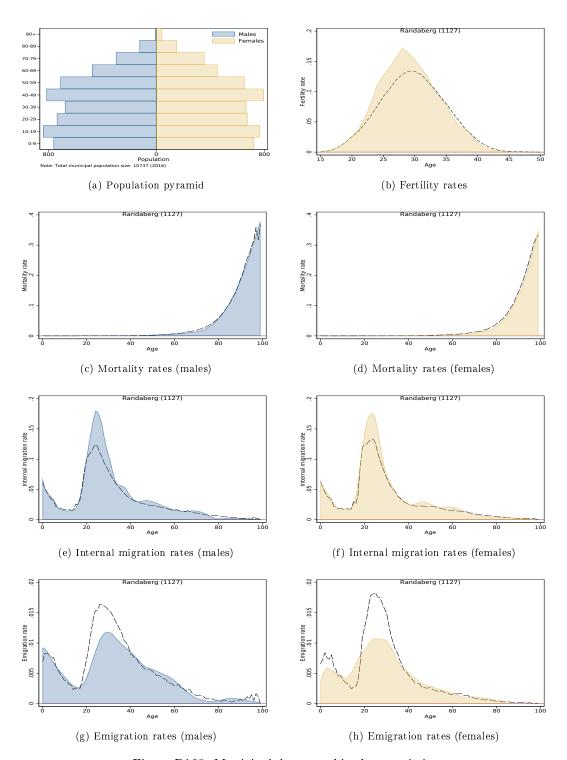


Figure D179: Municipal demographic characteristics

Randaberg (1127)



 $Figure\ D180:\ Municipal\ demographic\ characteristics$

Forsand (1129)

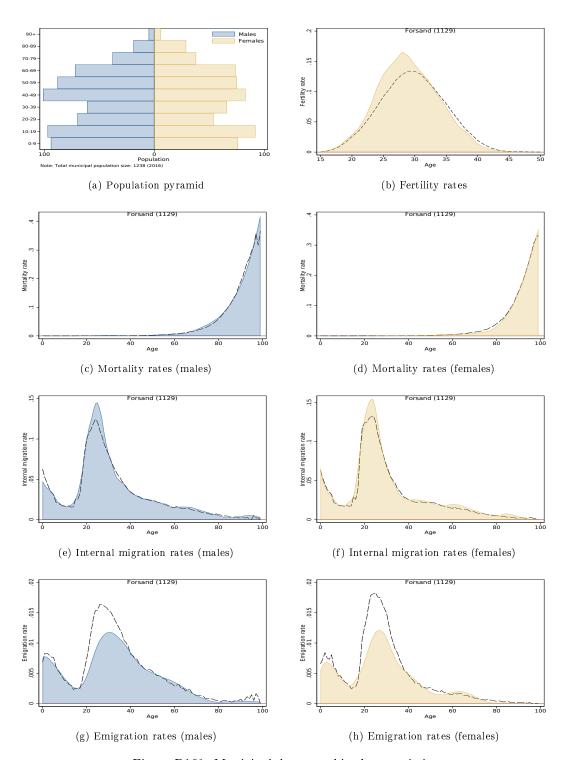


Figure D181: Municipal demographic characteristics

Strand (1130)

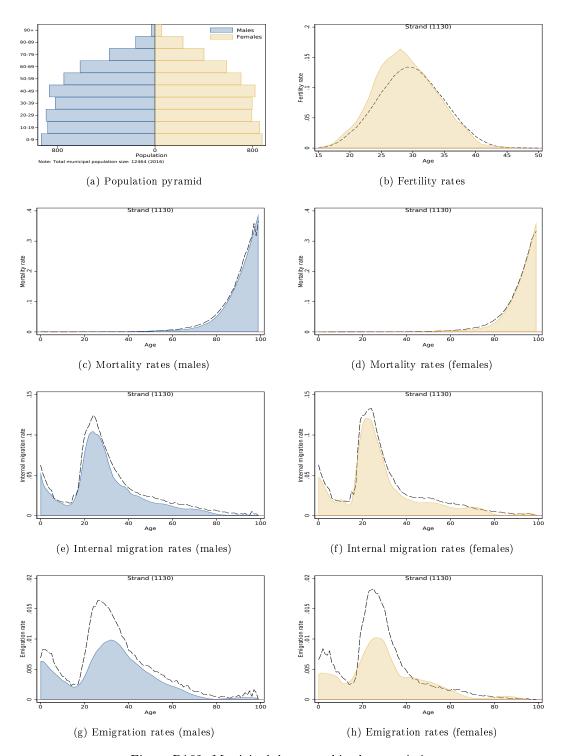


Figure D182: Municipal demographic characteristics

Hjelmeland (1133)

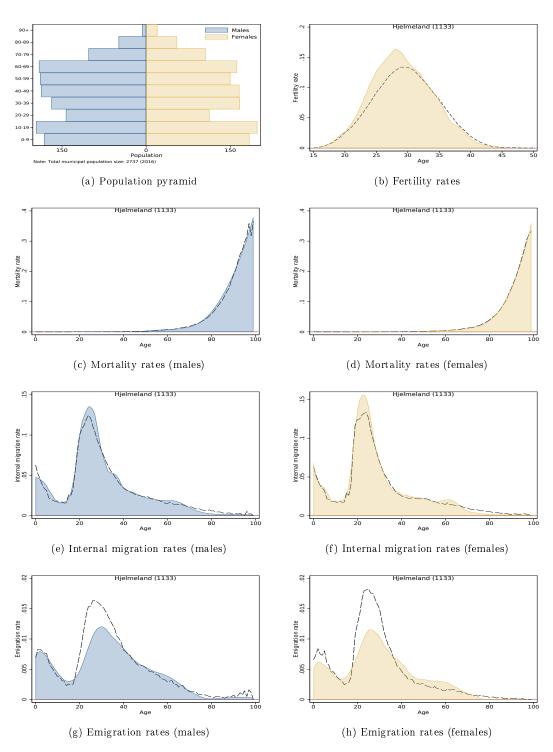


Figure D183: Municipal demographic characteristics

Suldal (1134)

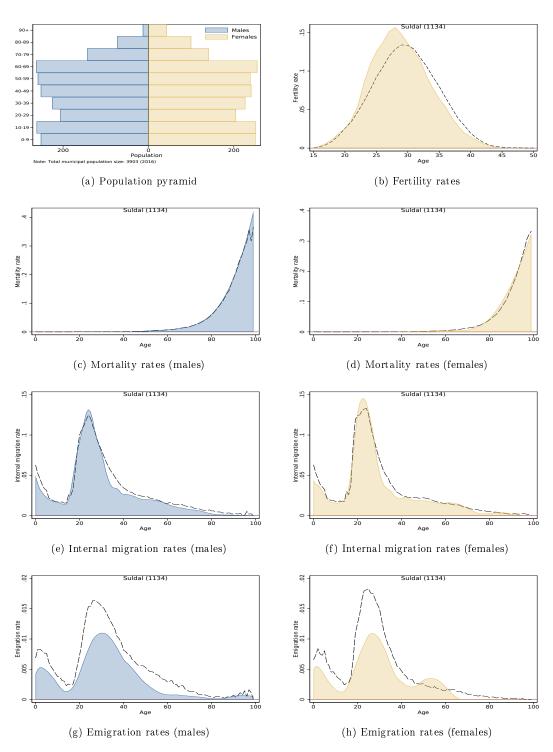
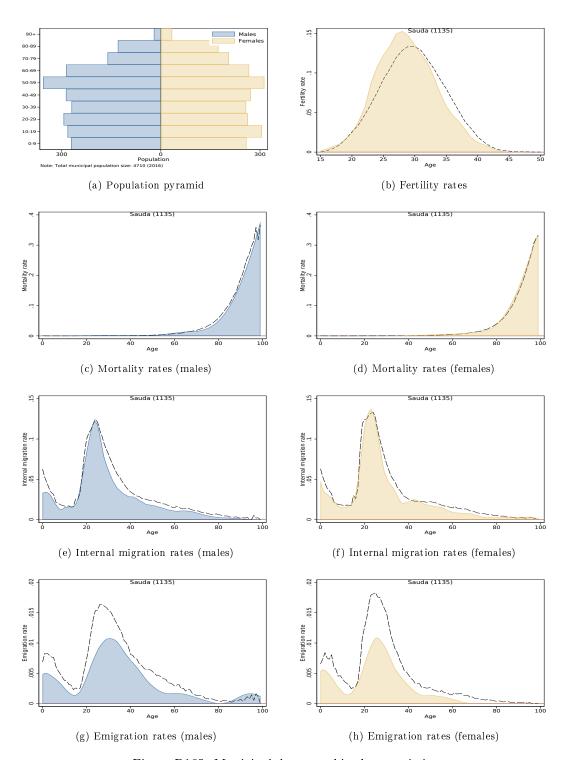


Figure D184: Municipal demographic characteristics

Sauda (1135)



 $Figure\ D185:\ Municipal\ demographic\ characteristics$

Finnøy (1141)

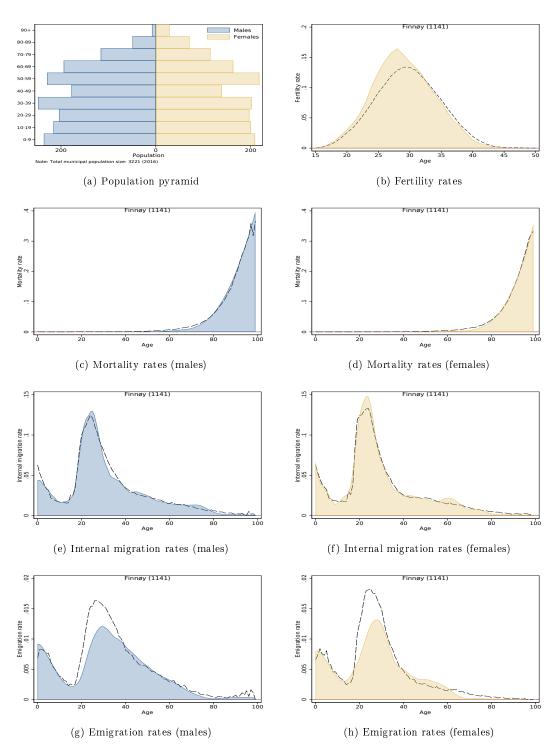


Figure D186: Municipal demographic characteristics

Rennesøy (1142)

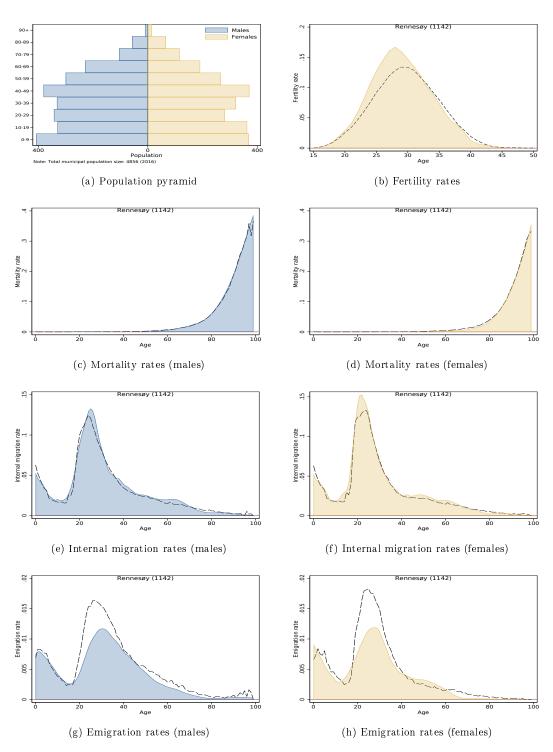


Figure D187: Municipal demographic characteristics

Kvitsøy (1144)

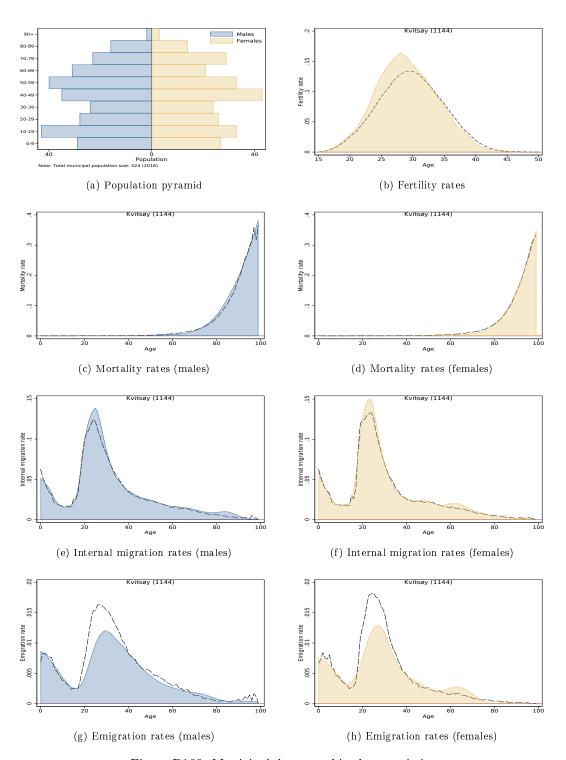


Figure D188: Municipal demographic characteristics

Bokn (1145)

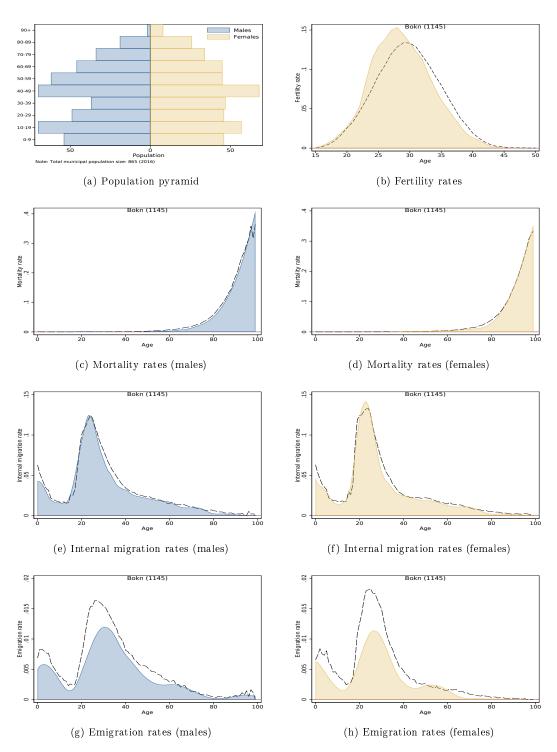


Figure D189: Municipal demographic characteristics

Tysvær (1146)

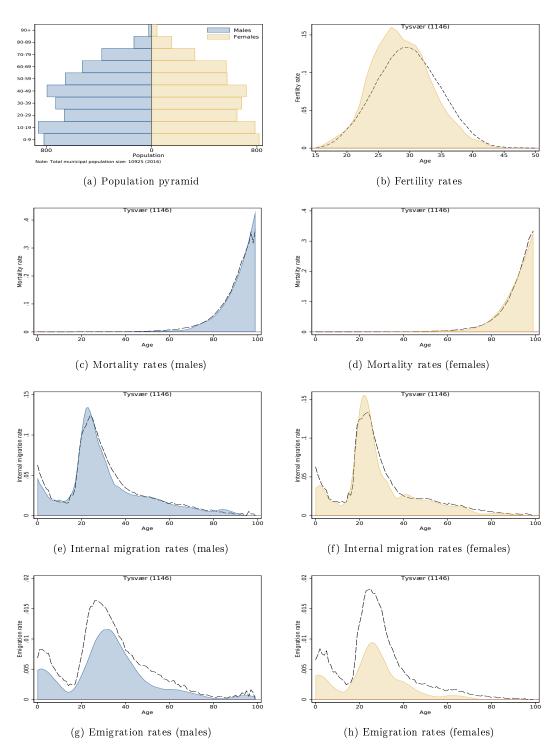


Figure D190: Municipal demographic characteristics

Karmøy (1149)

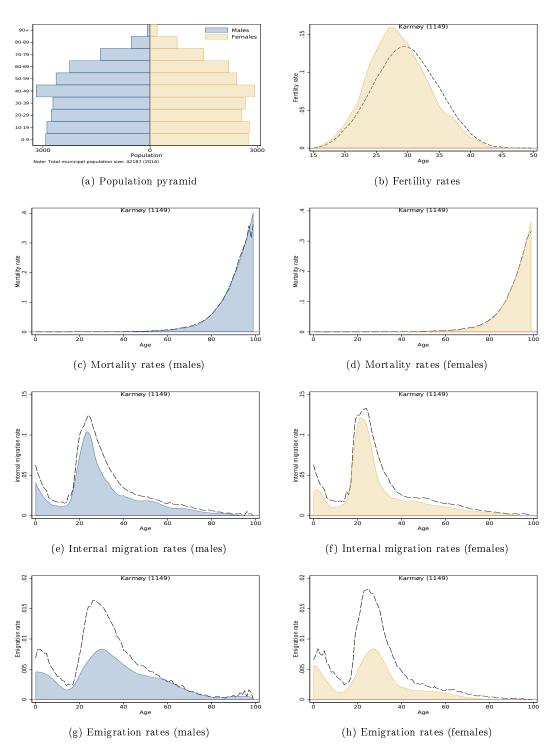


Figure D191: Municipal demographic characteristics

Utsira (1151)

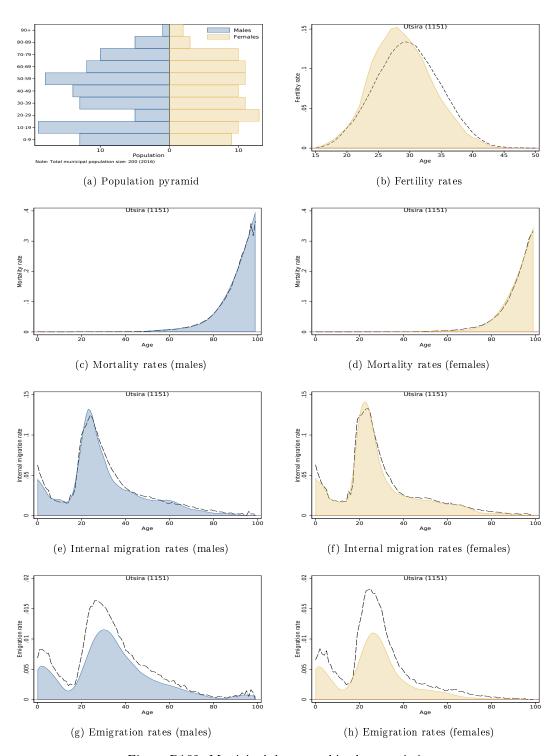


Figure D192: Municipal demographic characteristics

Vindafjord (1160)

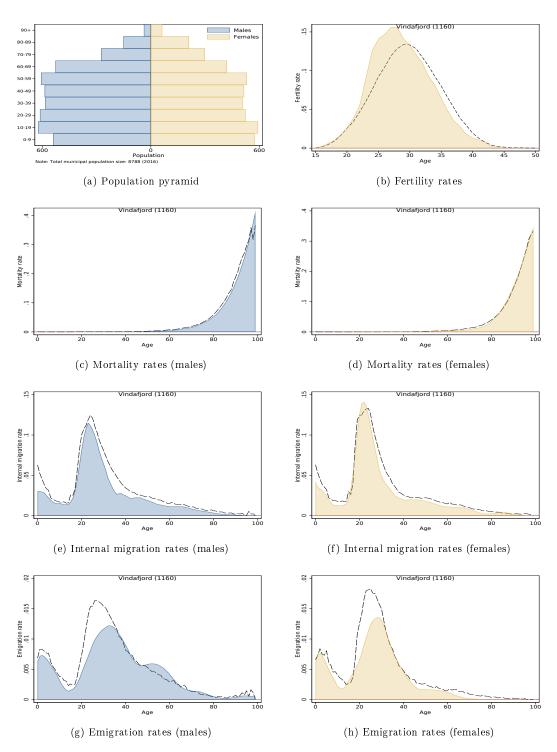


Figure D193: Municipal demographic characteristics

Bergen (1201)

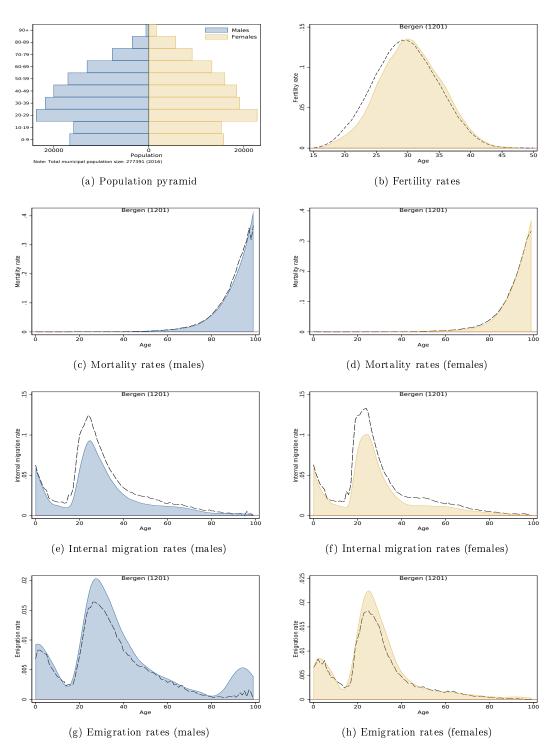


Figure D194: Municipal demographic characteristics

Etne (1211)

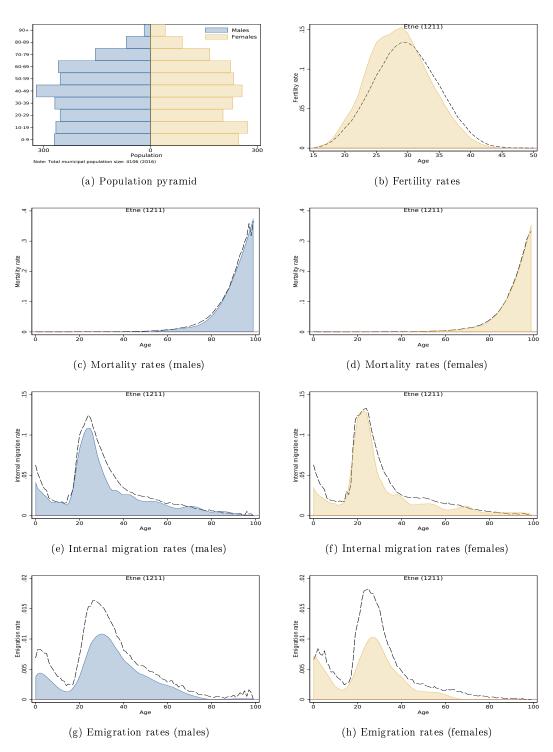


Figure D195: Municipal demographic characteristics

Sveio (1216)

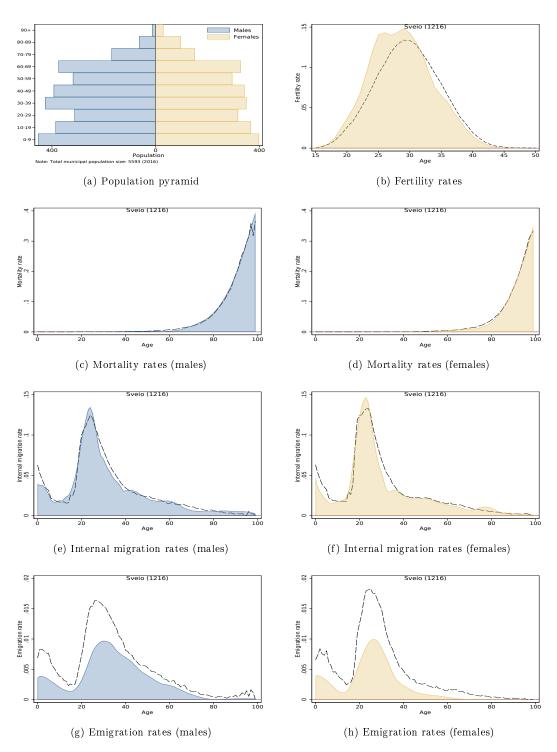


Figure D196: Municipal demographic characteristics

Bømlo (1219)

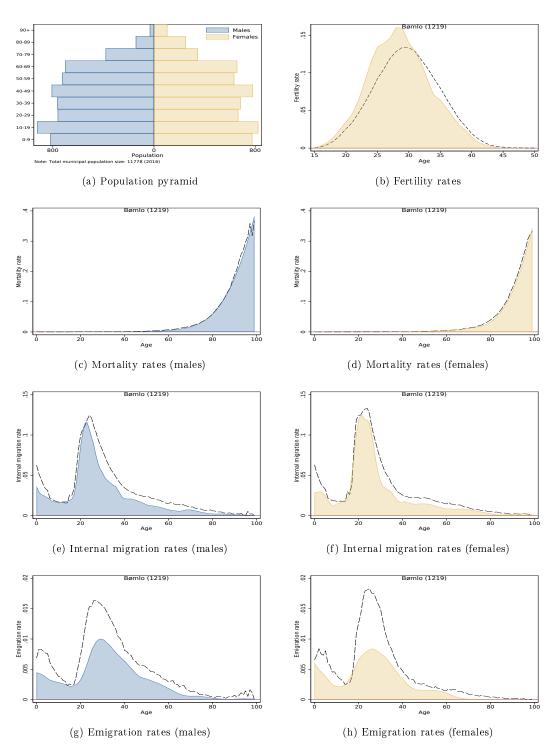


Figure D197: Municipal demographic characteristics

Stord (1221)

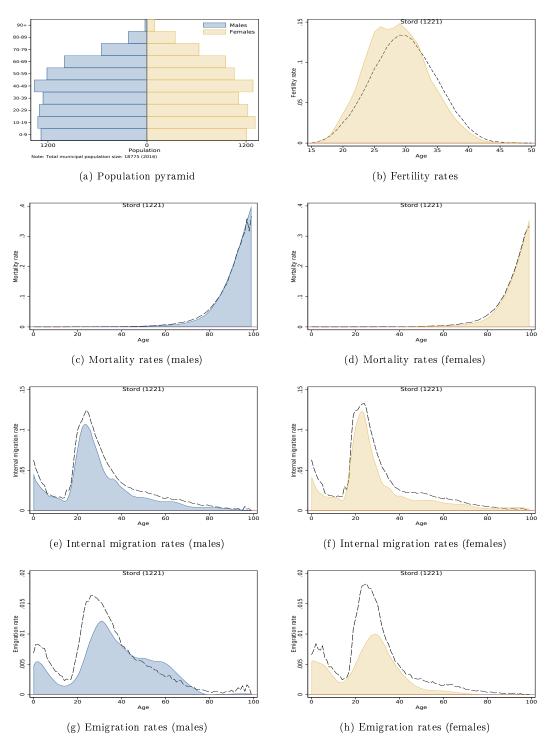


Figure D198: Municipal demographic characteristics

Fitjar (1222)

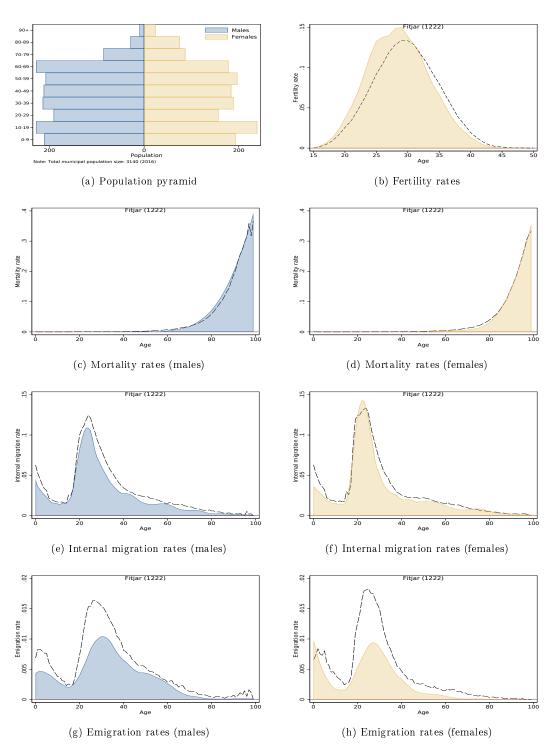
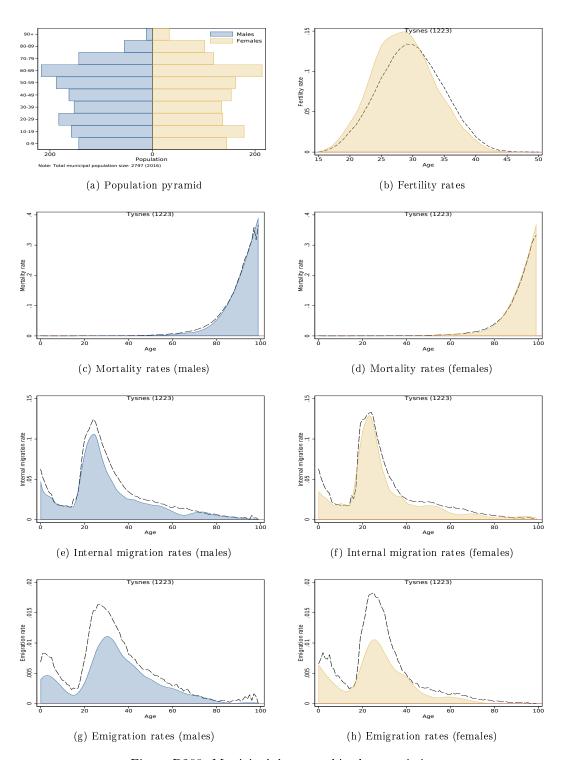


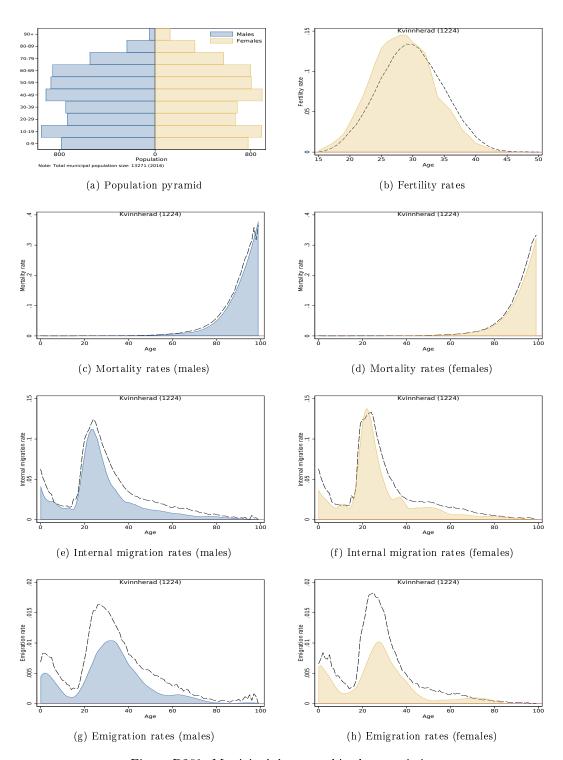
Figure D199: Municipal demographic characteristics

Tysnes (1223)



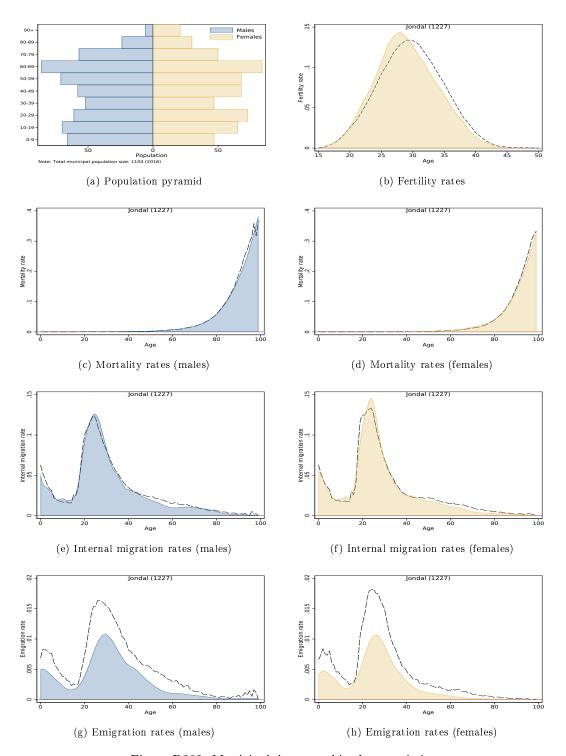
 $Figure\ D200:\ Municipal\ demographic\ characteristics$

Kvinnherad (1224)



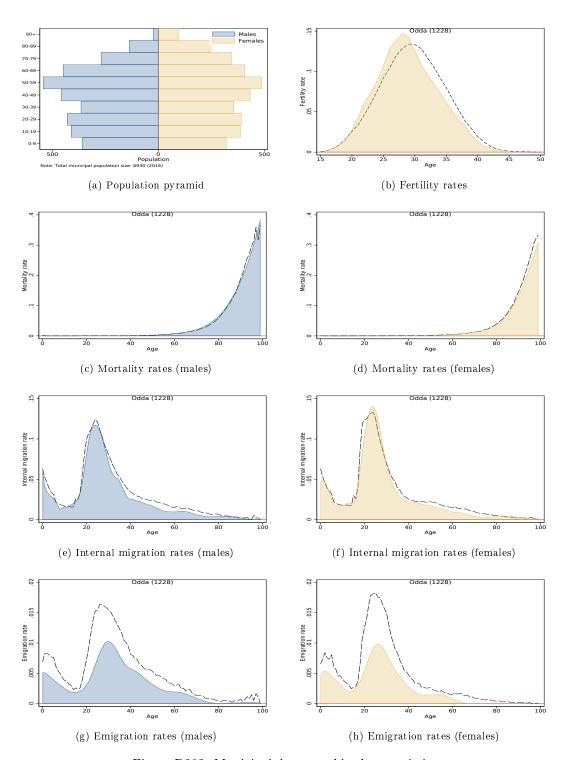
 $Figure\ D201:\ Municipal\ demographic\ characteristics$

Jondal (1227)



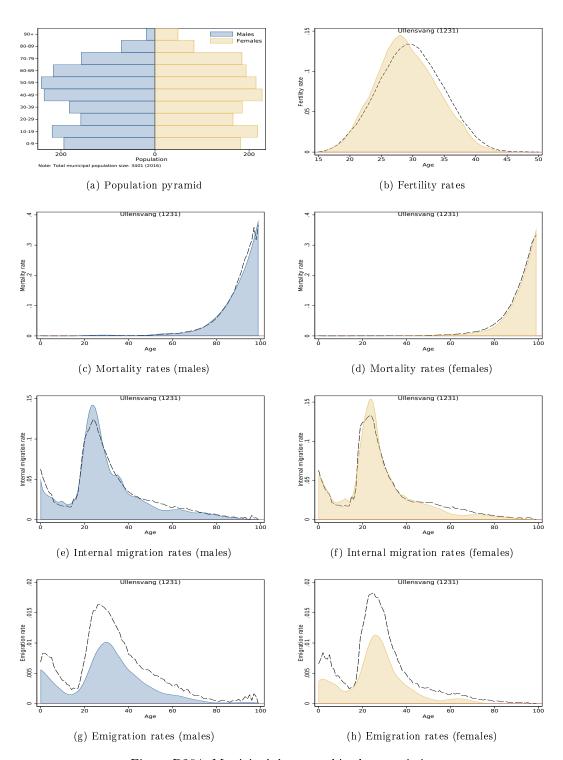
 $Figure\ D202:\ Municipal\ demographic\ characteristics$

Odda (1228)



 $Figure\ D203:\ Municipal\ demographic\ characteristics$

Ullensvang (1231)



 $Figure\ D204:\ Municipal\ demographic\ characteristics$

Eidfjord (1232)

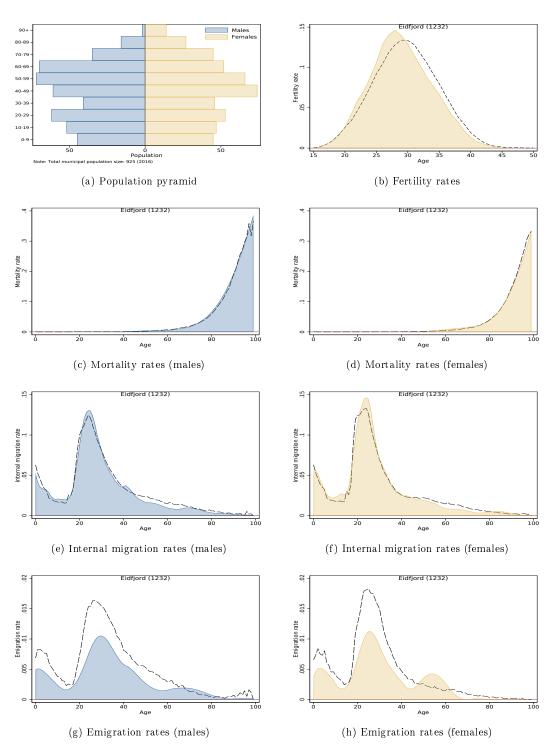


Figure D205: Municipal demographic characteristics

Ulvik (1233)

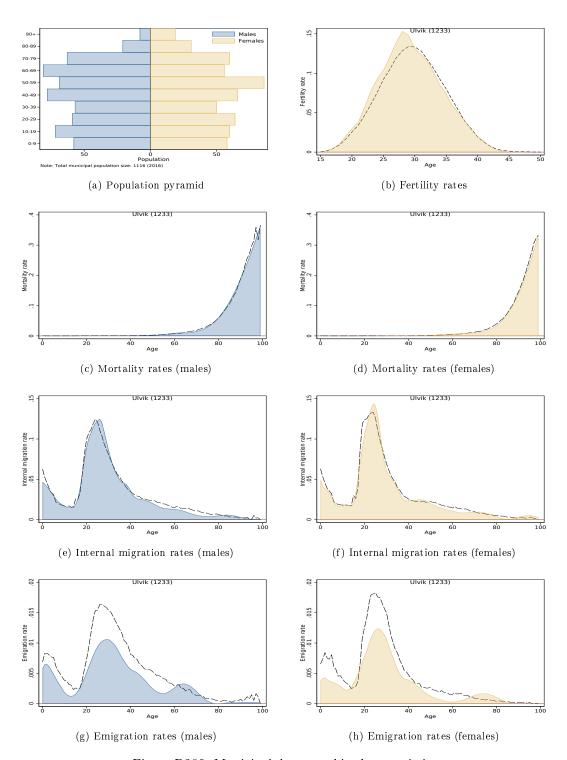


Figure D206: Municipal demographic characteristics

Granvin (1234)

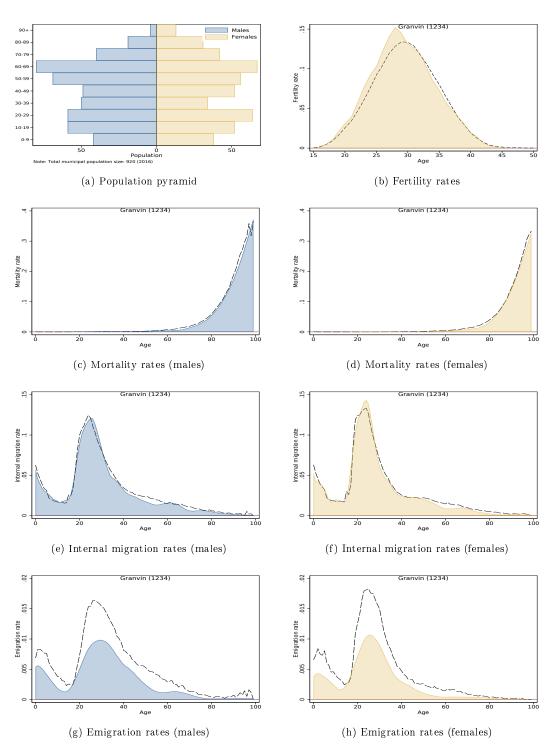
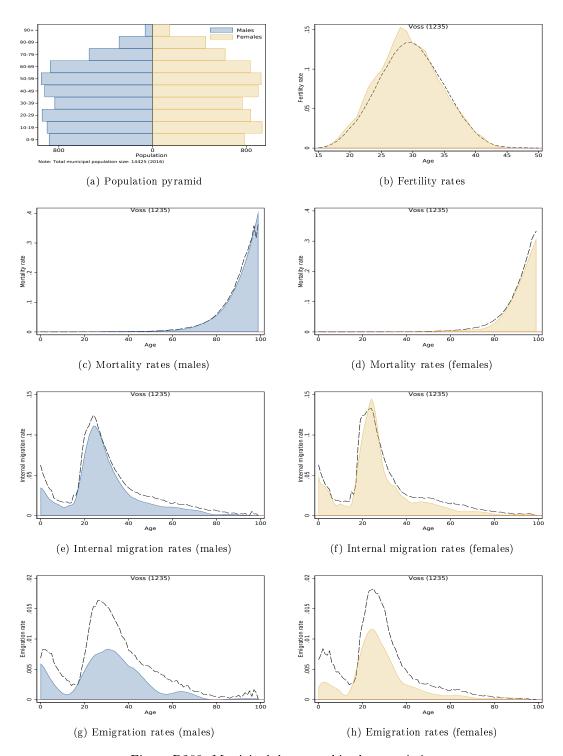


Figure D207: Municipal demographic characteristics

Voss (1235)



 $Figure\ D208:\ Municipal\ demographic\ characteristics$

Kvam (1238)

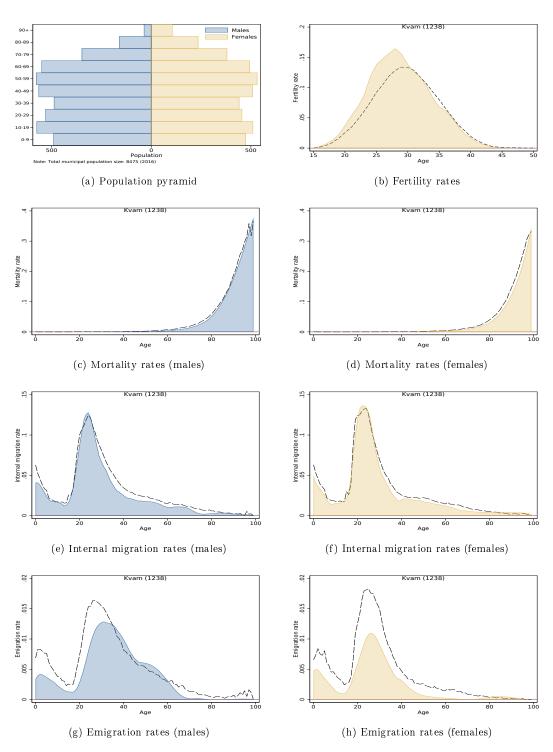
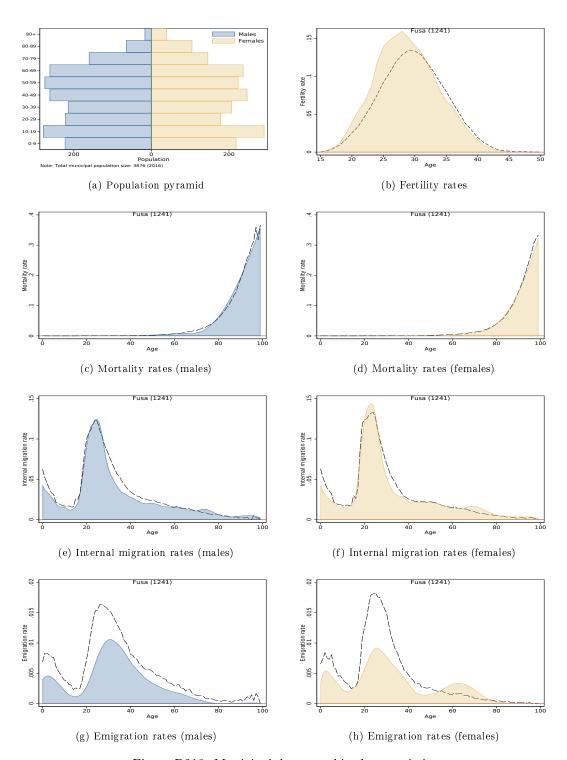


Figure D209: Municipal demographic characteristics

Fusa (1241)



 $Figure\ D210:\ Municipal\ demographic\ characteristics$

Samnanger (1242)

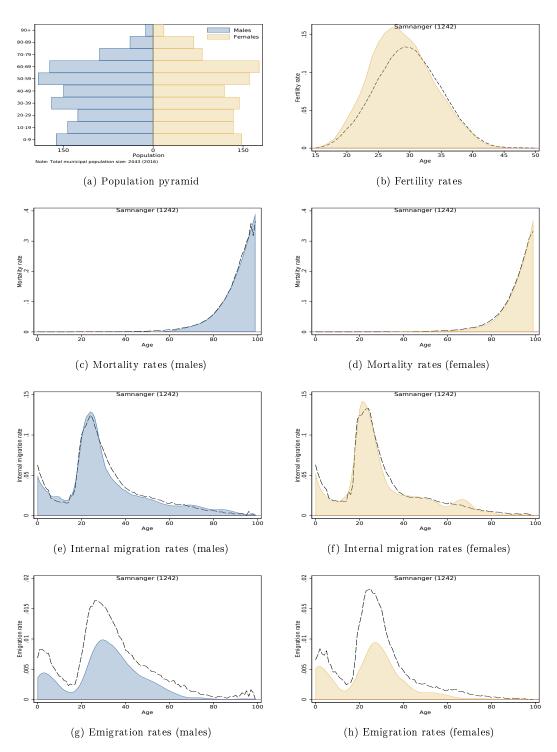
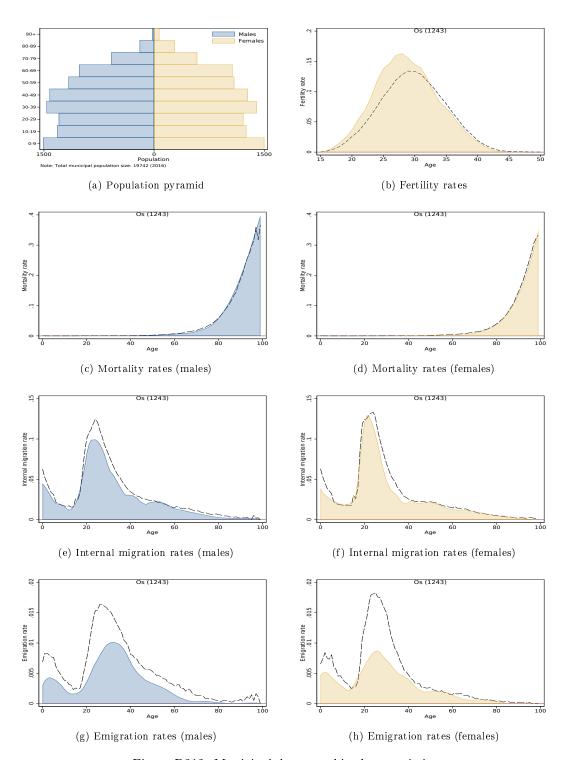


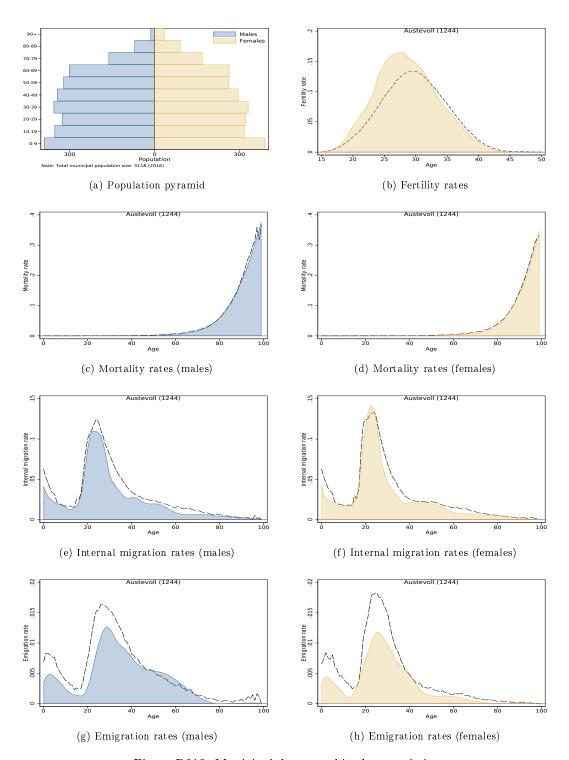
Figure D211: Municipal demographic characteristics

Os (1243)



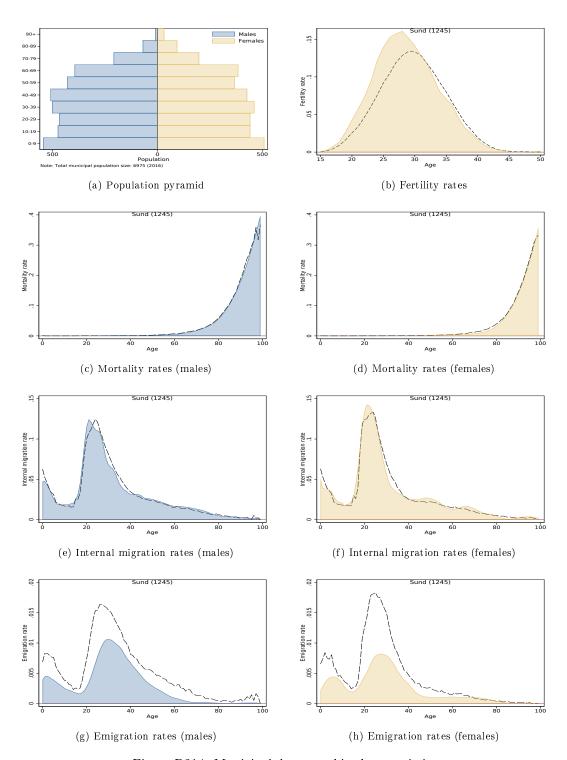
 $Figure\ D212:\ Municipal\ demographic\ characteristics$

Austevoll (1244)



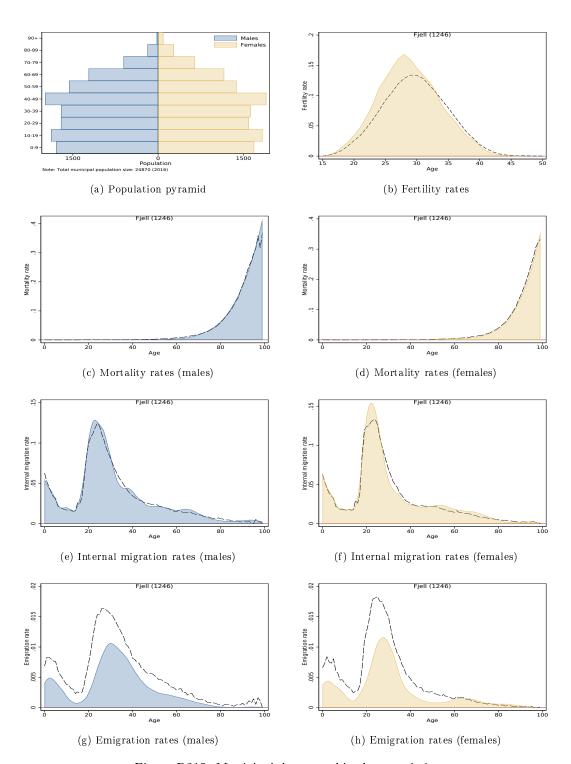
 $Figure\ D213:\ Municipal\ demographic\ characteristics$

Sund (1245)



 $Figure\ D214:\ Municipal\ demographic\ characteristics$

Fjell (1246)



 $Figure\ D215:\ Municipal\ demographic\ characteristics$

Askøy (1247)

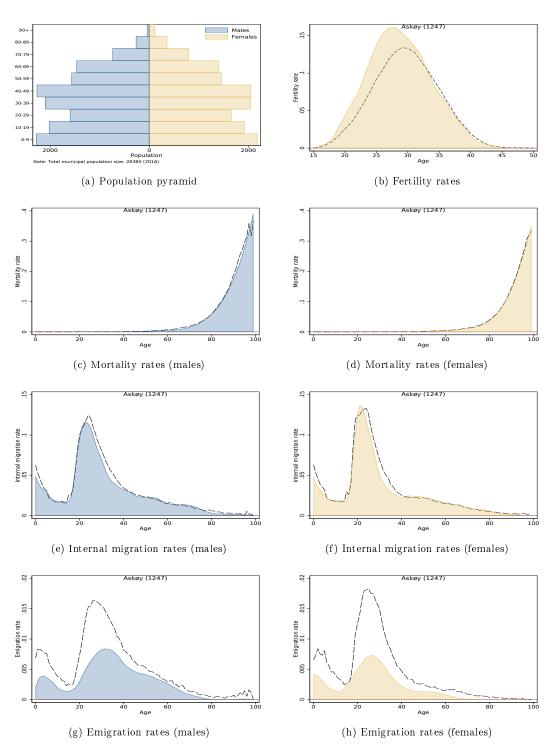
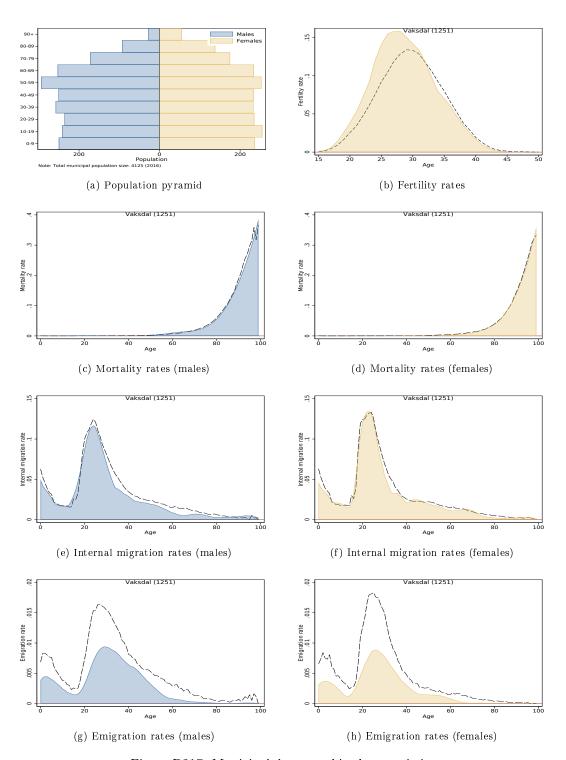


Figure D216: Municipal demographic characteristics

Vaksdal (1251)



 $Figure\ D217:\ Municipal\ demographic\ characteristics$

Modalen (1252)

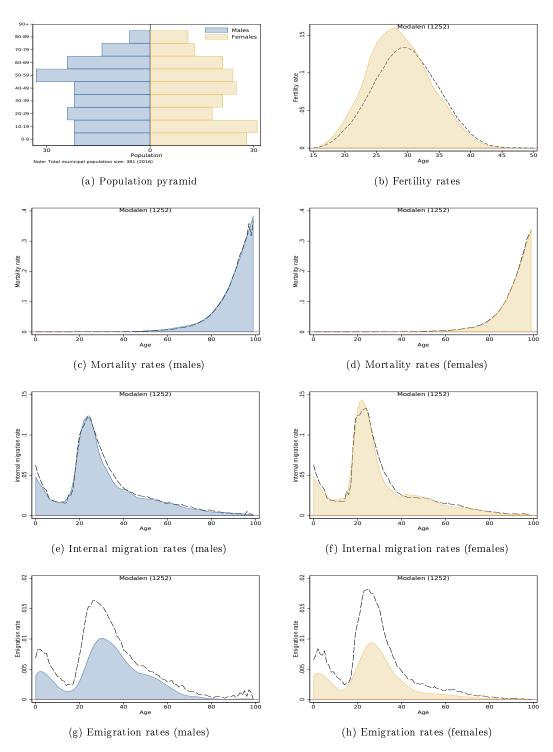


Figure D218: Municipal demographic characteristics

Osterøy (1253)

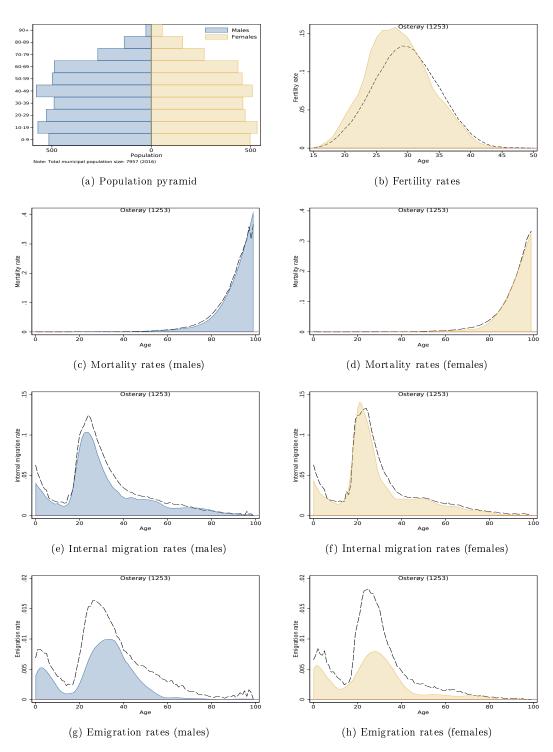
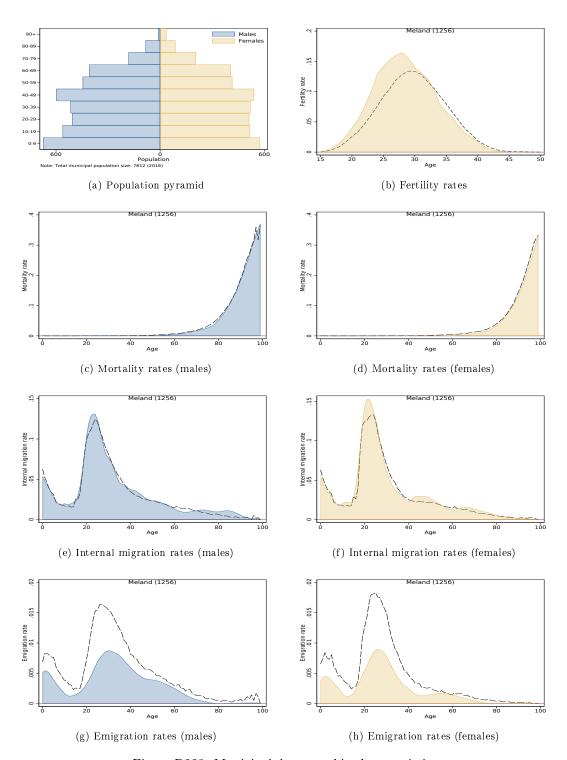


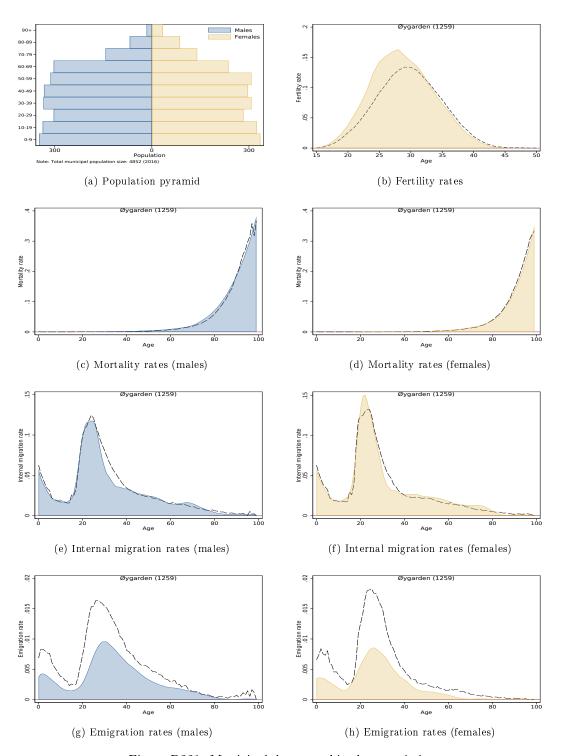
Figure D219: Municipal demographic characteristics

Meland (1256)



 $Figure\ D220:\ Municipal\ demographic\ characteristics$

Øygarden (1259)



 $Figure\ D221:\ Municipal\ demographic\ characteristics$

Radøy (1260)

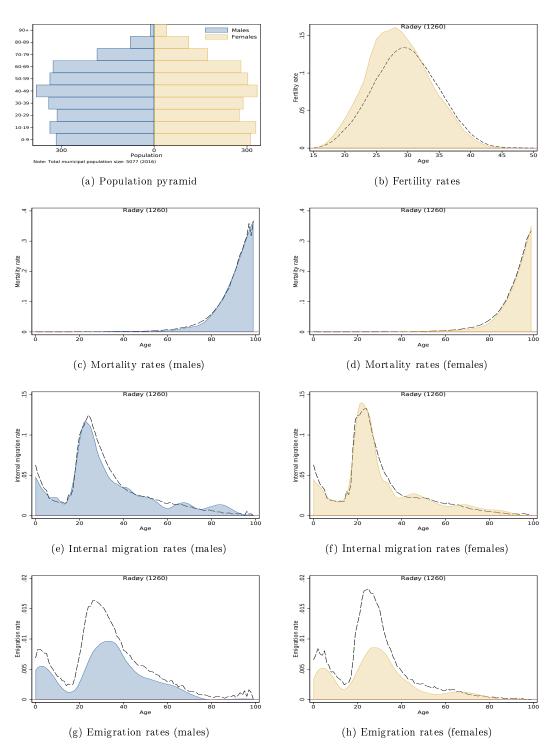


Figure D222: Municipal demographic characteristics

Lindås (1263)

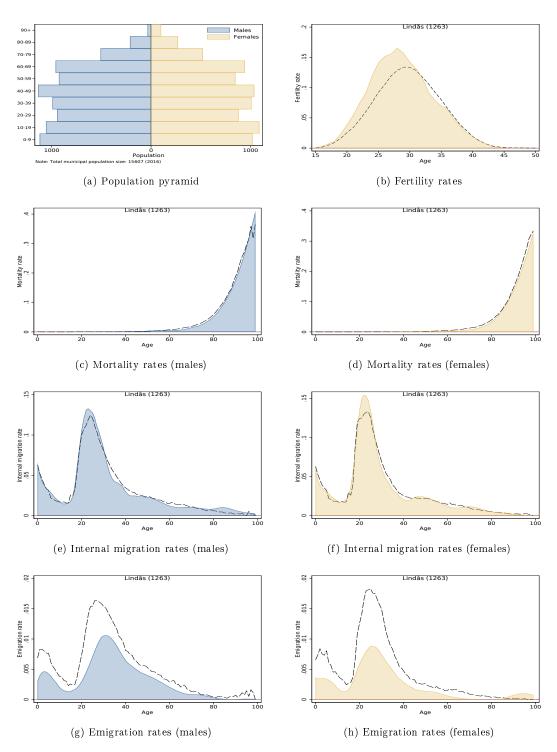


Figure D223: Municipal demographic characteristics

Austrheim (1264)

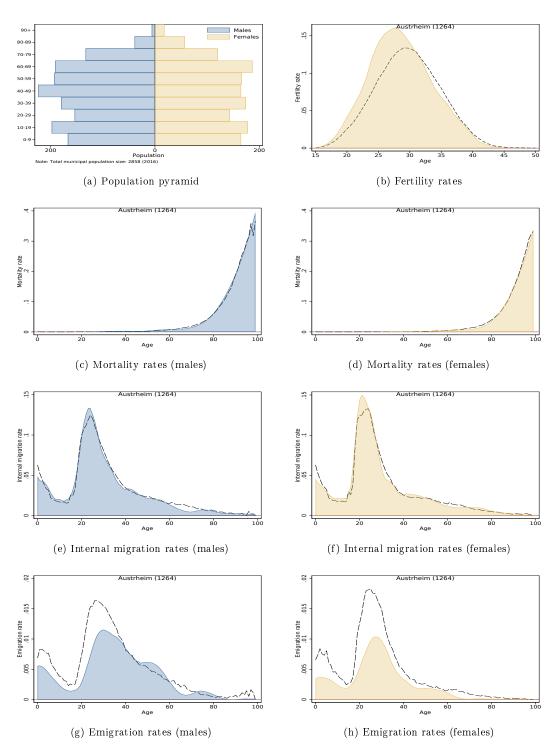


Figure D224: Municipal demographic characteristics

Fedje (1265)

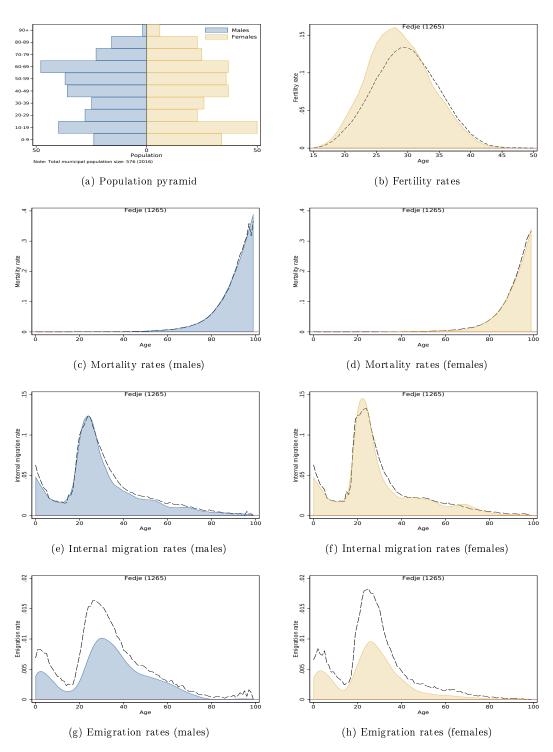


Figure D225: Municipal demographic characteristics

Masfjorden (1266)

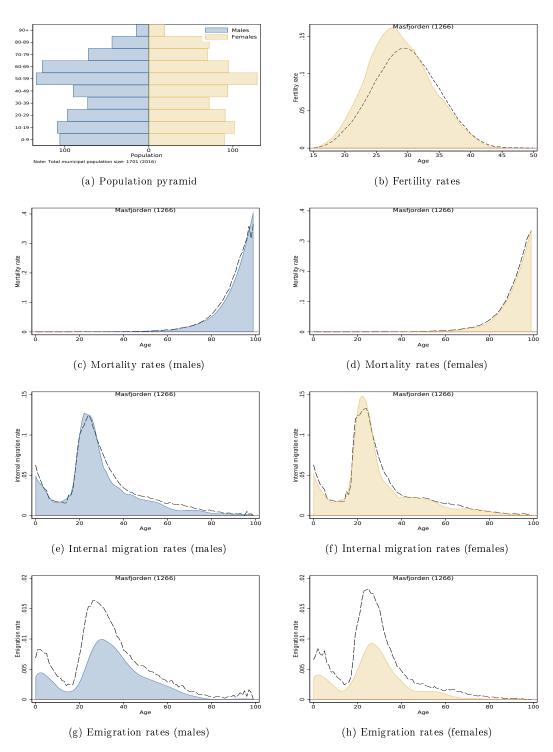


Figure D226: Municipal demographic characteristics

Flora (1401)

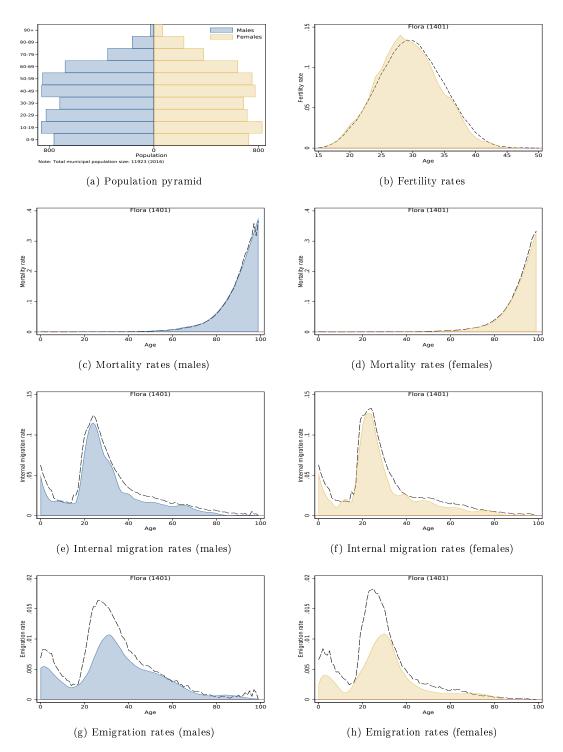


Figure D227: Municipal demographic characteristics

Gulen (1411)

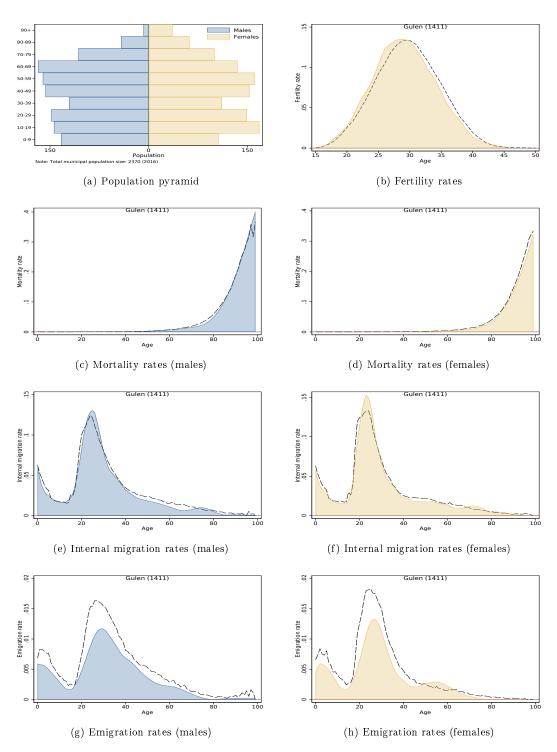


Figure D228: Municipal demographic characteristics

Solund (1412)

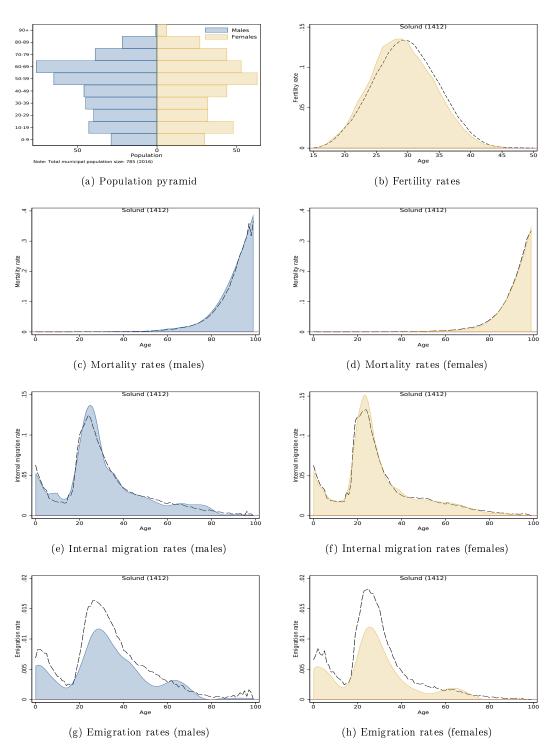
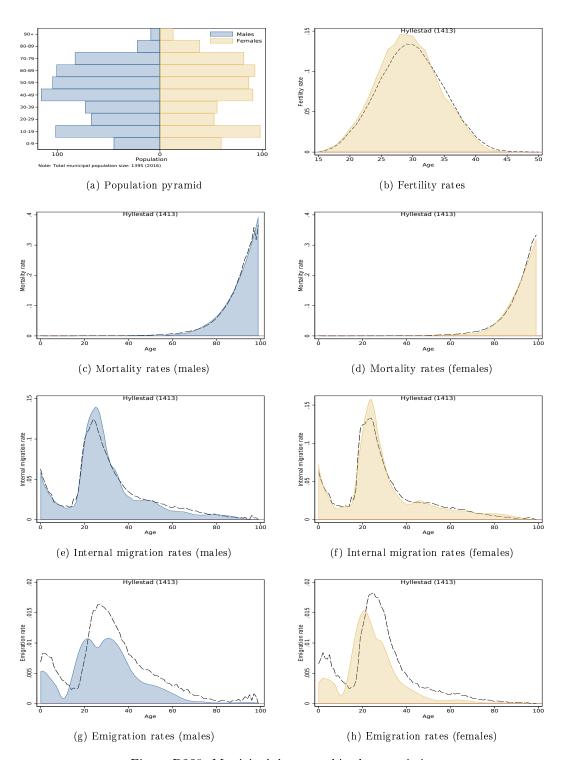


Figure D229: Municipal demographic characteristics

Hyllestad (1413)



 $Figure\ D230:\ Municipal\ demographic\ characteristics$

Høyanger (1416)

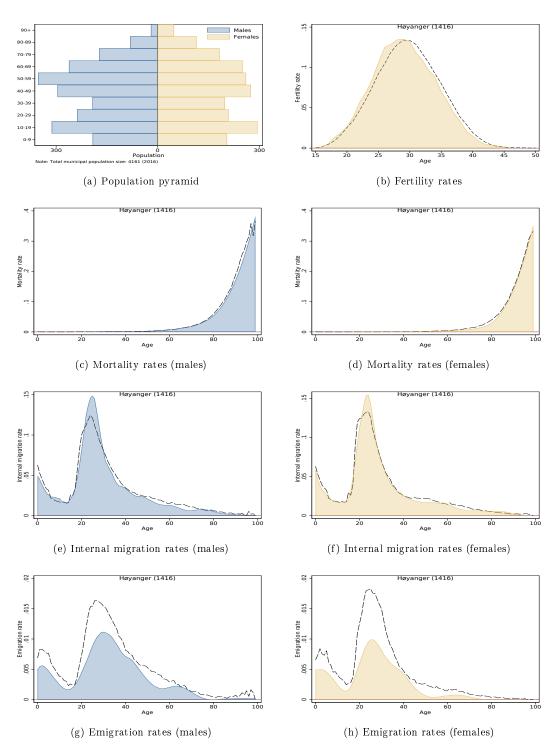
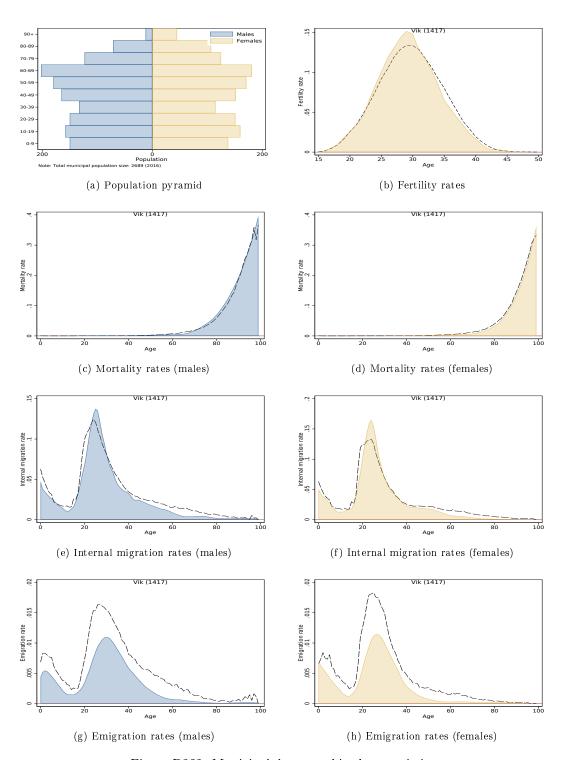


Figure D231: Municipal demographic characteristics

Vik (1417)



 $Figure\ D232:\ Municipal\ demographic\ characteristics$

Balestrand (1418)

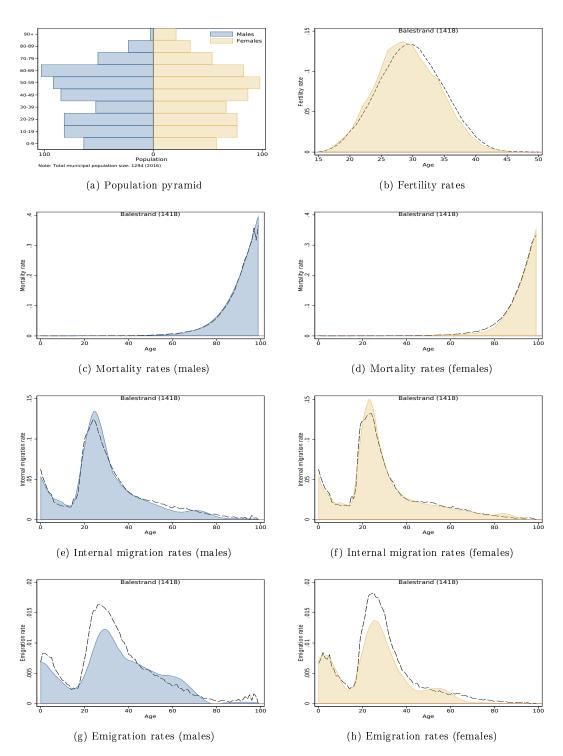


Figure D233: Municipal demographic characteristics

Leikanger (1419)

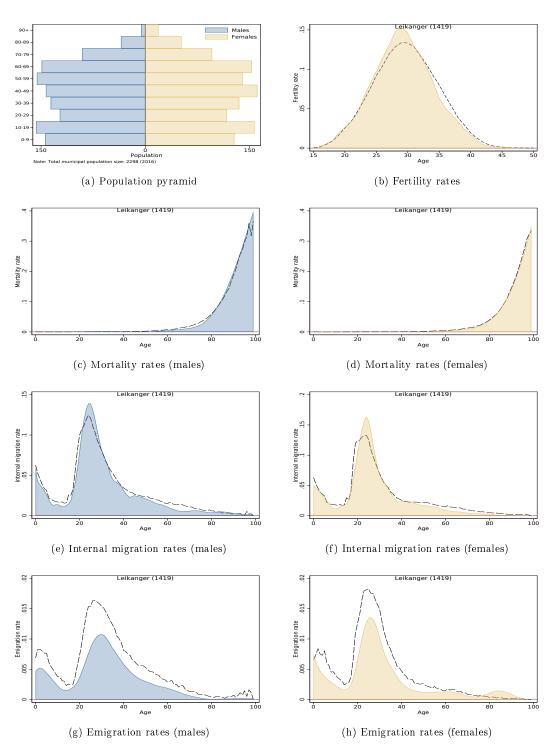
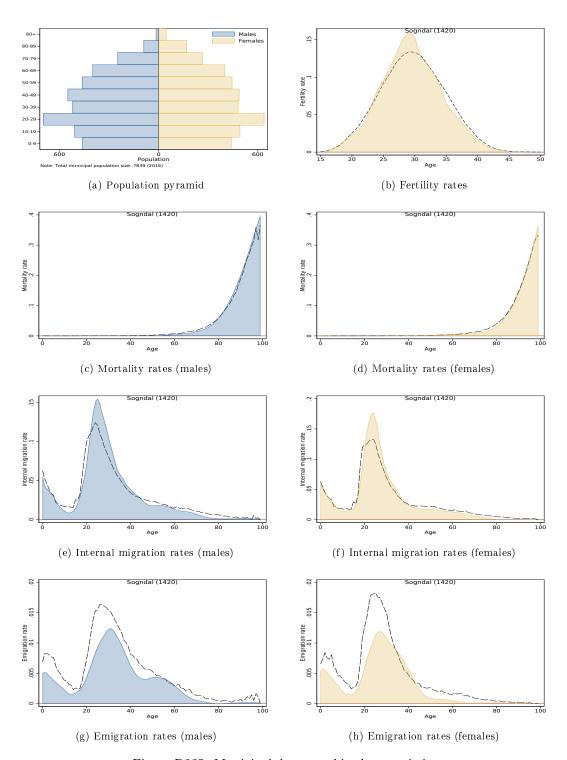


Figure D234: Municipal demographic characteristics

Sogndal (1420)



 $Figure\ D235:\ Municipal\ demographic\ characteristics$

Aurland (1421)

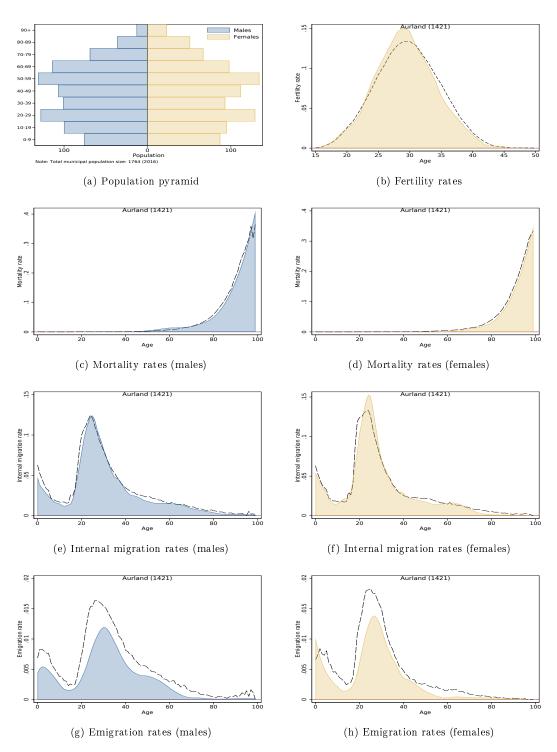
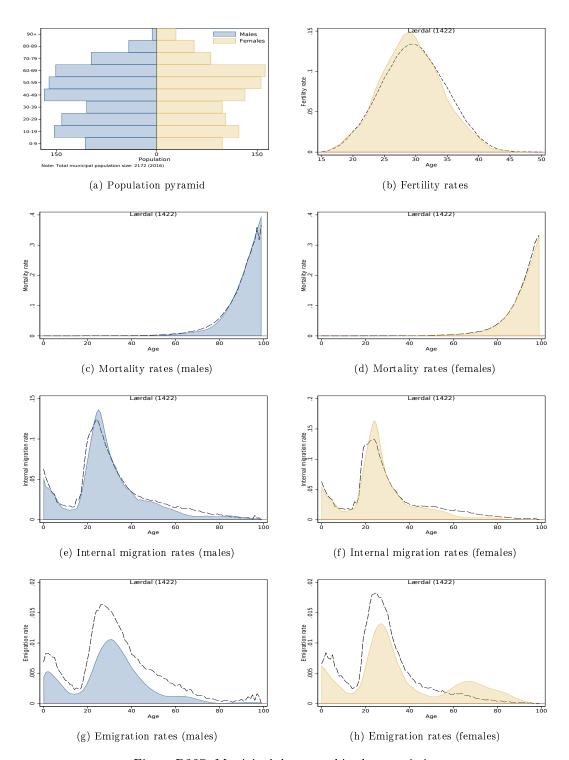


Figure D236: Municipal demographic characteristics

Lærdal (1422)



 $Figure\ D237:\ Municipal\ demographic\ characteristics$

$m \mathring{A}rdal~(1424)$

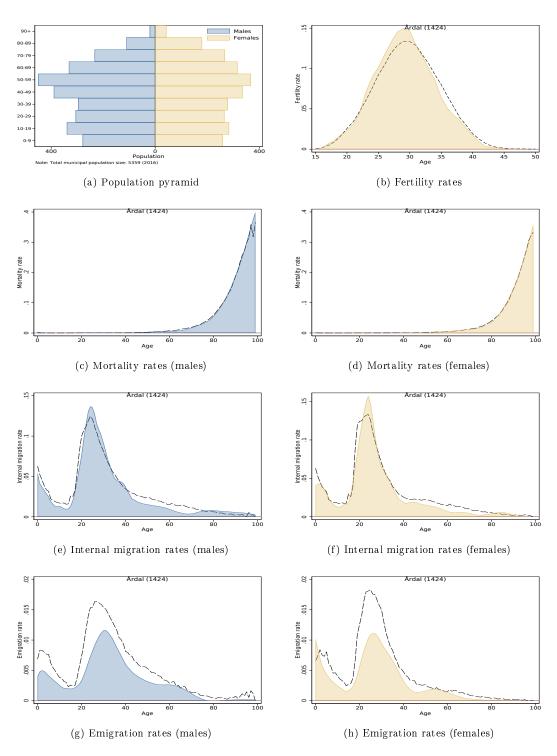


Figure D238: Municipal demographic characteristics

Luster (1426)

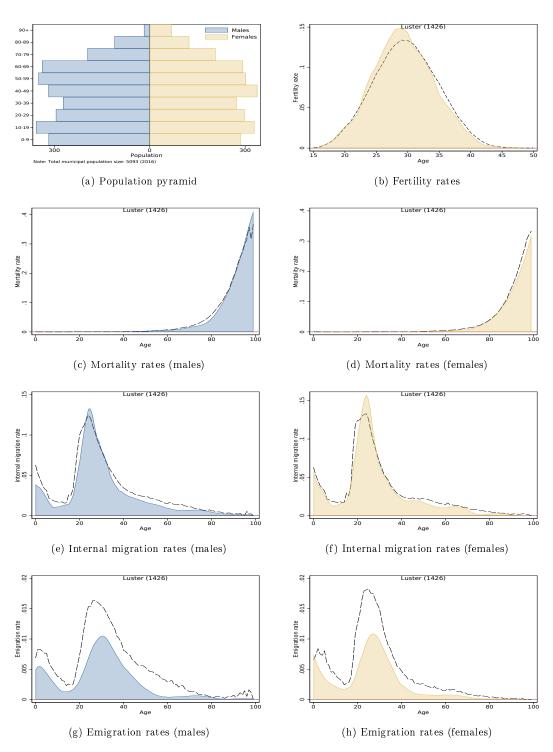
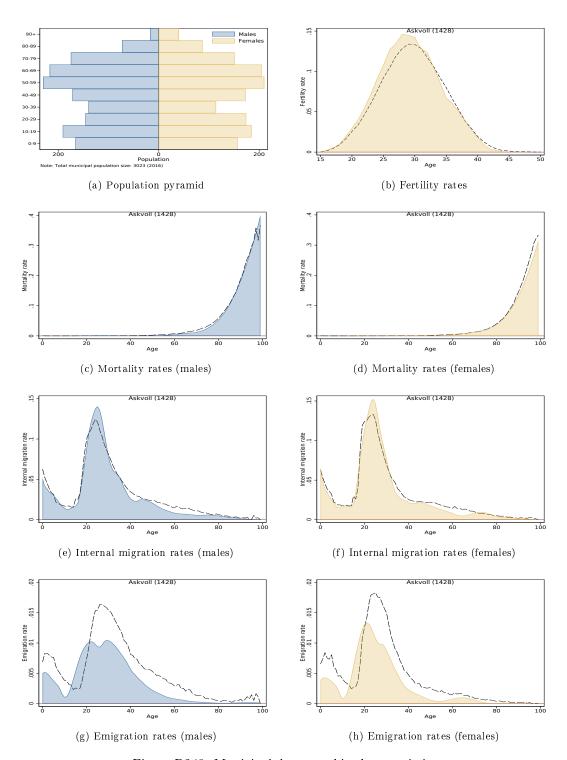


Figure D239: Municipal demographic characteristics

Askvoll (1428)



 $Figure\ D240:\ Municipal\ demographic\ characteristics$

Fjaler (1429)

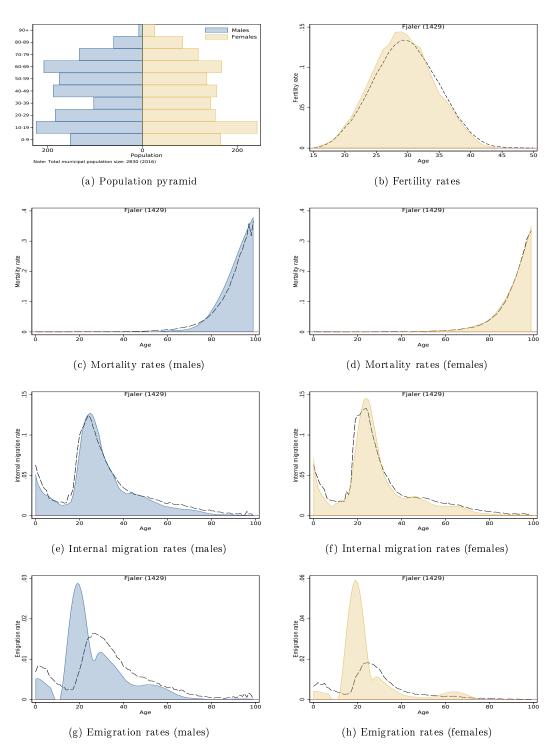


Figure D241: Municipal demographic characteristics

Gaular (1430)

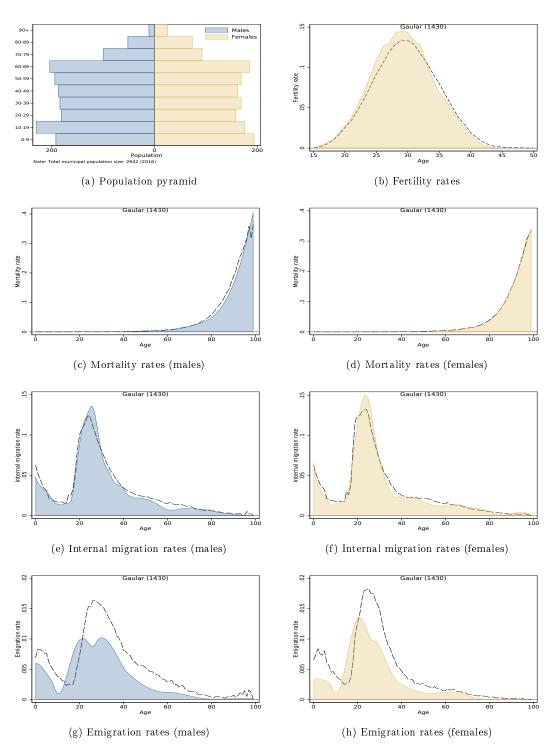
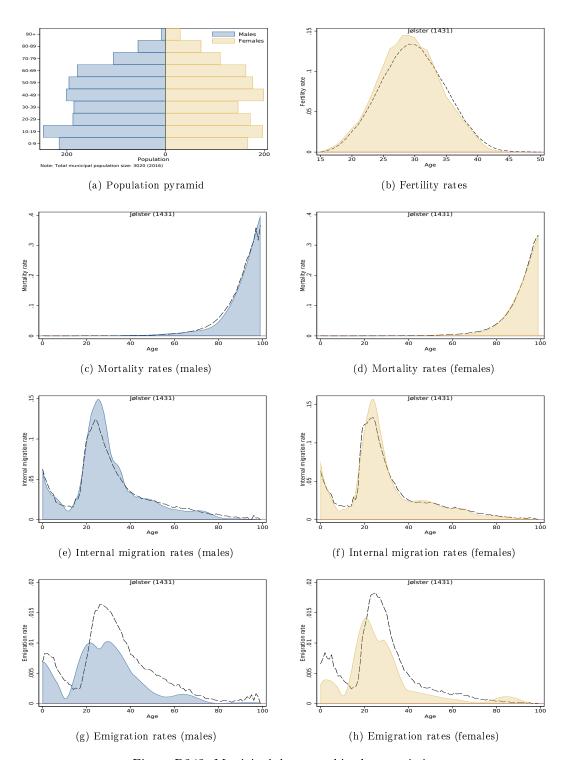


Figure D242: Municipal demographic characteristics

Jølster (1431)



 $Figure\ D243:\ Municipal\ demographic\ characteristics$

Førde (1432)

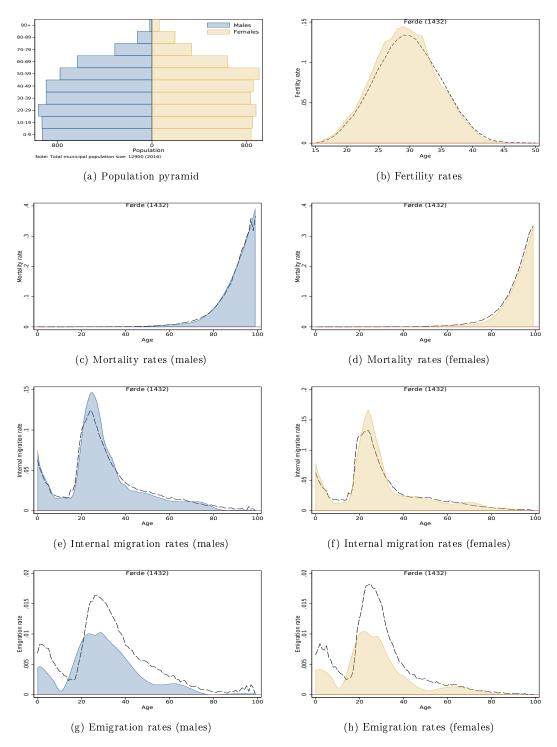


Figure D244: Municipal demographic characteristics

Naustdal (1433)

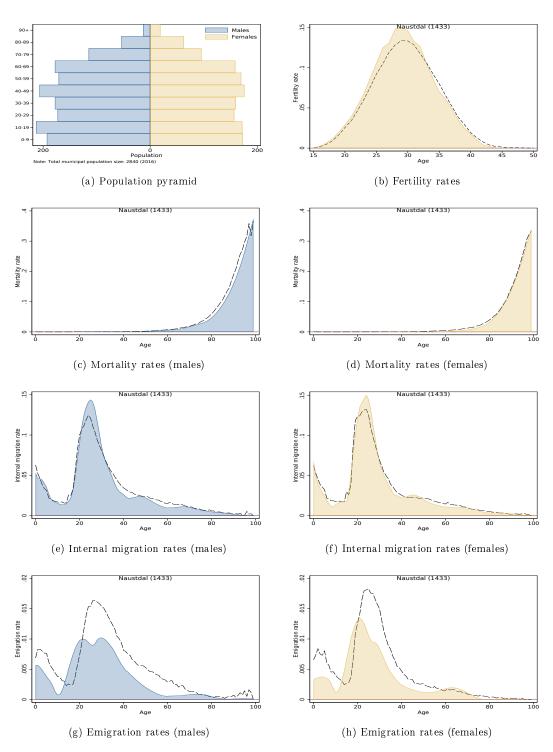
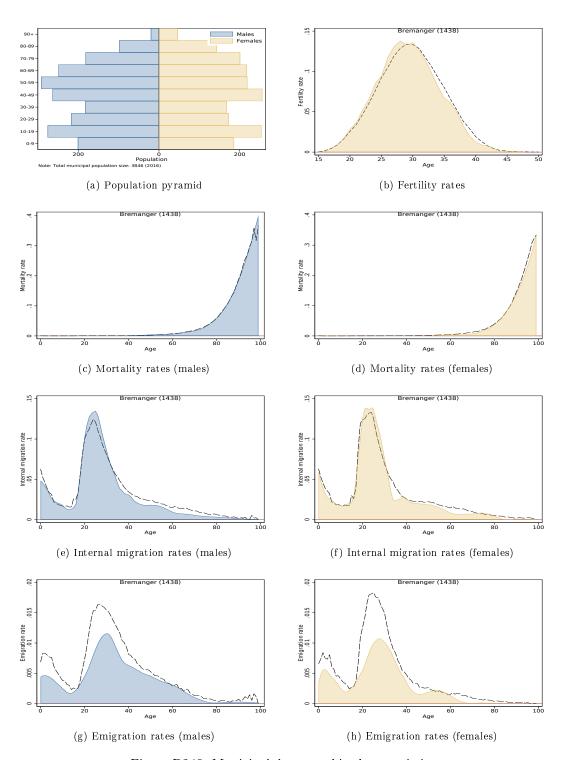


Figure D245: Municipal demographic characteristics

Bremanger (1438)



 $Figure\ D246:\ Municipal\ demographic\ characteristics$

Vågsøy (1439)

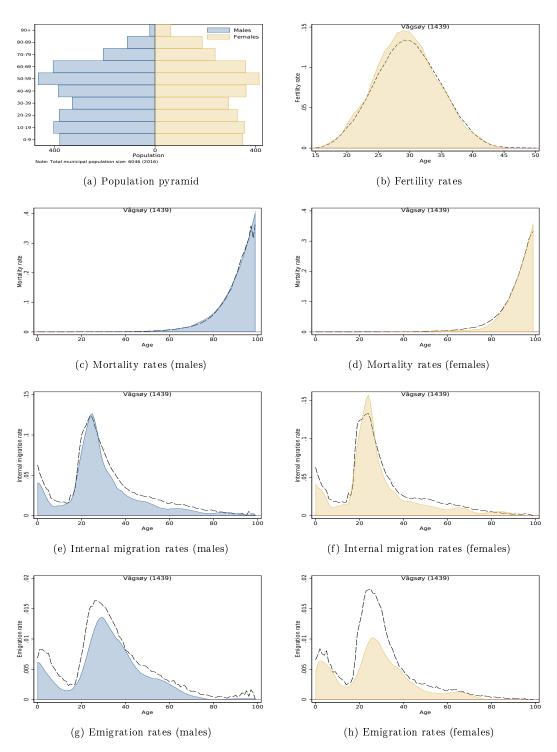


Figure D247: Municipal demographic characteristics

Selje (1441)

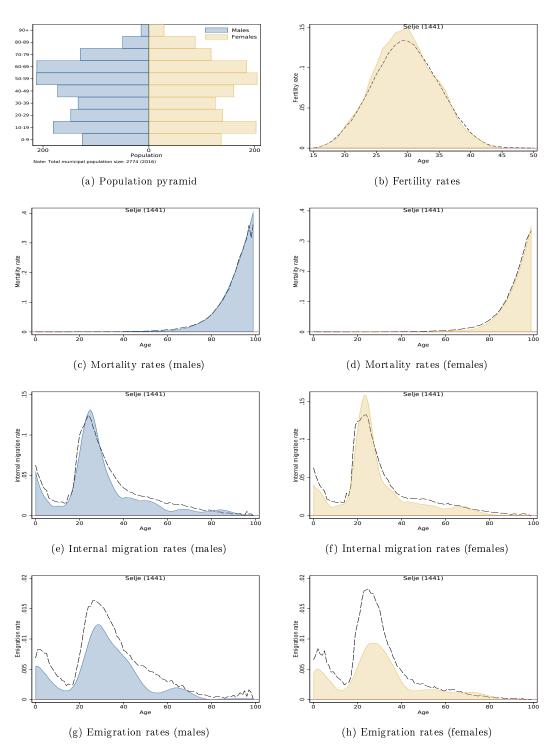


Figure D248: Municipal demographic characteristics

Eid (1443)

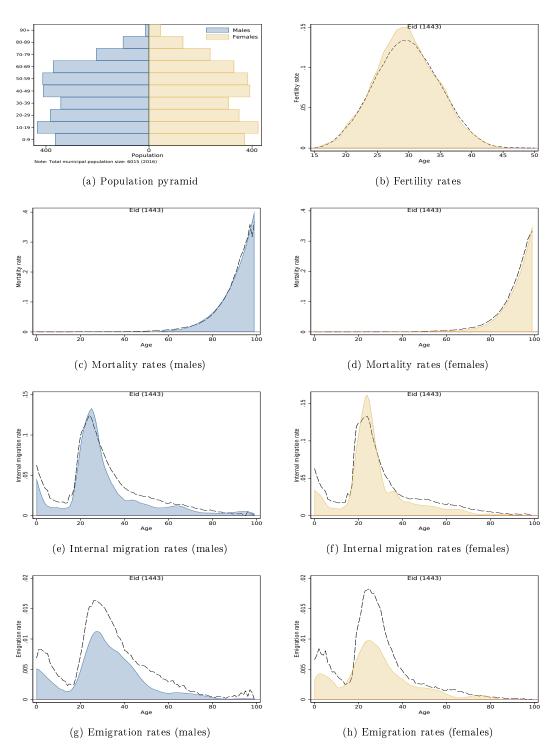


Figure D249: Municipal demographic characteristics

Hornindal (1444)

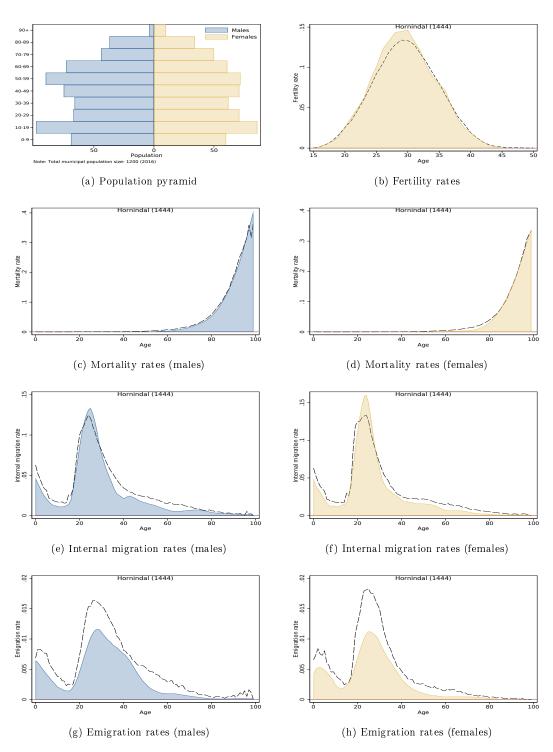
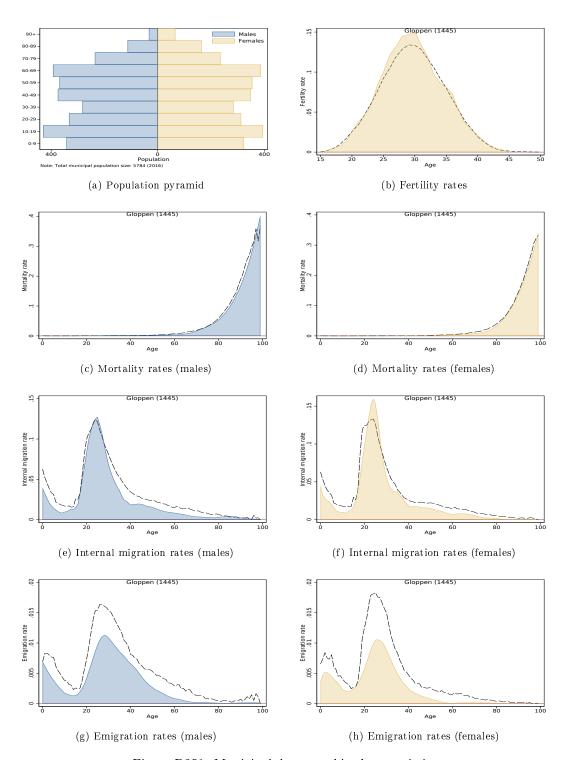


Figure D250: Municipal demographic characteristics

Gloppen (1445)



 $Figure\ D251:\ Municipal\ demographic\ characteristics$

Stryn (1449)

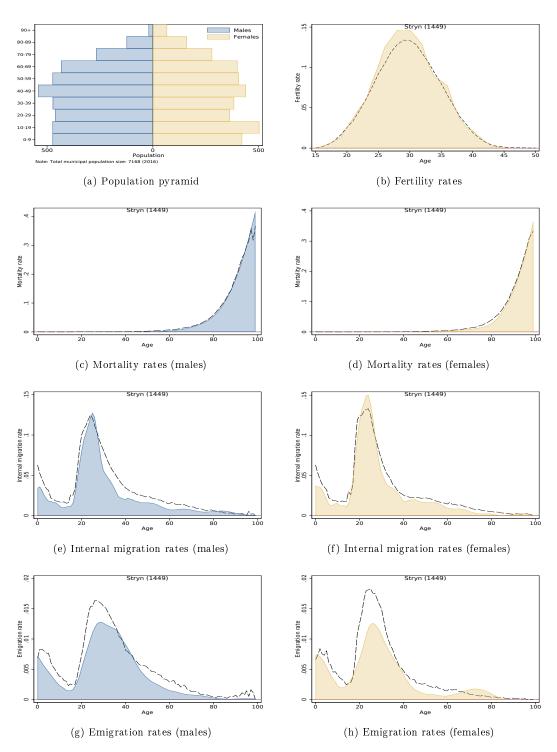


Figure D252: Municipal demographic characteristics

Molde (1502)

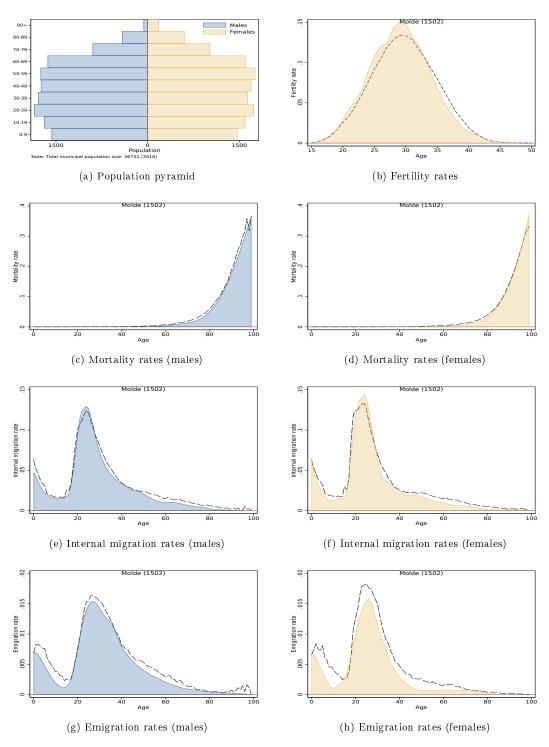


Figure D253: Municipal demographic characteristics

Ålesund (1504)

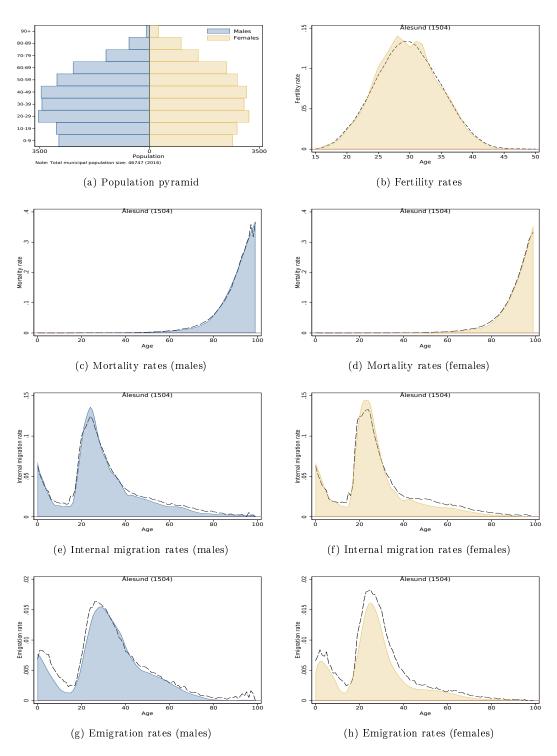


Figure D254: Municipal demographic characteristics

Kristiansund (1505)

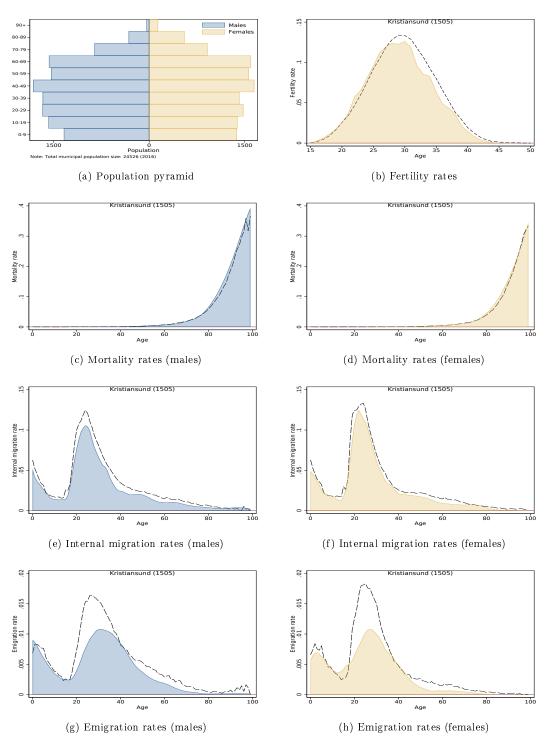


Figure D255: Municipal demographic characteristics

Vanylven (1511)

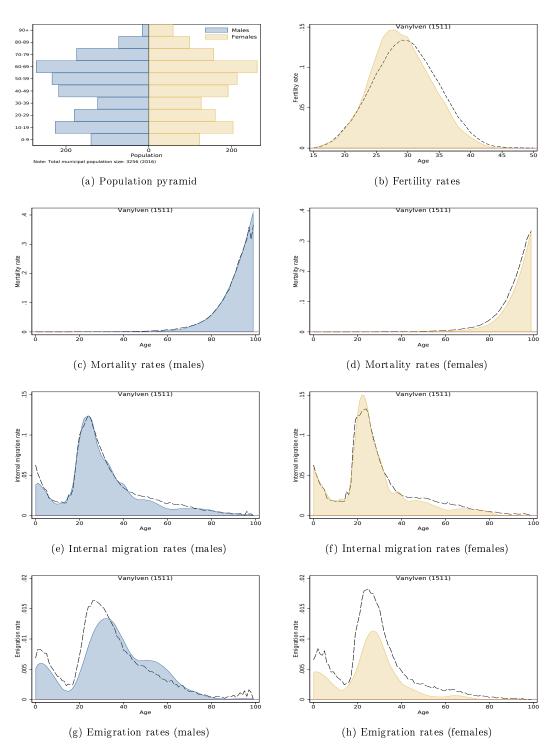
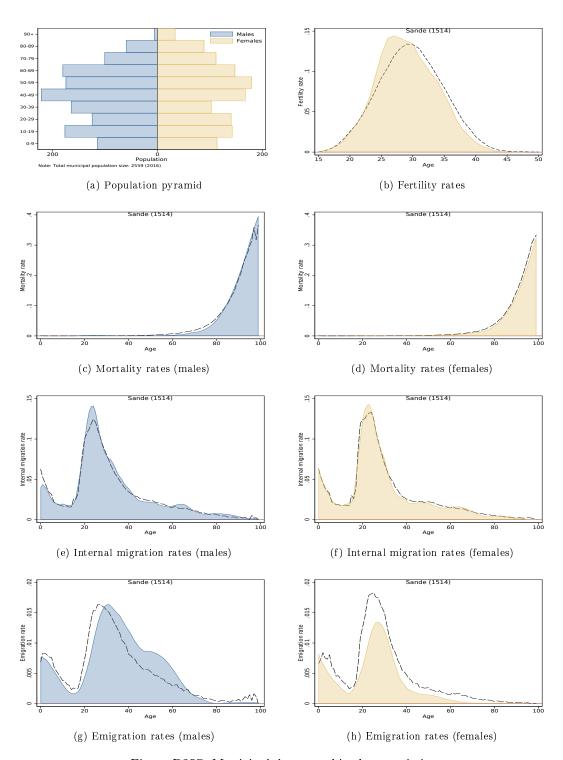


Figure D256: Municipal demographic characteristics

Sande (1514)



 $Figure\ D257:\ Municipal\ demographic\ characteristics$

Herøy (1515)

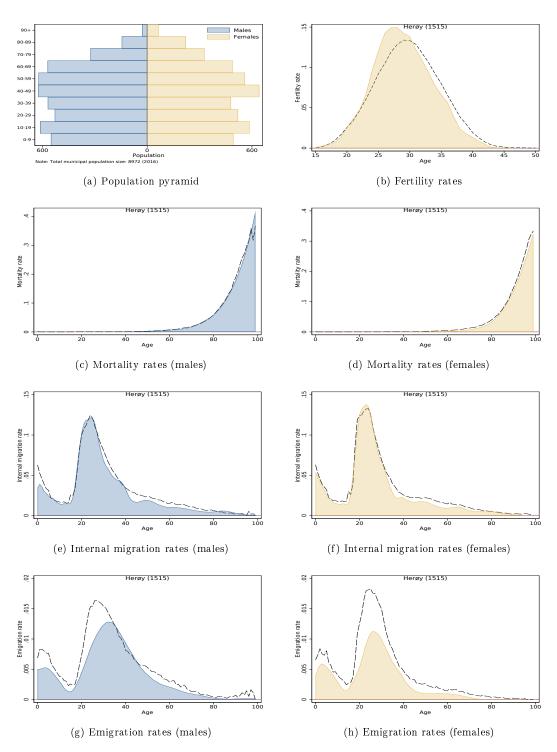


Figure D258: Municipal demographic characteristics

Ulstein (1516)

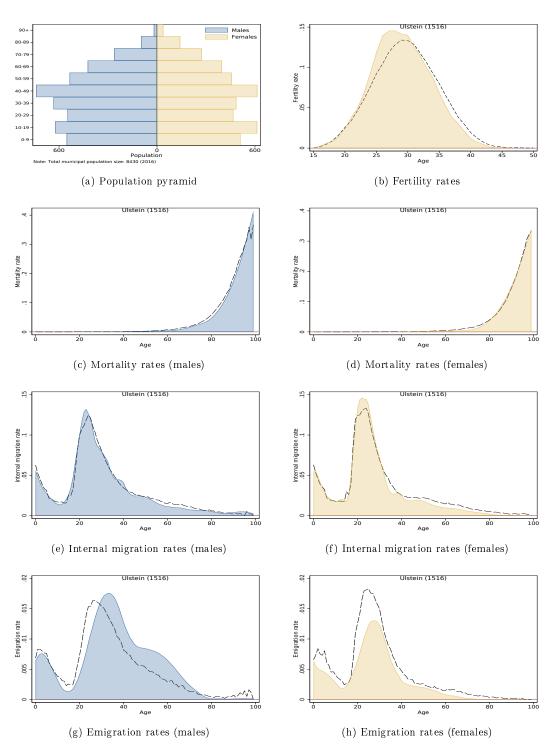
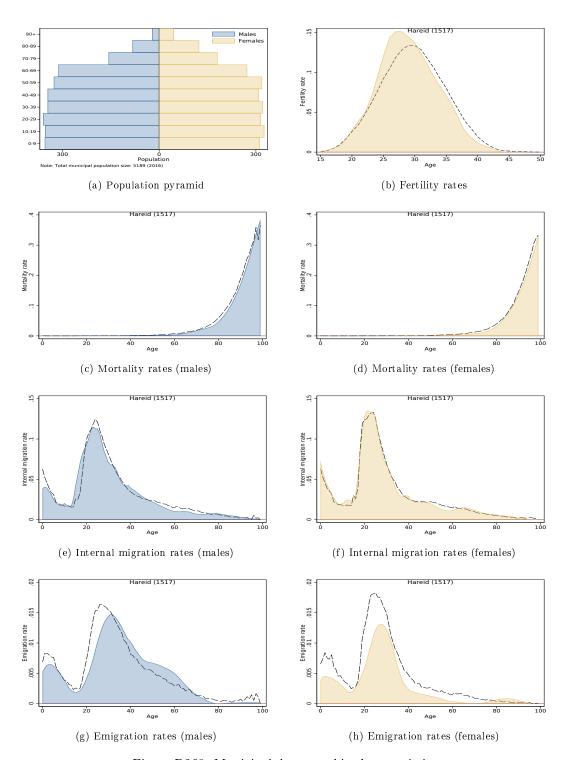


Figure D259: Municipal demographic characteristics

Hareid (1517)



 $Figure\ D260:\ Municipal\ demographic\ characteristics$

Volda (1519)

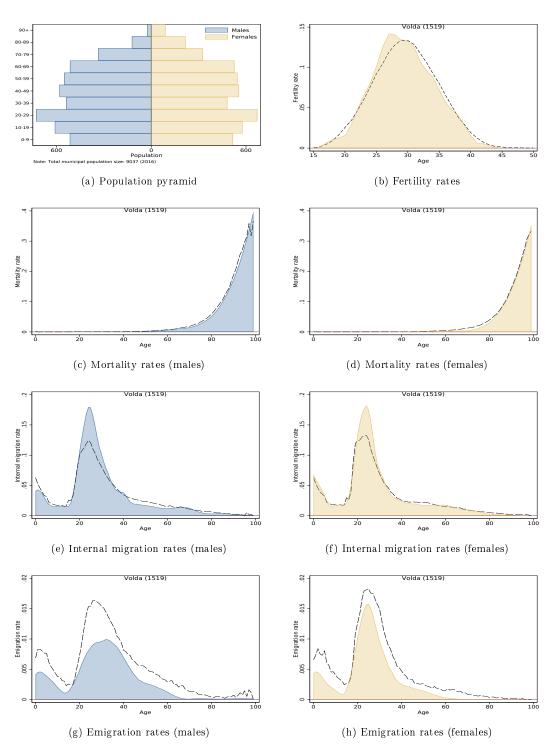


Figure D261: Municipal demographic characteristics

Ørsta (1520)

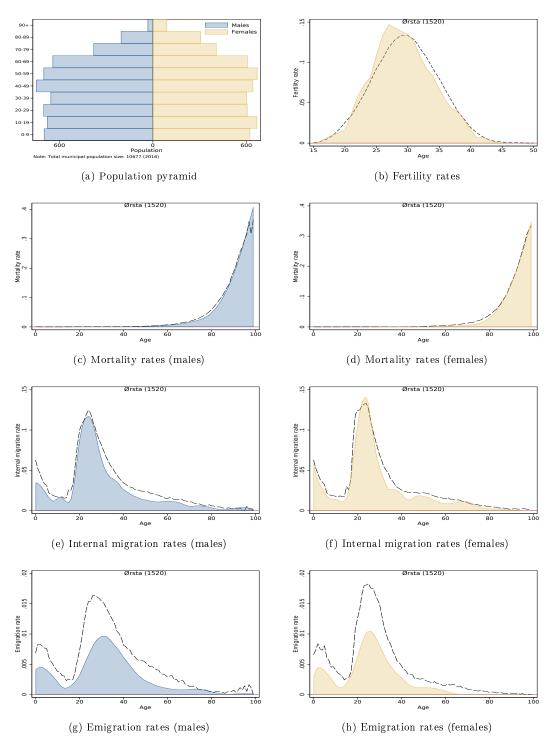


Figure D262: Municipal demographic characteristics

Ørskog (1523)

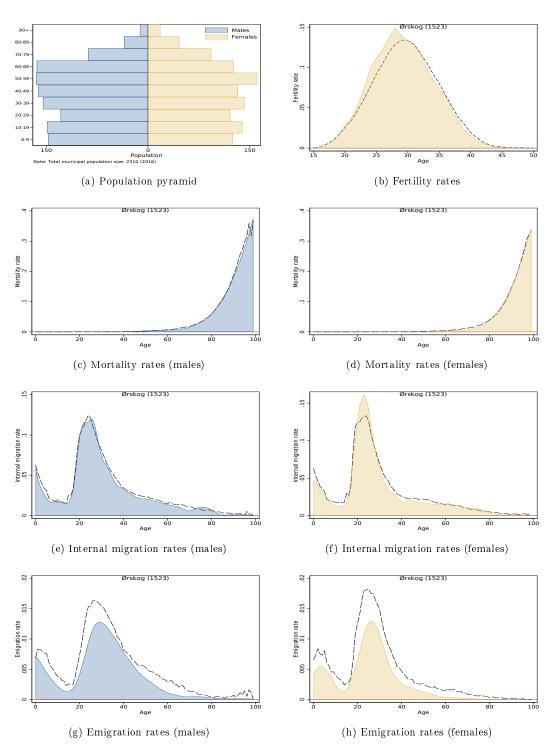


Figure D263: Municipal demographic characteristics

Norddal (1524)

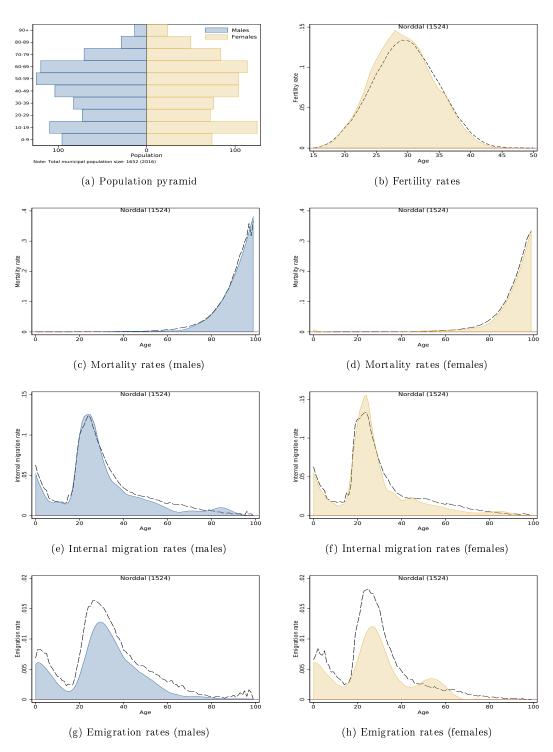
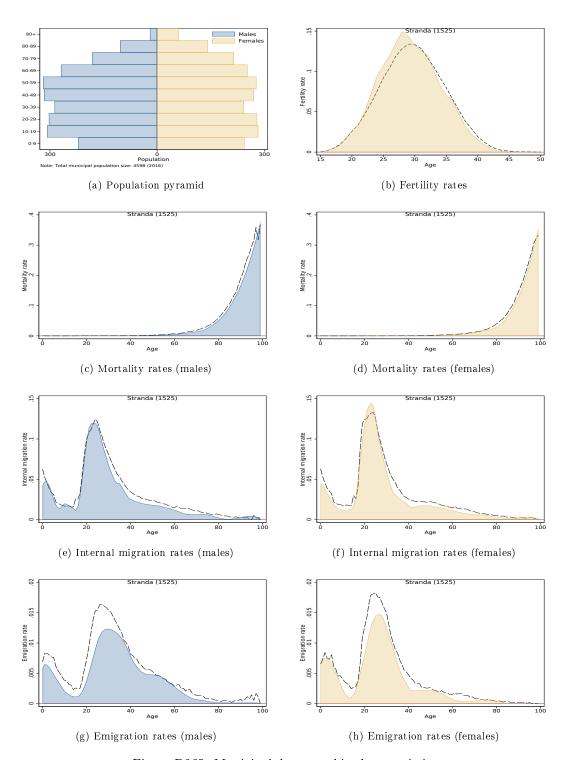


Figure D264: Municipal demographic characteristics

Stranda (1525)



 $Figure\ D265:\ Municipal\ demographic\ characteristics$

Stordal (1526)

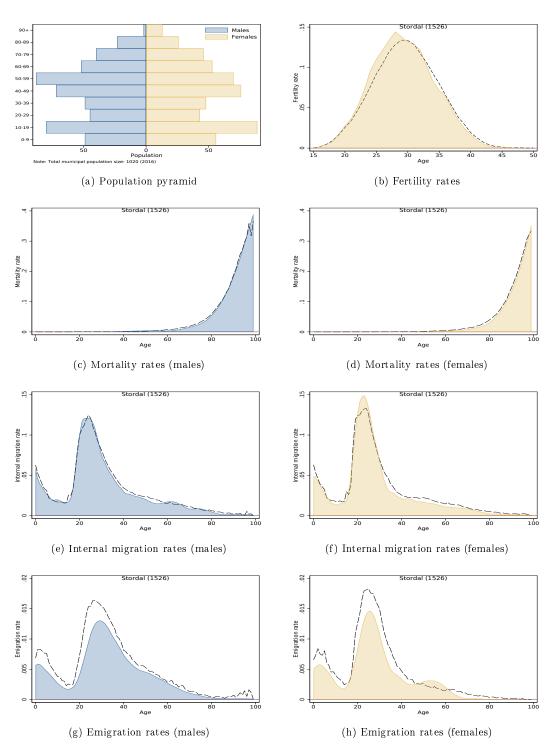


Figure D266: Municipal demographic characteristics

Sykkylven (1528)

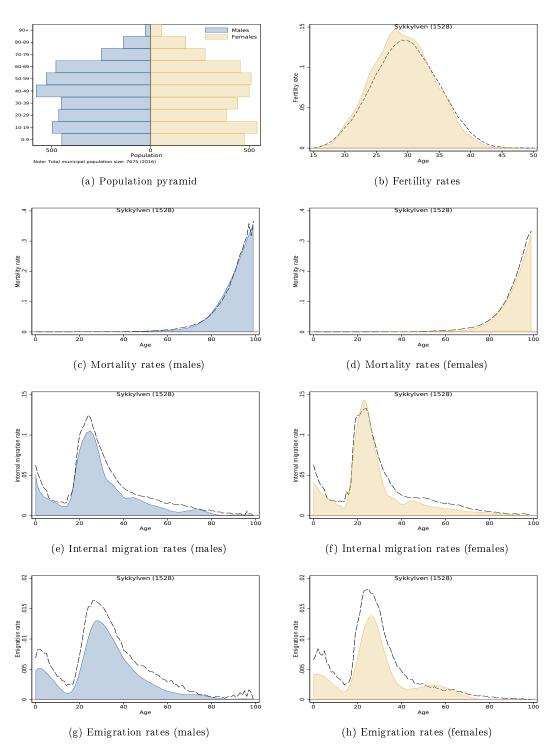


Figure D267: Municipal demographic characteristics

Skodje (1529)

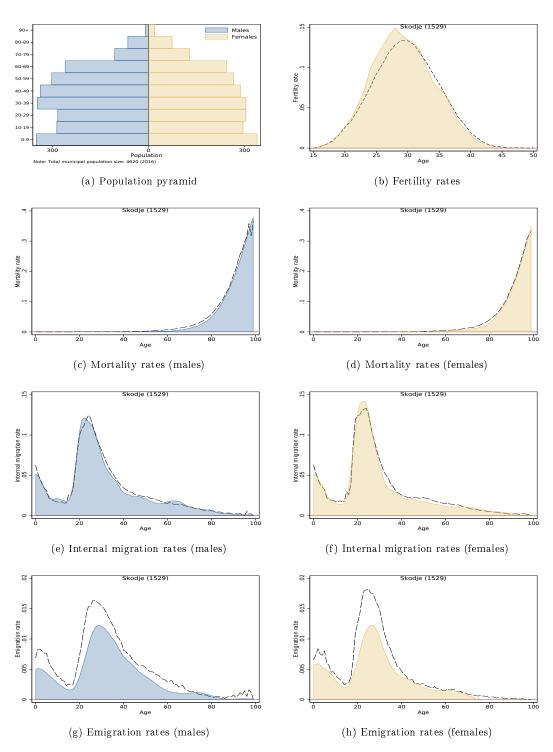
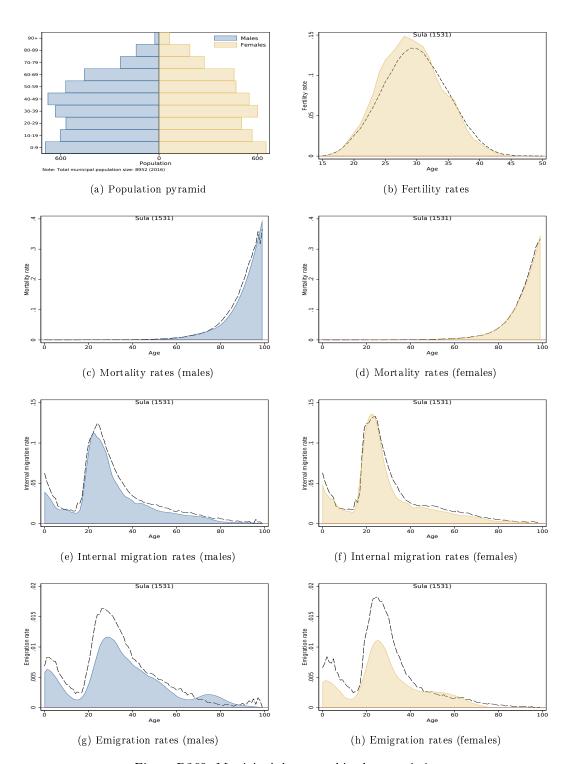


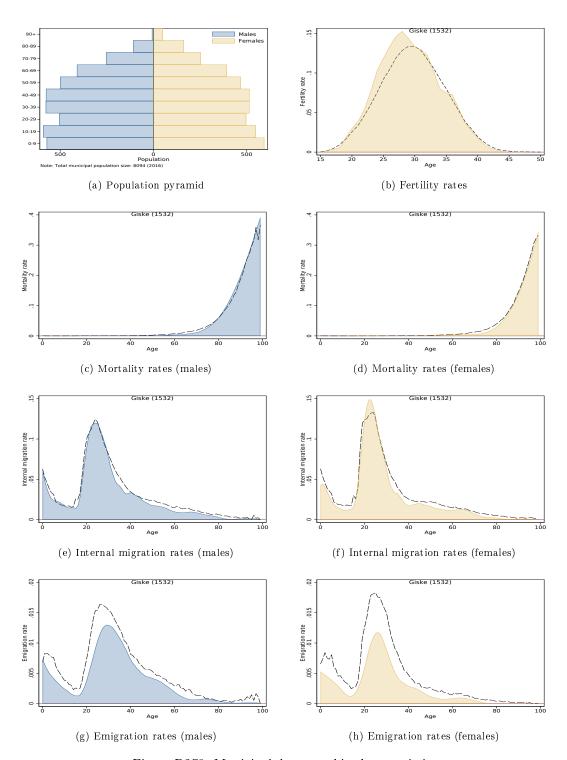
Figure D268: Municipal demographic characteristics

Sula (1531)



 $Figure\ D269:\ Municipal\ demographic\ characteristics$

Giske (1532)



 $Figure\ D270:\ Municipal\ demographic\ characteristics$

Haram (1534)

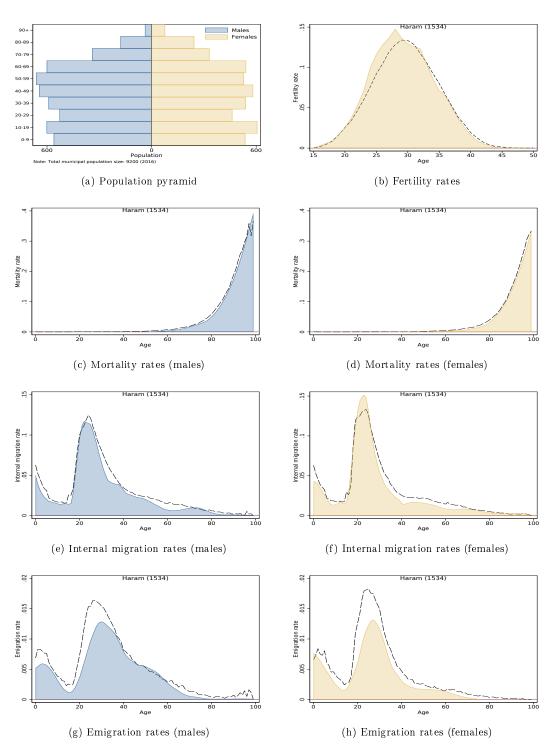


Figure D271: Municipal demographic characteristics

Vestnes (1535)

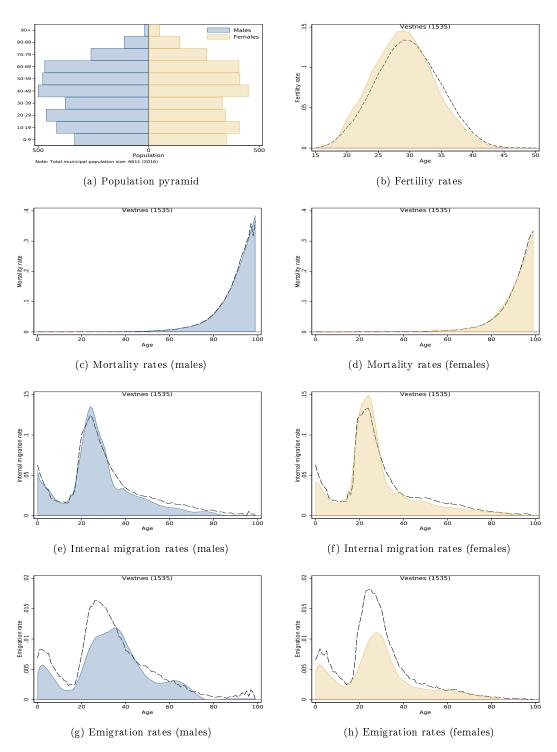


Figure D272: Municipal demographic characteristics

Rauma (1539)

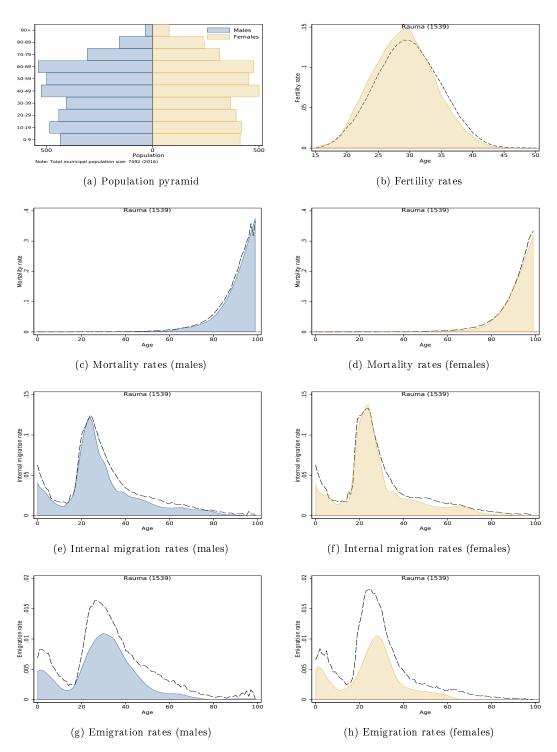


Figure D273: Municipal demographic characteristics

Nesset (1543)

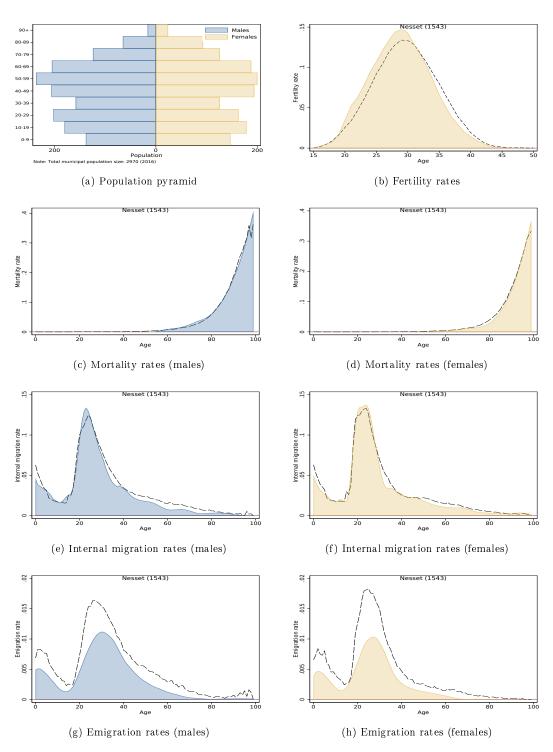


Figure D274: Municipal demographic characteristics

Midsund (1545)

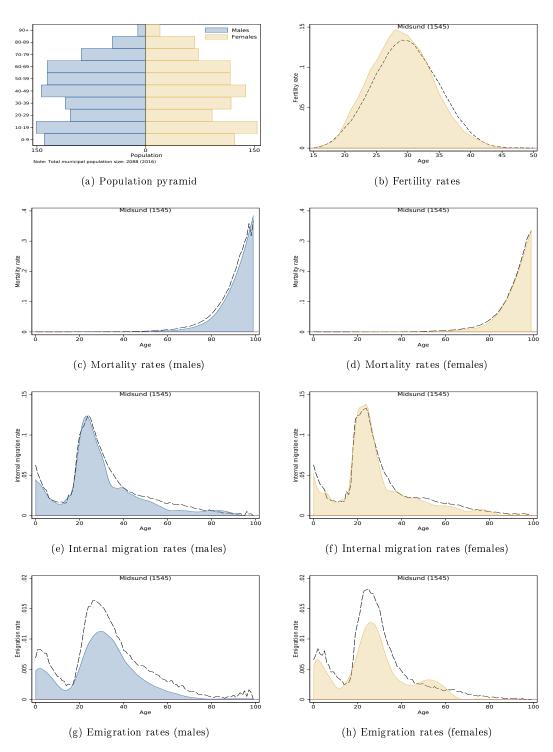


Figure D275: Municipal demographic characteristics

Sandøy (1546)

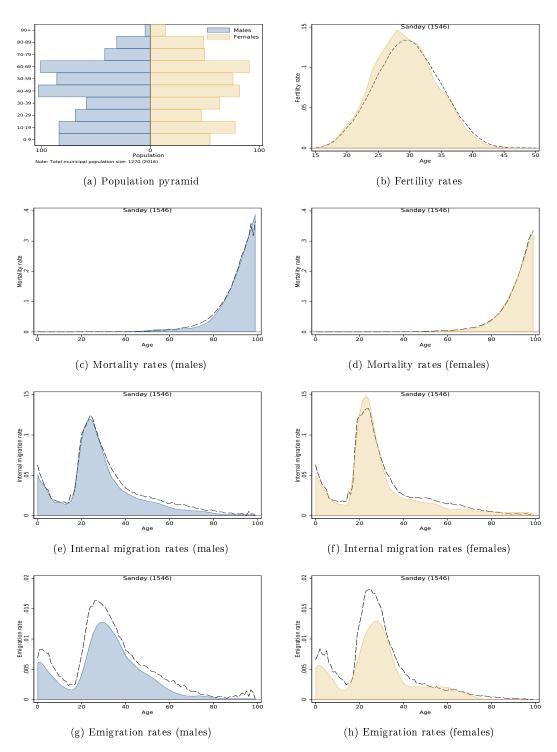


Figure D276: Municipal demographic characteristics

Aukra (1547)

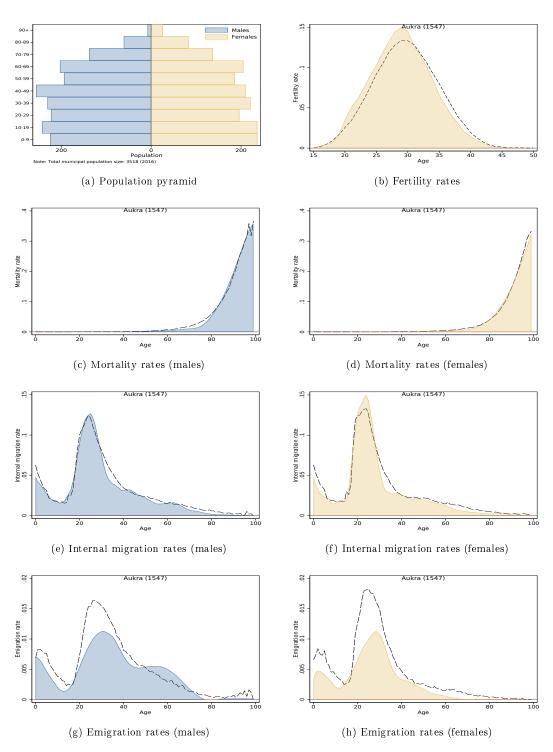
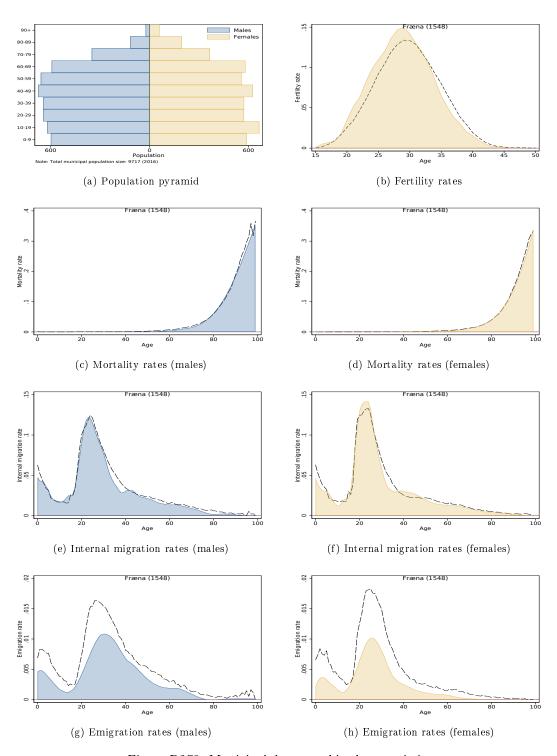


Figure D277: Municipal demographic characteristics

Fræna (1548)



 $Figure\ D278:\ Municipal\ demographic\ characteristics$

Eide (1551)

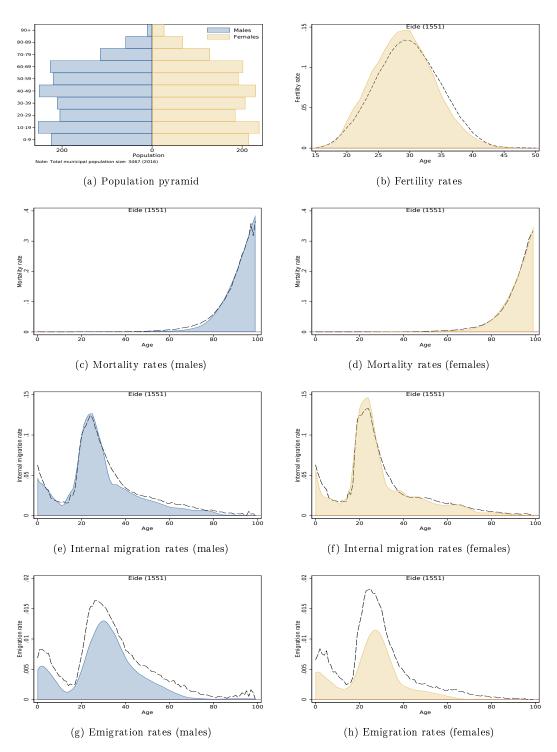


Figure D279: Municipal demographic characteristics

Averøy (1554)

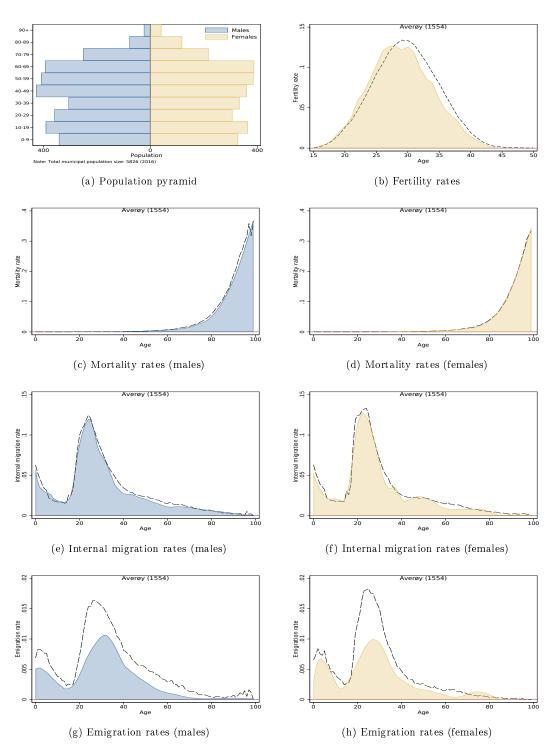


Figure D280: Municipal demographic characteristics

Gjemnes (1557)

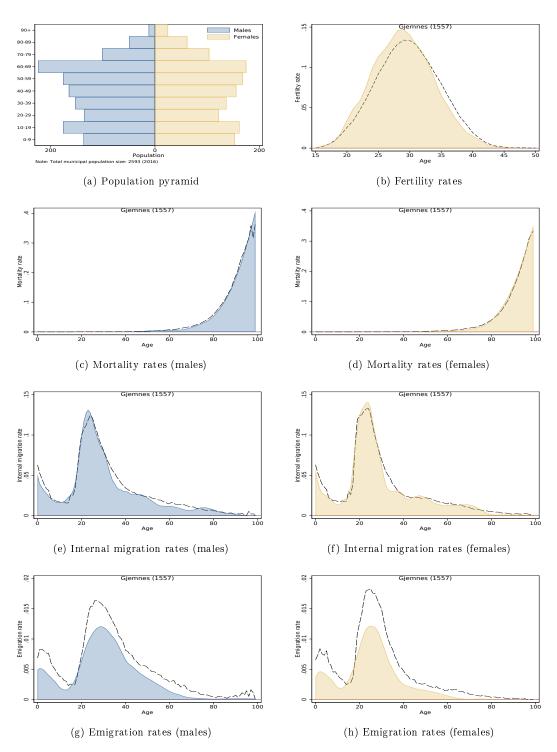


Figure D281: Municipal demographic characteristics

Tingvoll (1560)

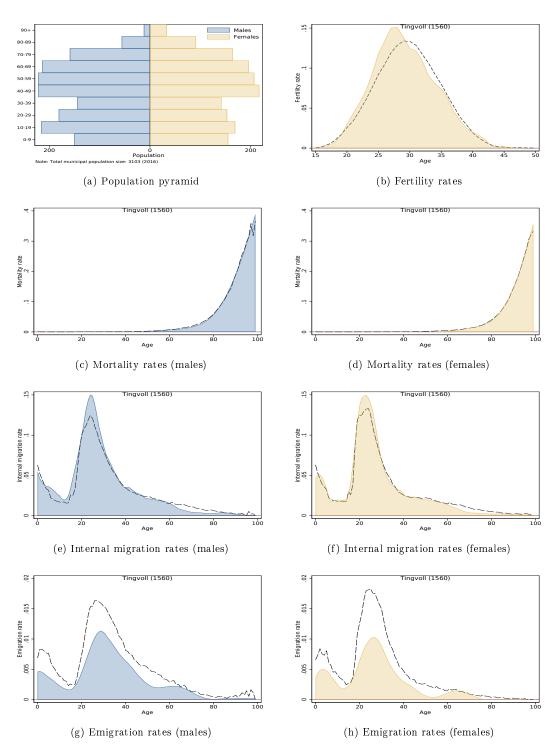


Figure D282: Municipal demographic characteristics

Sunndal (1563)

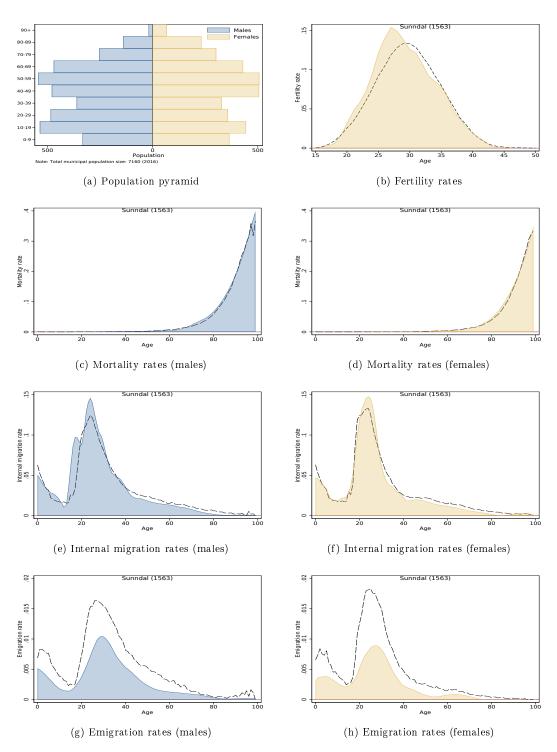


Figure D283: Municipal demographic characteristics

Surnadal (1566)

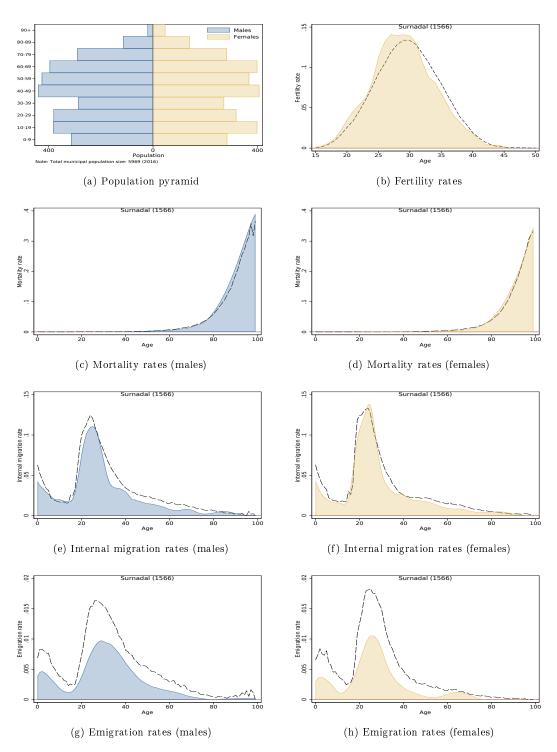
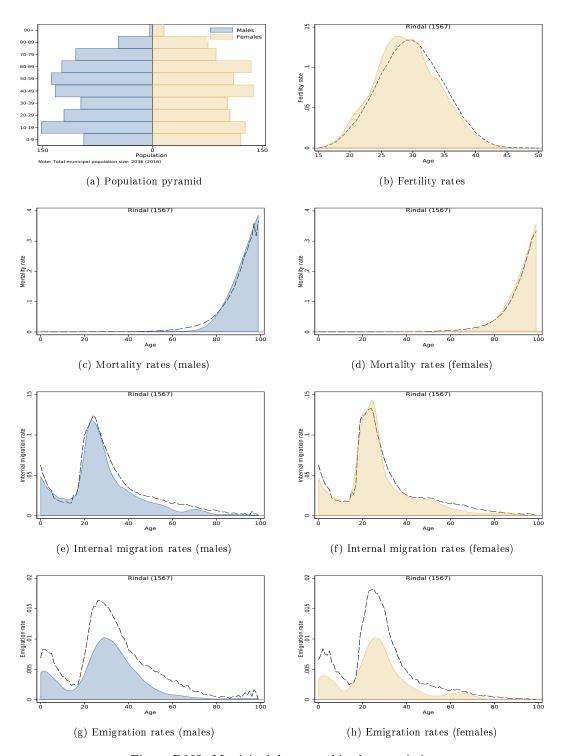


Figure D284: Municipal demographic characteristics

Rindal (1567)



 $Figure\ D285:\ Municipal\ demographic\ characteristics$

Halsa (1571)

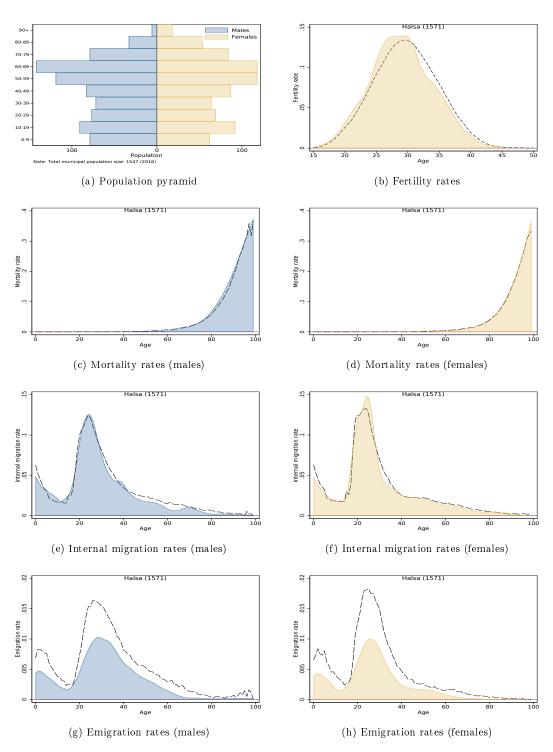


Figure D286: Municipal demographic characteristics

Smøla (1573)

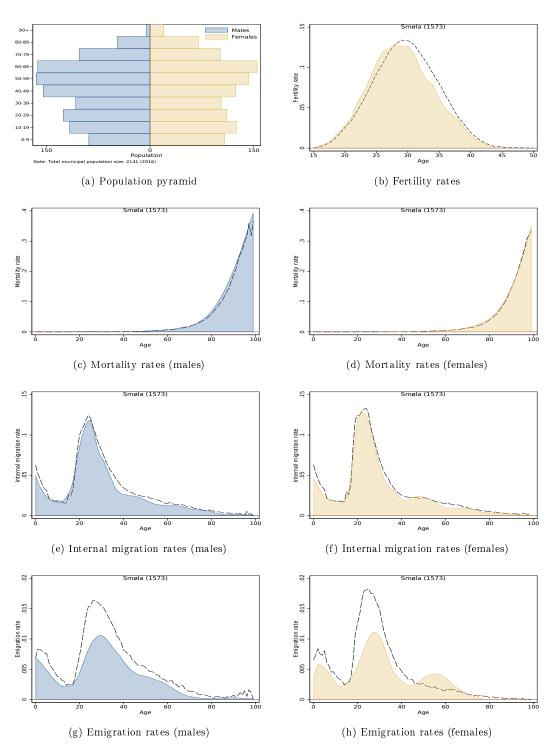
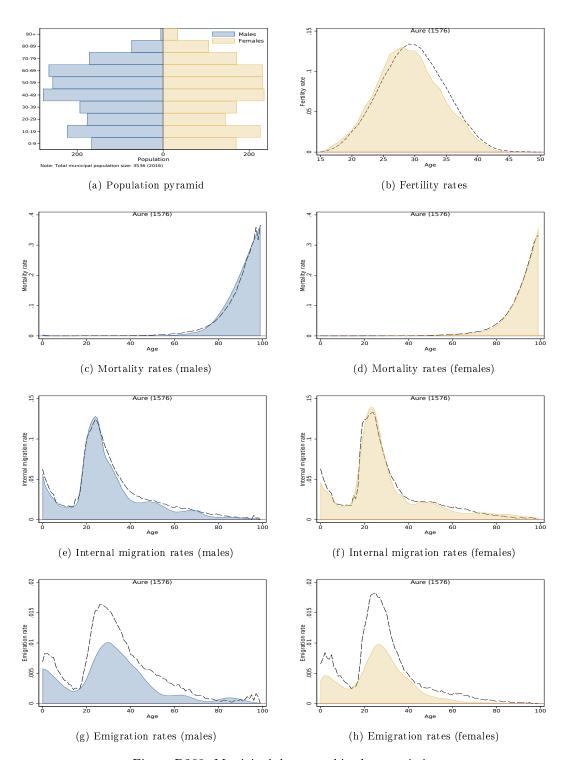


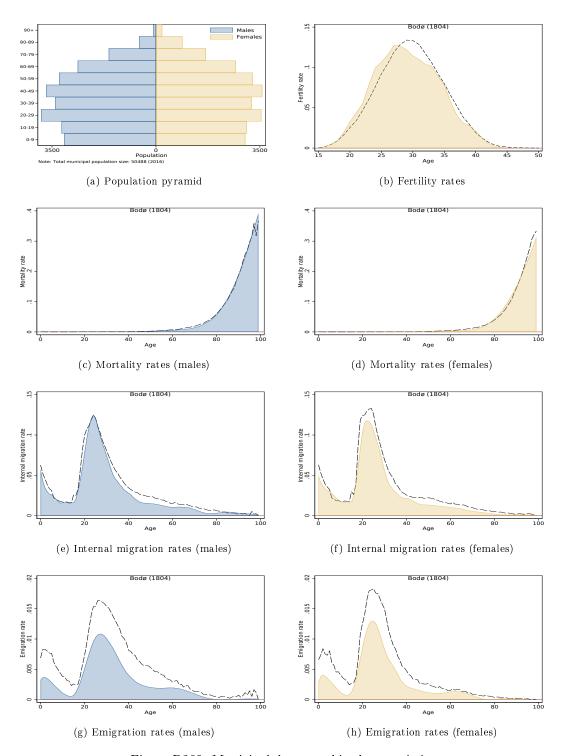
Figure D287: Municipal demographic characteristics

Aure (1576)



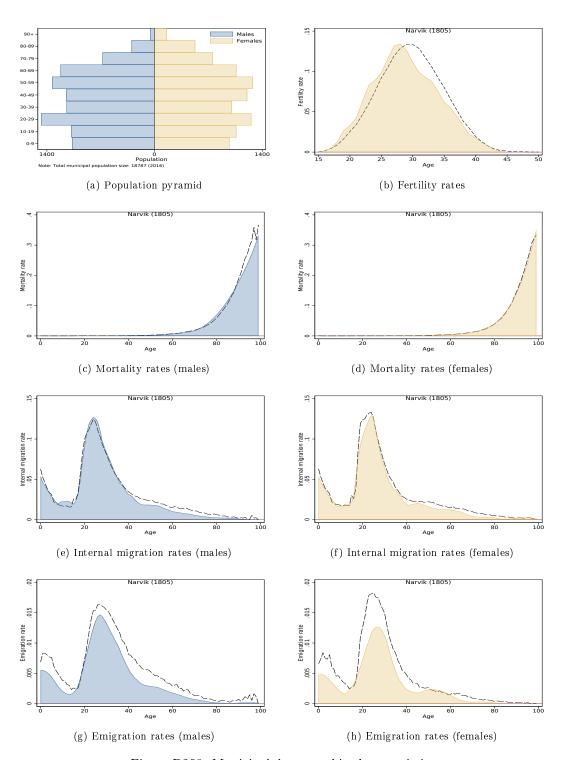
 $Figure\ D288:\ Municipal\ demographic\ characteristics$

Bodø(1804)



 $Figure\ D289:\ Municipal\ demographic\ characteristics$

Narvik (1805)



 $Figure\ D290:\ Municipal\ demographic\ characteristics$

Bindal (1811)

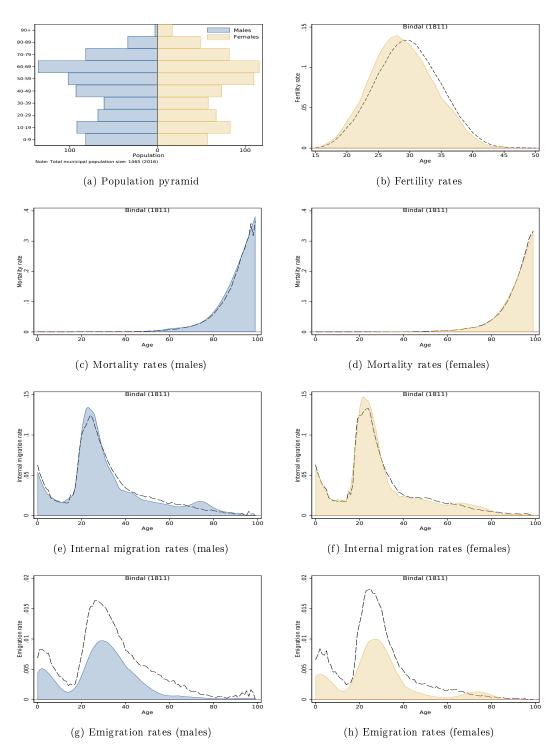


Figure D291: Municipal demographic characteristics

Sømna (1812)

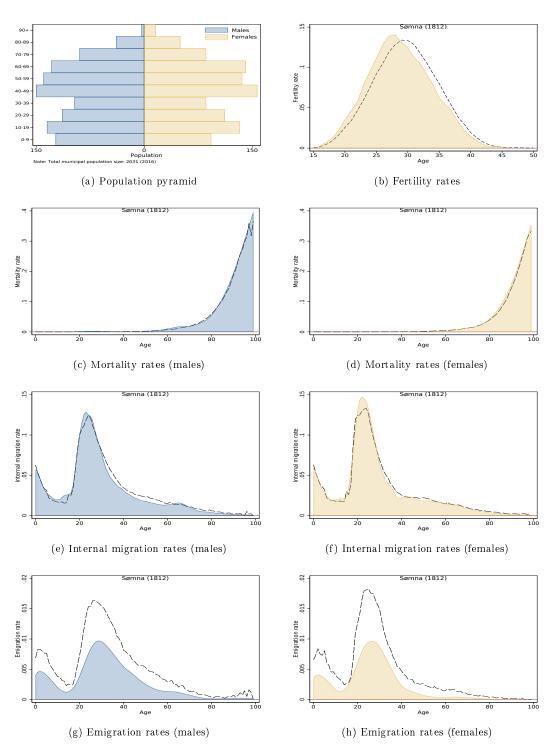


Figure D292: Municipal demographic characteristics

Brønnøy (1813)

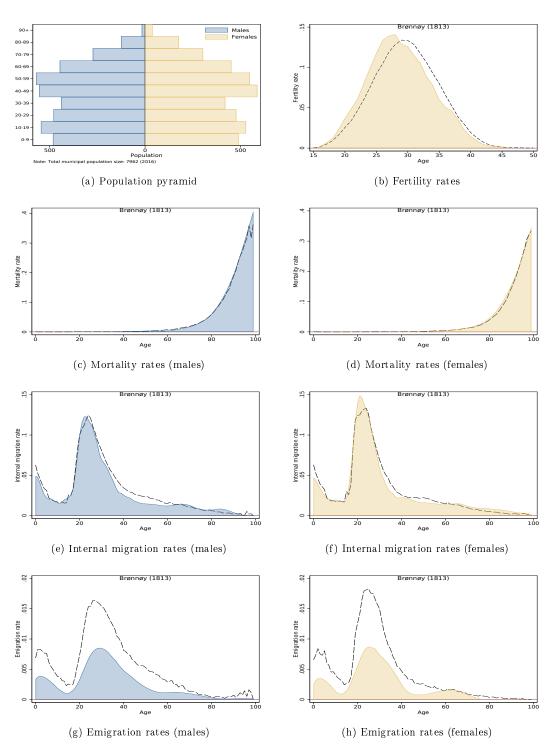


Figure D293: Municipal demographic characteristics

Vega (1815)

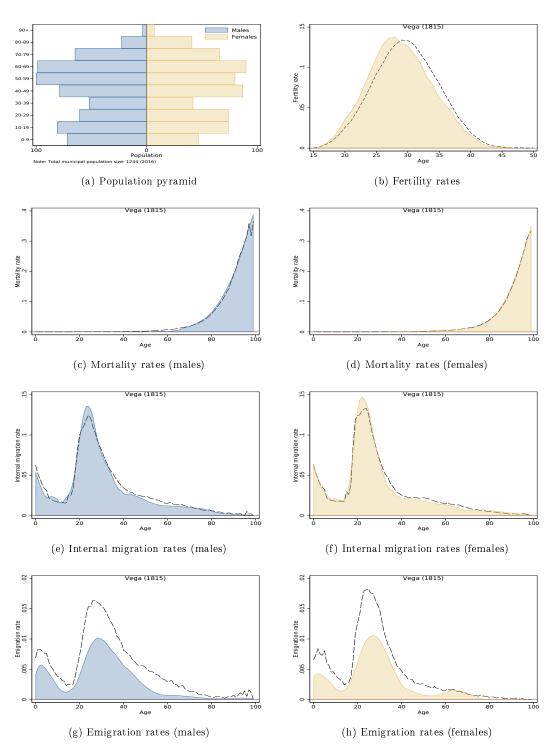


Figure D294: Municipal demographic characteristics

Vevelstad (1816)

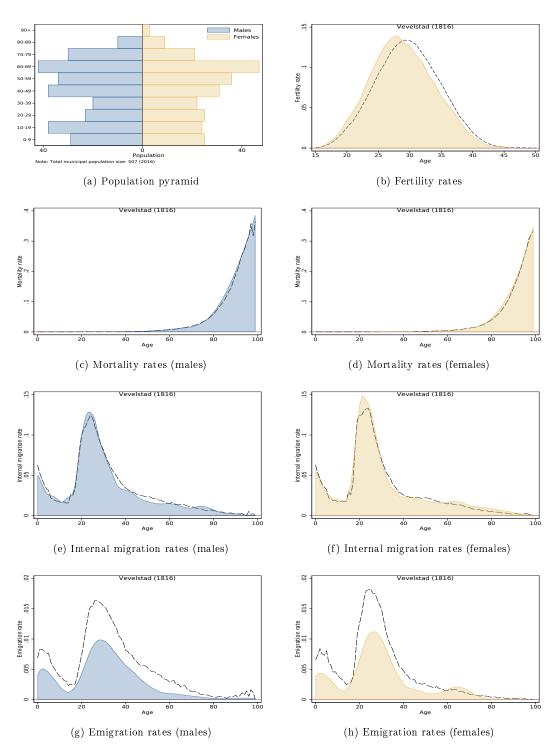


Figure D295: Municipal demographic characteristics

Herøy (1818)

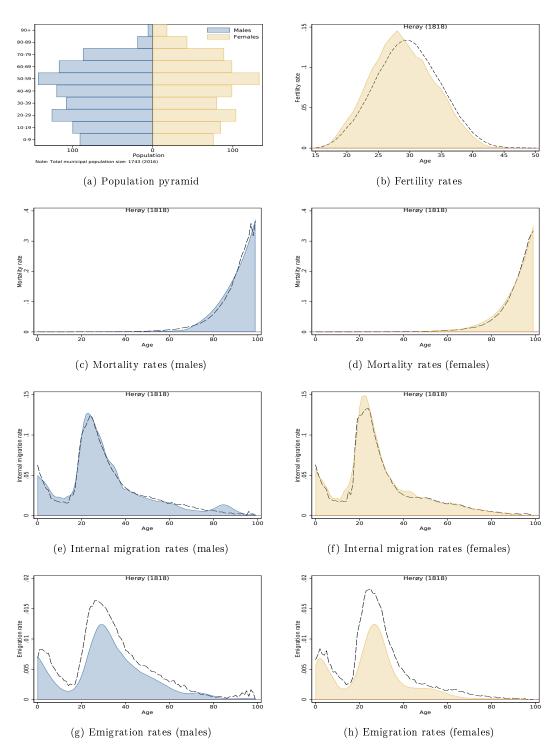


Figure D296: Municipal demographic characteristics

Alstahaug (1820)

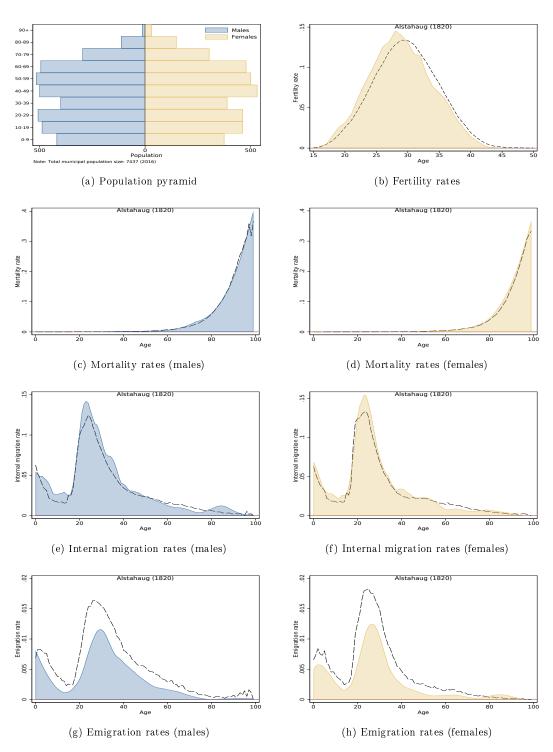


Figure D297: Municipal demographic characteristics

Leirfjord (1822)

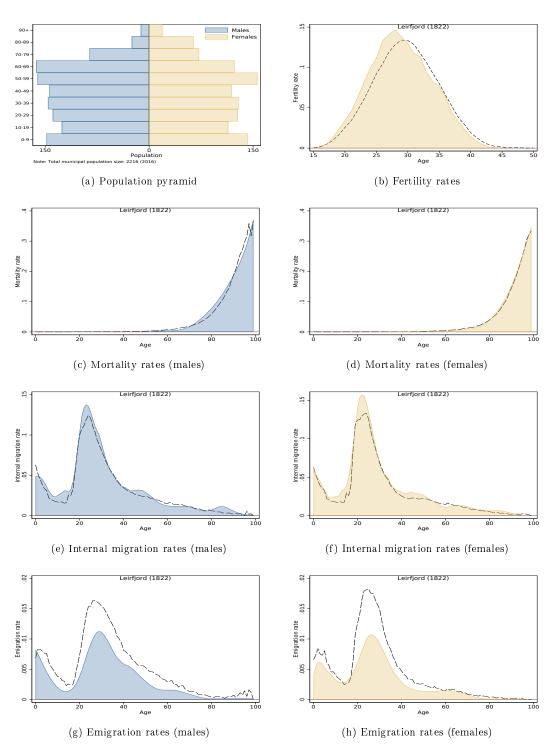


Figure D298: Municipal demographic characteristics

Vefsn (1824)

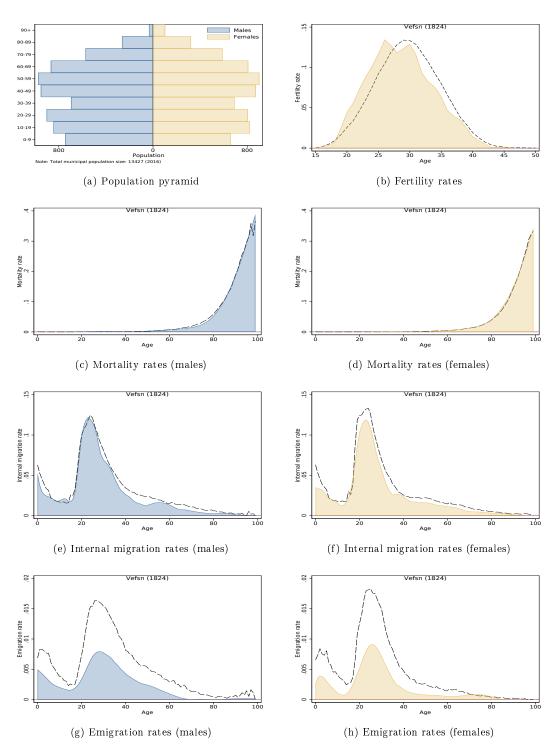


Figure D299: Municipal demographic characteristics

Grane (1825)

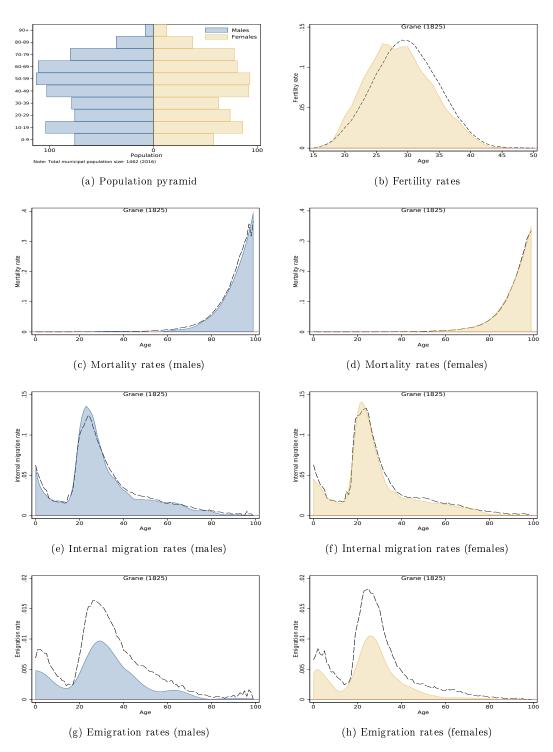
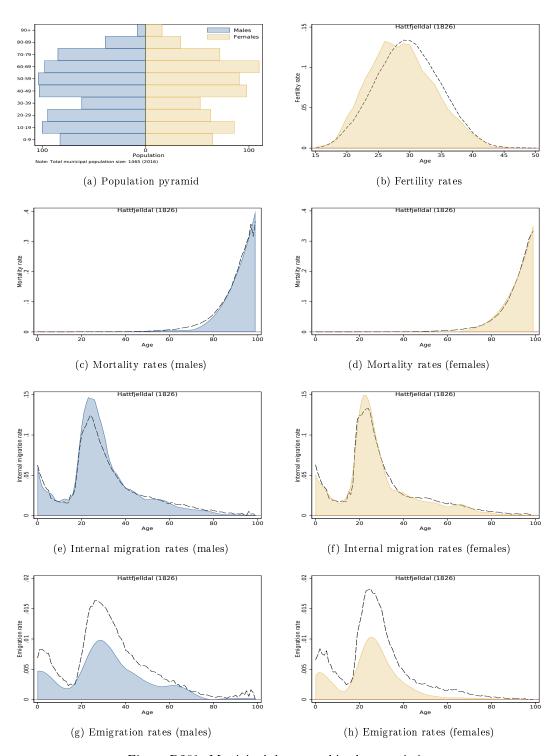


Figure D300: Municipal demographic characteristics

Hattfjelldal (1826)



 $Figure\ D301:\ Municipal\ demographic\ characteristics$

Dønna (1827)

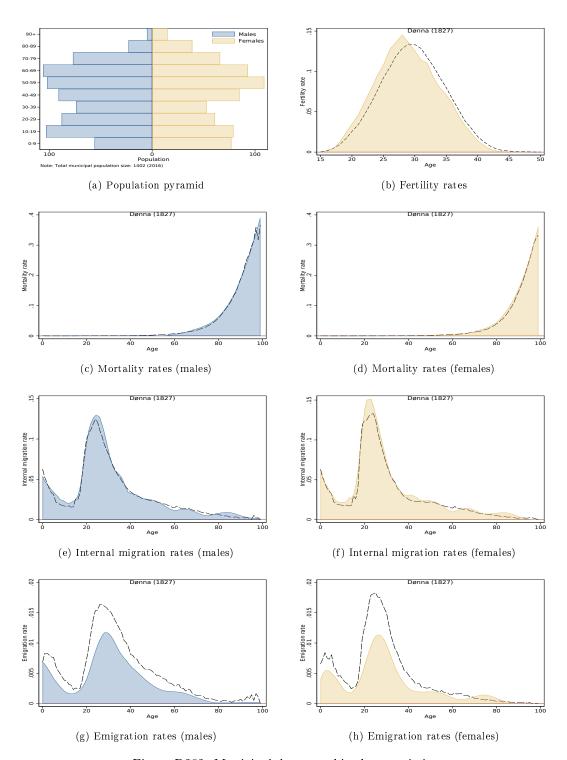


Figure D302: Municipal demographic characteristics

Nesna (1828)

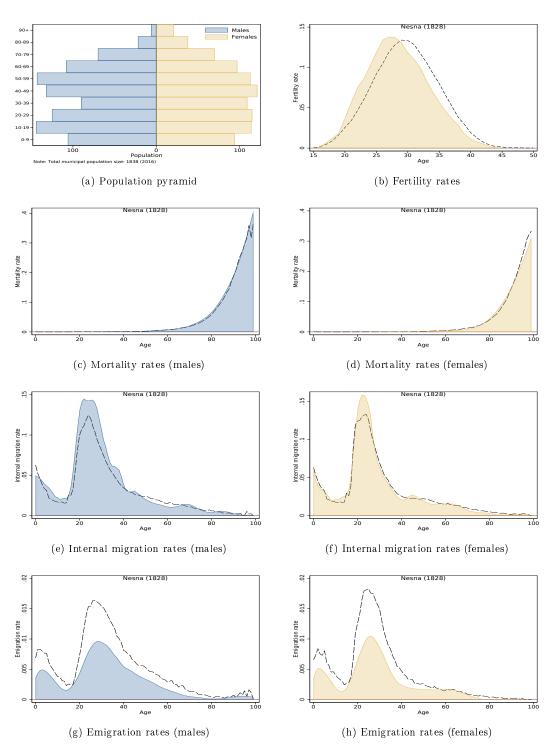


Figure D303: Municipal demographic characteristics

Hemnes (1832)

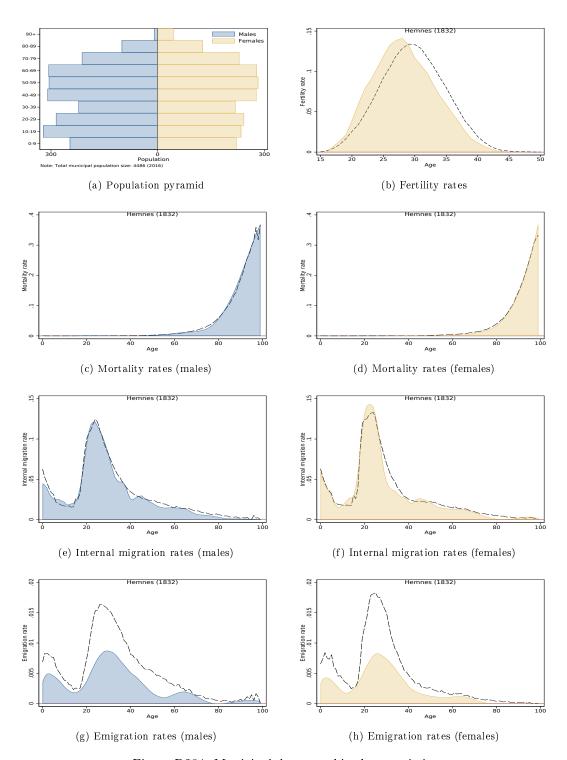


Figure D304: Municipal demographic characteristics

Rana (1833)

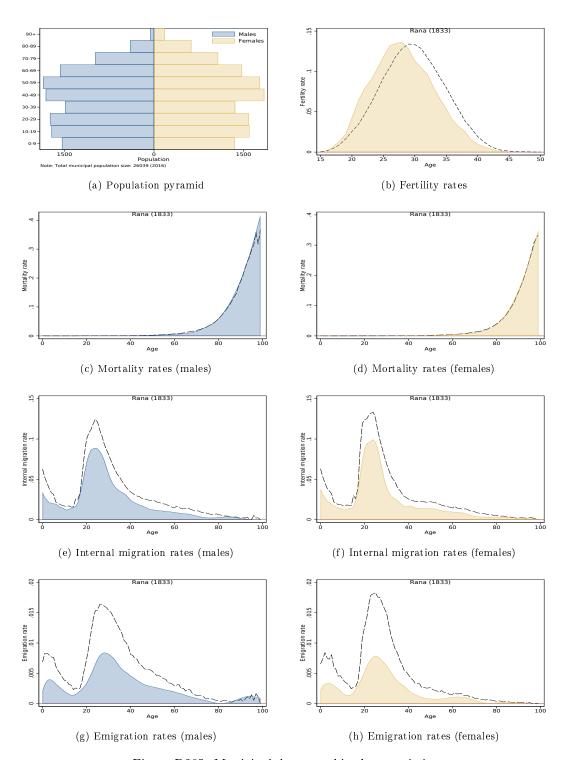
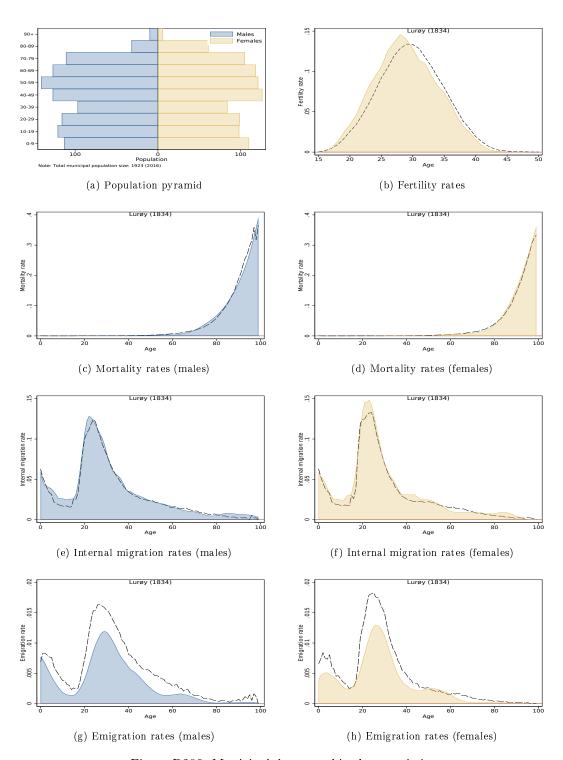


Figure D305: Municipal demographic characteristics

Lurøy (1834)



 $Figure\ D306:\ Municipal\ demographic\ characteristics$

Træna (1835)

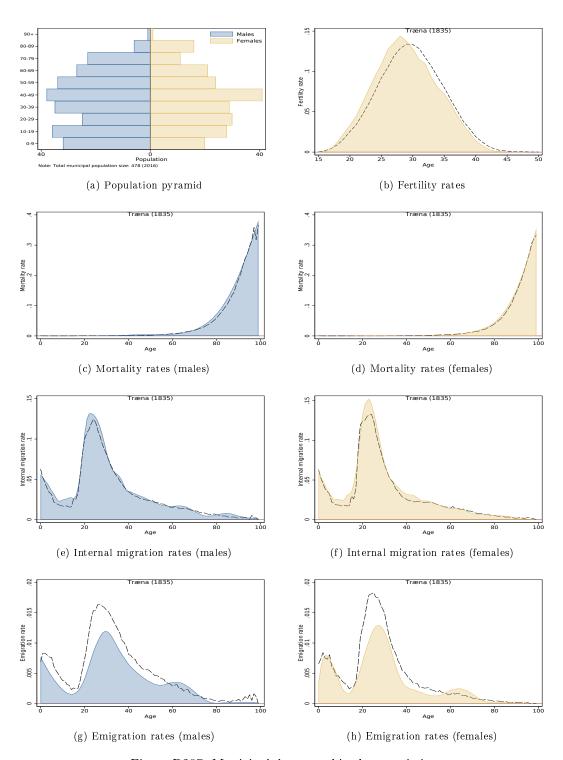


Figure D307: Municipal demographic characteristics

Rødøy (1836)

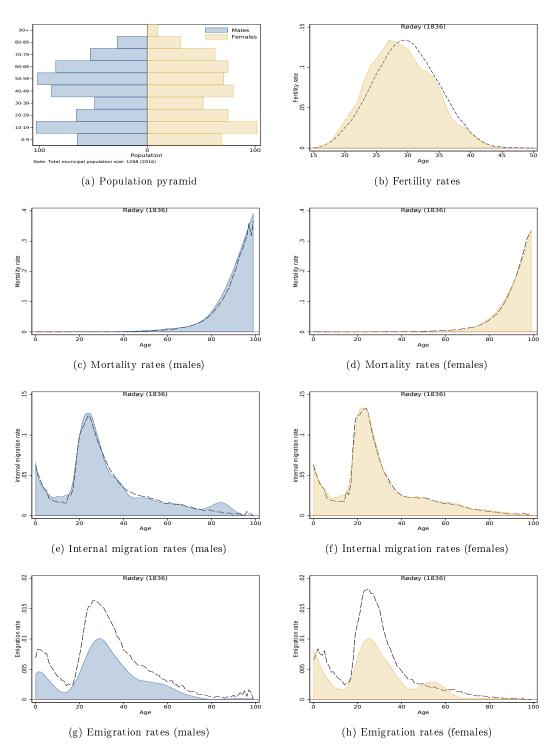


Figure D308: Municipal demographic characteristics

Meløy (1837)

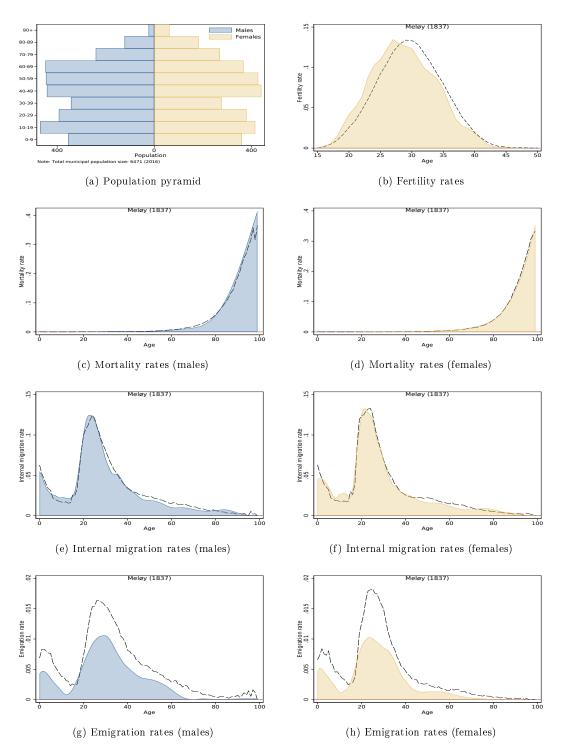


Figure D309: Municipal demographic characteristics

Gildeskål (1838)

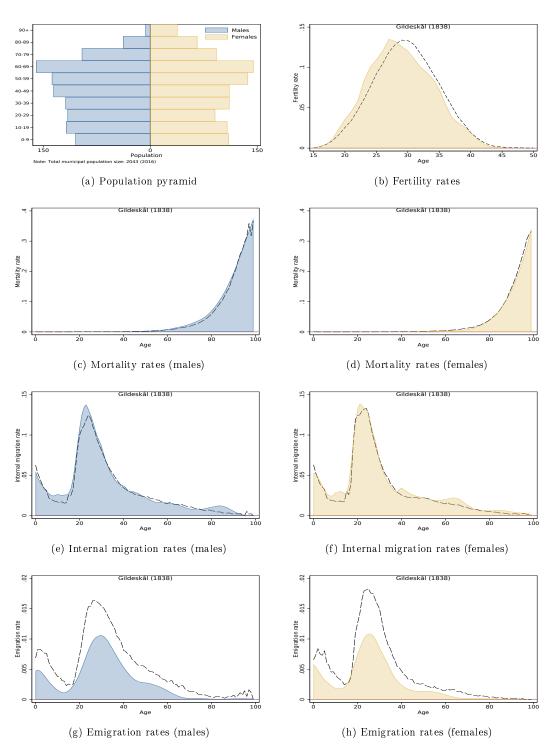
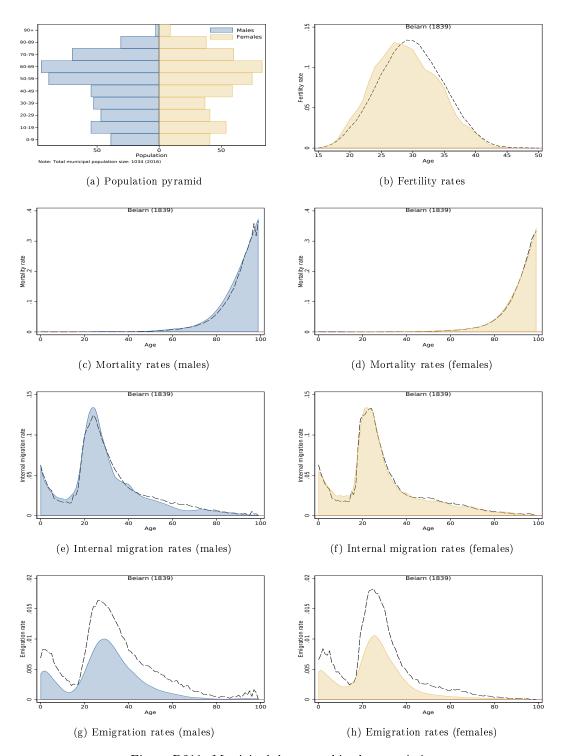


Figure D310: Municipal demographic characteristics

Beiarn (1839)



 $Figure\ D311:\ Municipal\ demographic\ characteristics$

Saltdal (1840)

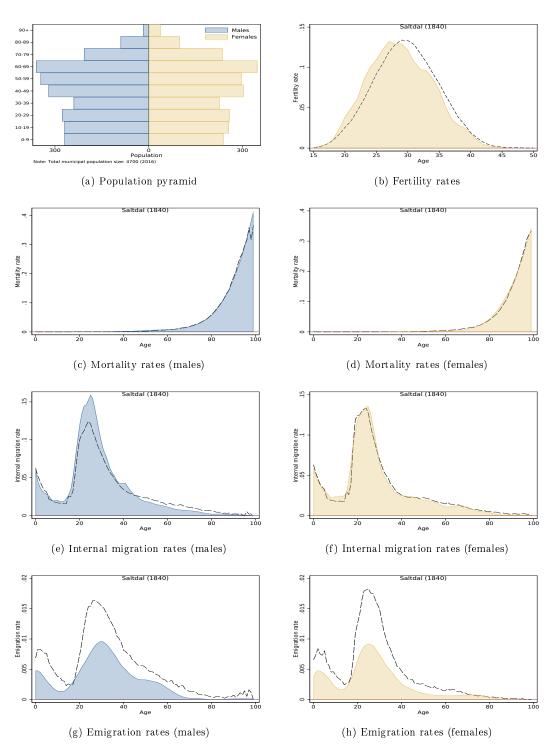
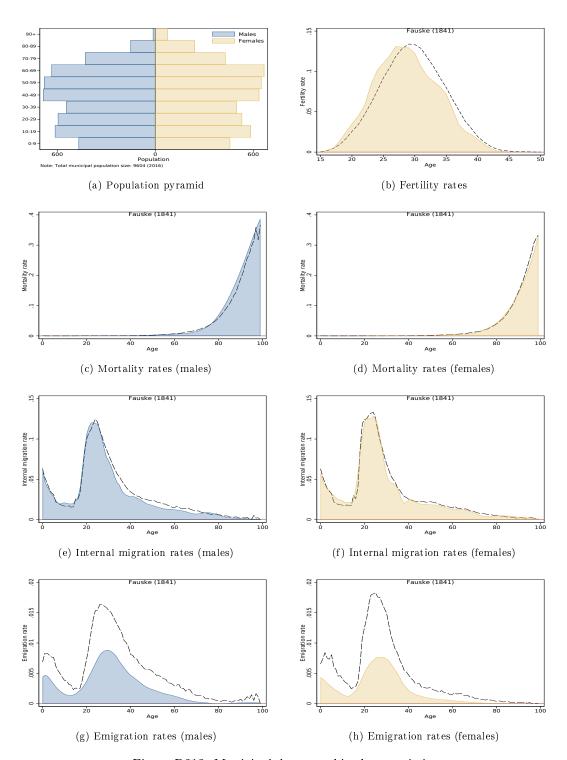


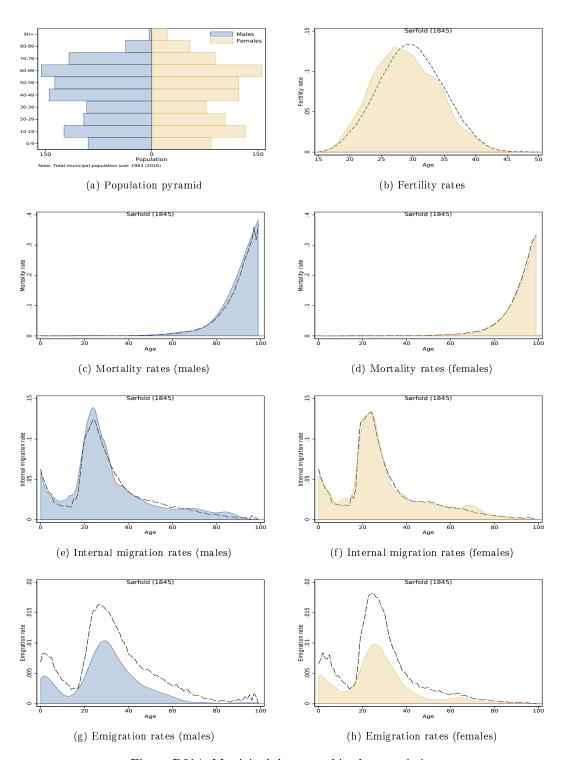
Figure D312: Municipal demographic characteristics

Fauske (1841)



 $Figure\ D313:\ Municipal\ demographic\ characteristics$

Sørfold (1845)



 $Figure\ D314:\ Municipal\ demographic\ characteristics$

Steigen (1848)

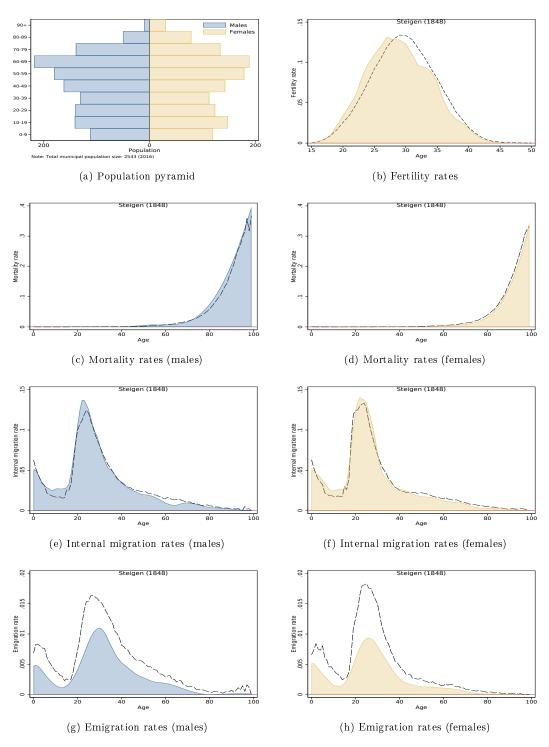


Figure D315: Municipal demographic characteristics

Hamarøy (1849)

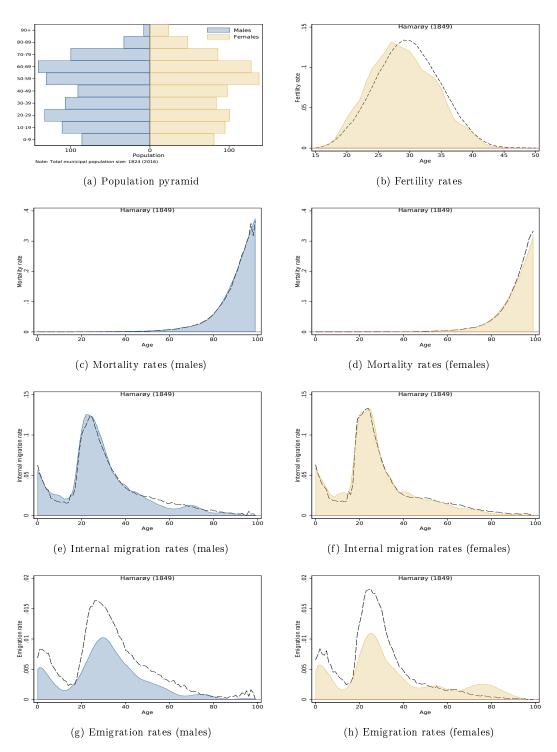


Figure D316: Municipal demographic characteristics

Tysfjord (1850)

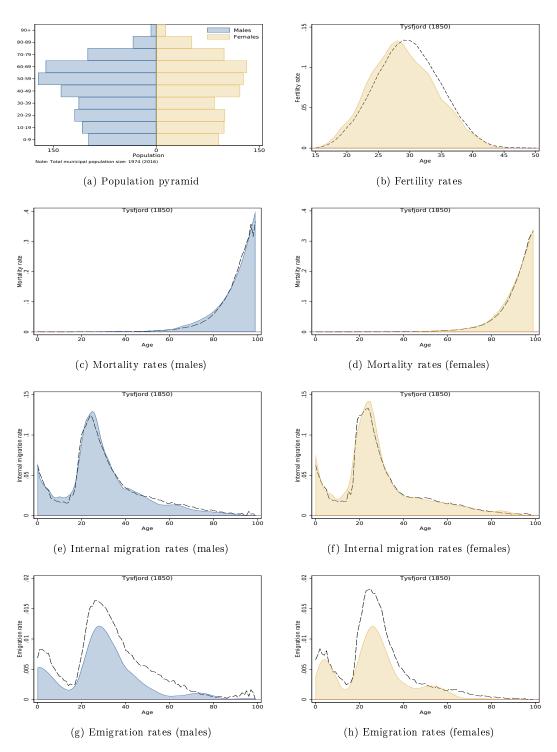


Figure D317: Municipal demographic characteristics

Lødingen (1851)

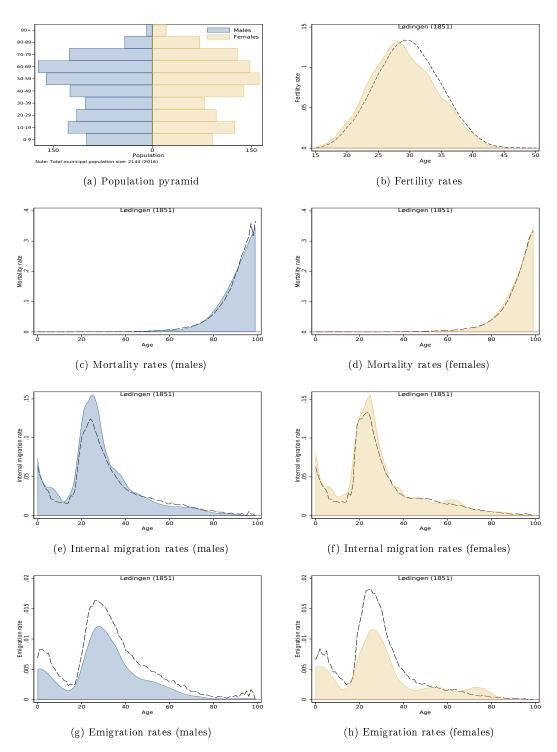


Figure D318: Municipal demographic characteristics

Tjeldsund (1852)

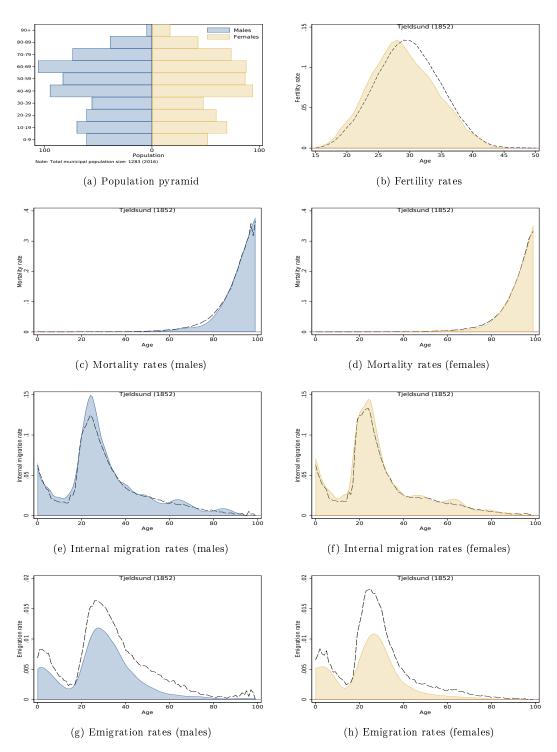


Figure D319: Municipal demographic characteristics

Evenes (1853)

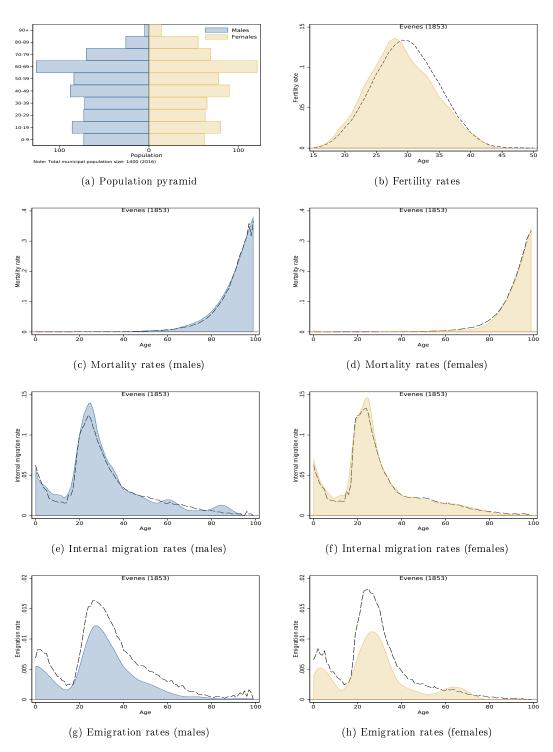


Figure D320: Municipal demographic characteristics

Ballangen (1854)

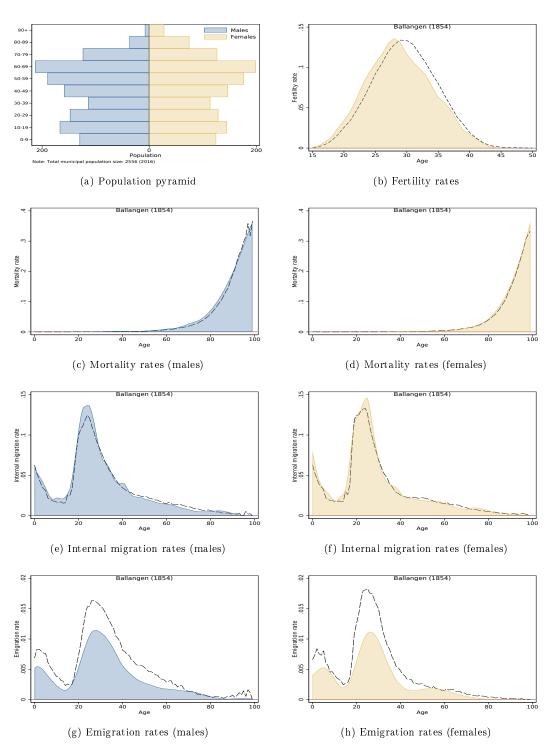
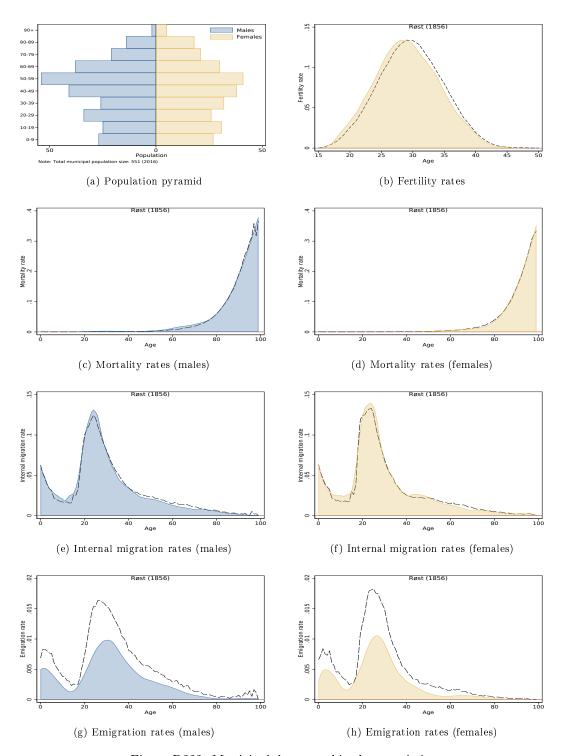


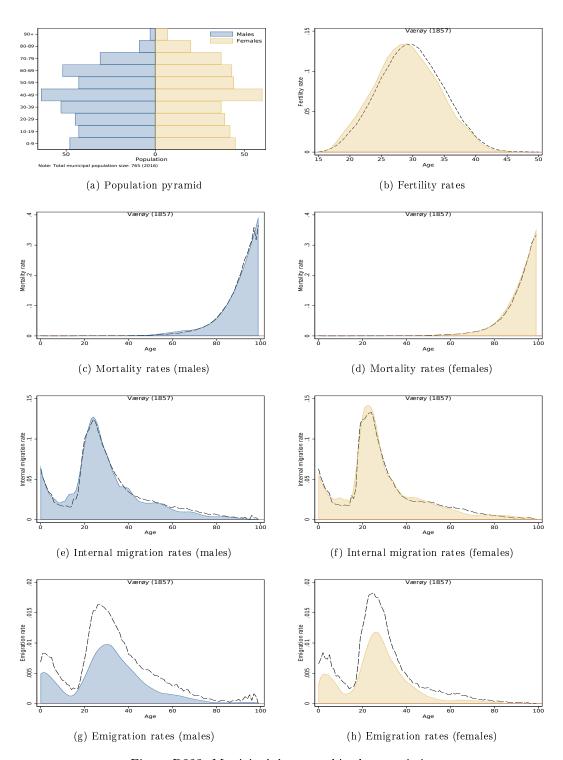
Figure D321: Municipal demographic characteristics

Røst (1856)



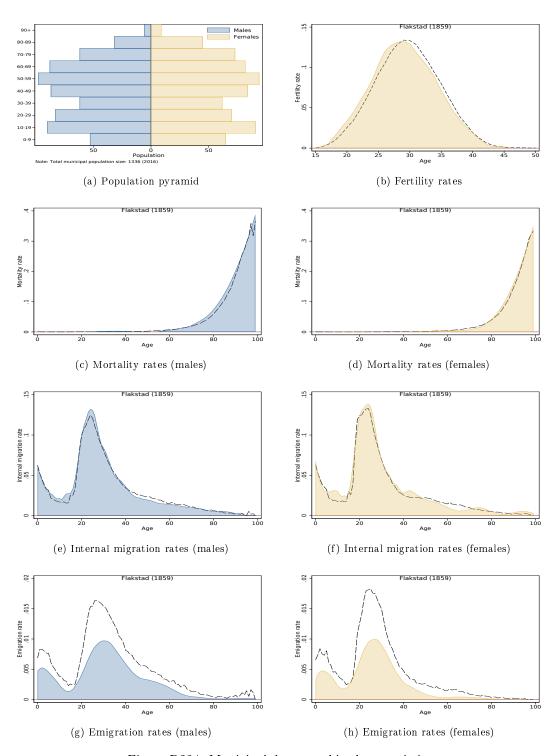
 $Figure\ D322:\ Municipal\ demographic\ characteristics$

Værøy (1857)



 $Figure\ D323:\ Municipal\ demographic\ characteristics$

Flakstad (1859)



 $Figure\ D324:\ Municipal\ demographic\ characteristics$

Vestvågøy (1860)

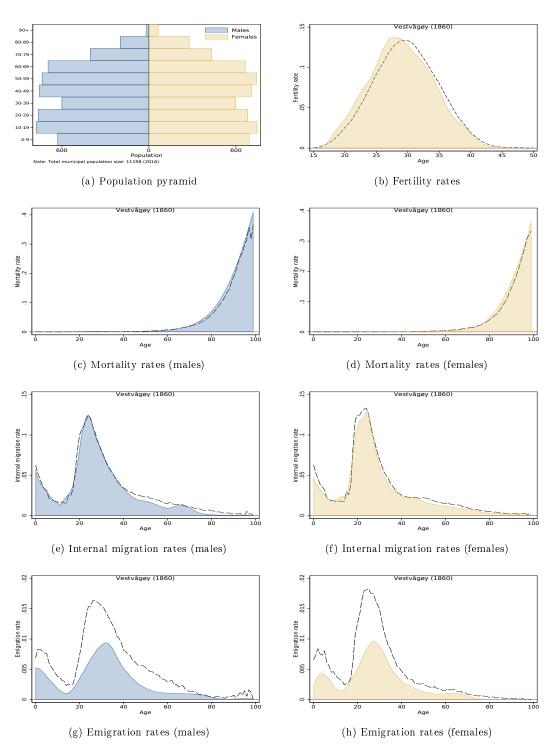
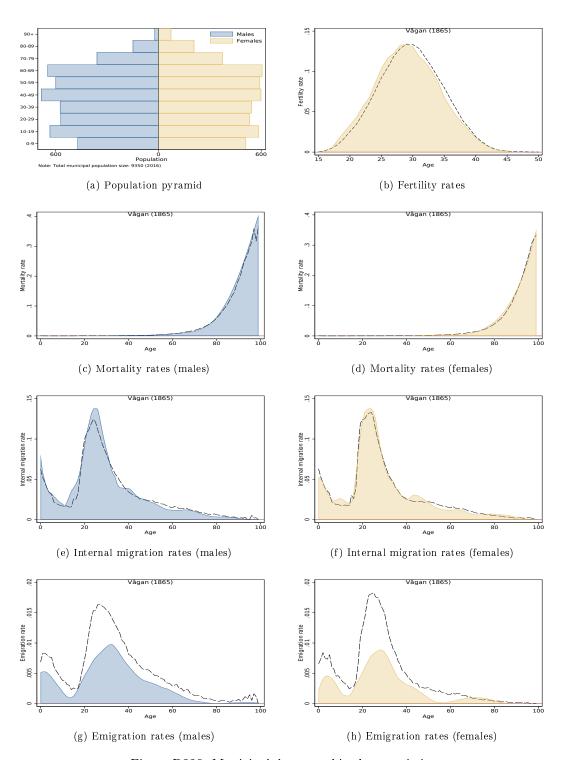


Figure D325: Municipal demographic characteristics

Vågan (1865)



 $Figure\ D326:\ Municipal\ demographic\ characteristics$

Hadsel (1866)

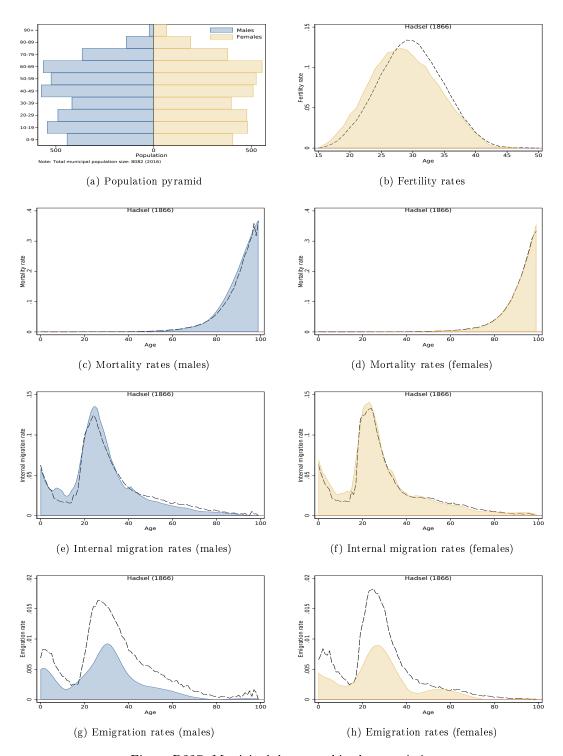


Figure D327: Municipal demographic characteristics

Bø(1867)

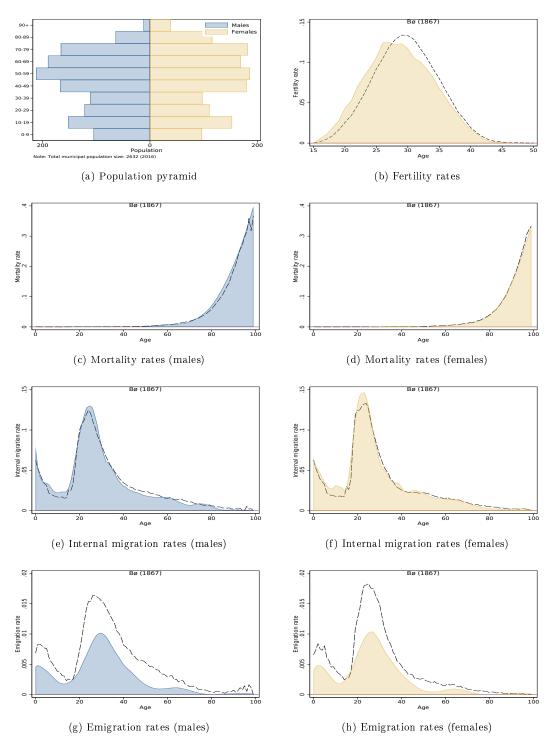
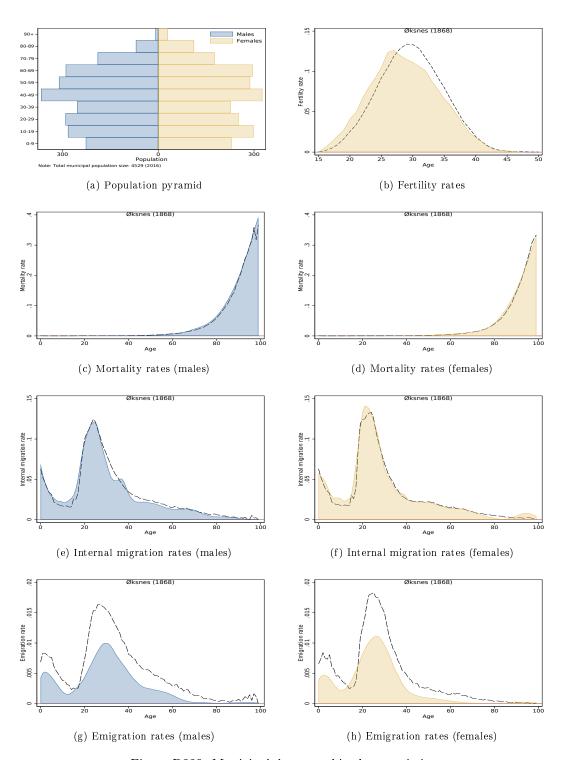


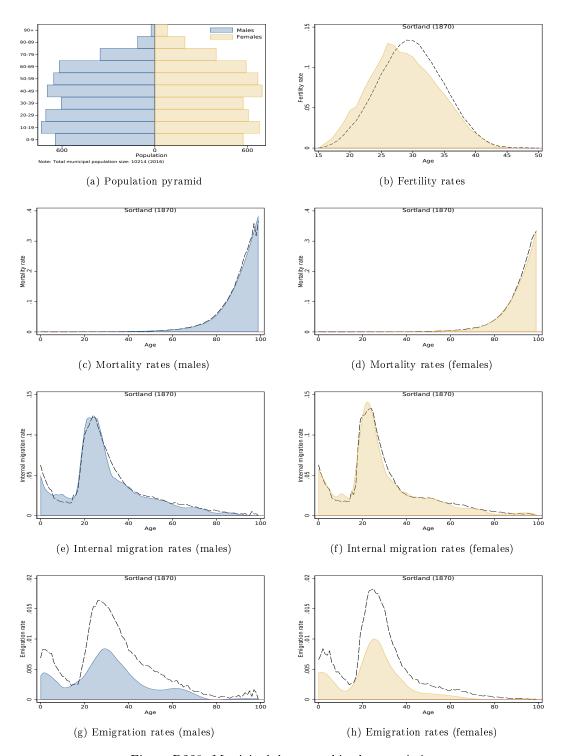
Figure D328: Municipal demographic characteristics

Øksnes (1868)



 $Figure\ D329:\ Municipal\ demographic\ characteristics$

Sortland (1870)



 $Figure\ D330:\ Municipal\ demographic\ characteristics$

Andøy (1871)

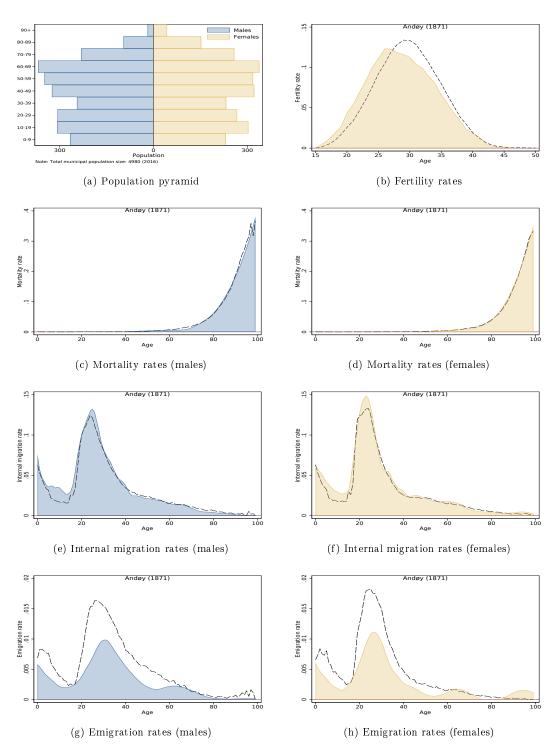


Figure D331: Municipal demographic characteristics

Moskenes (1874)

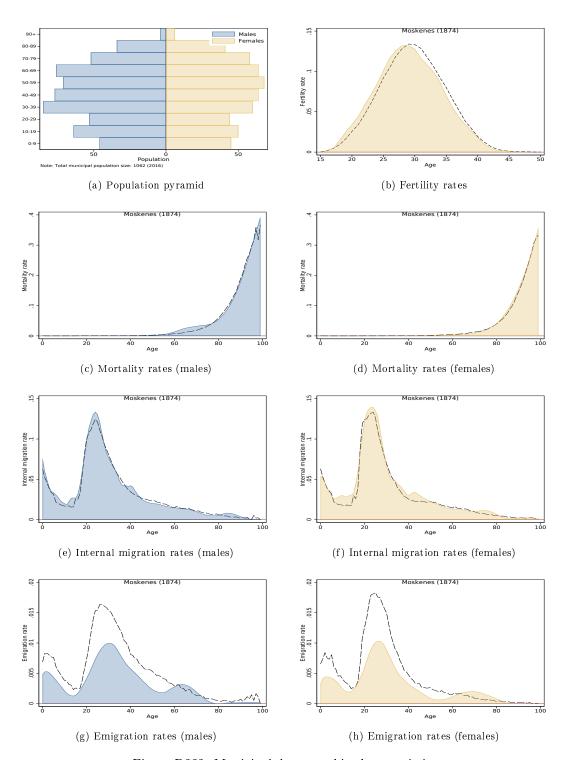


Figure D332: Municipal demographic characteristics

Tromsø(1902)

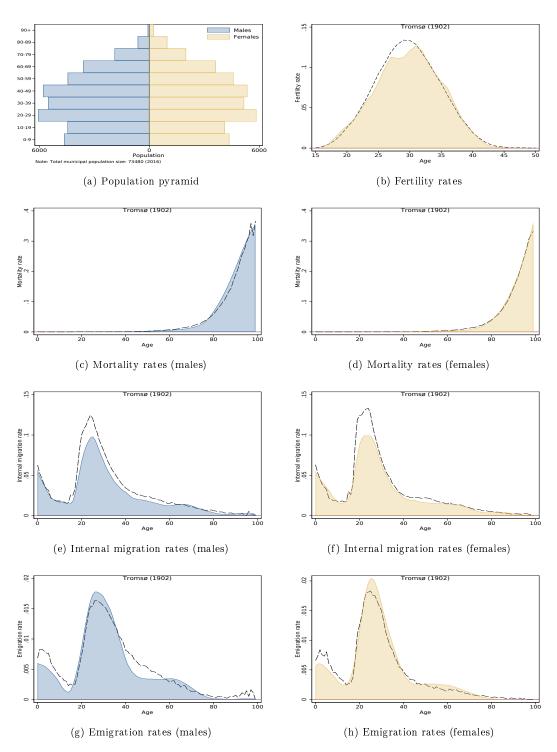


Figure D333: Municipal demographic characteristics

Harstad (1903)

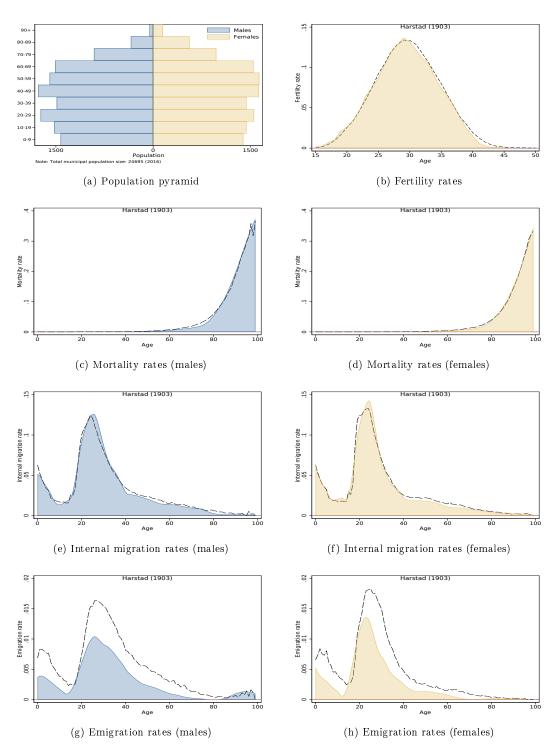


Figure D334: Municipal demographic characteristics

Kvæfjord (1911)

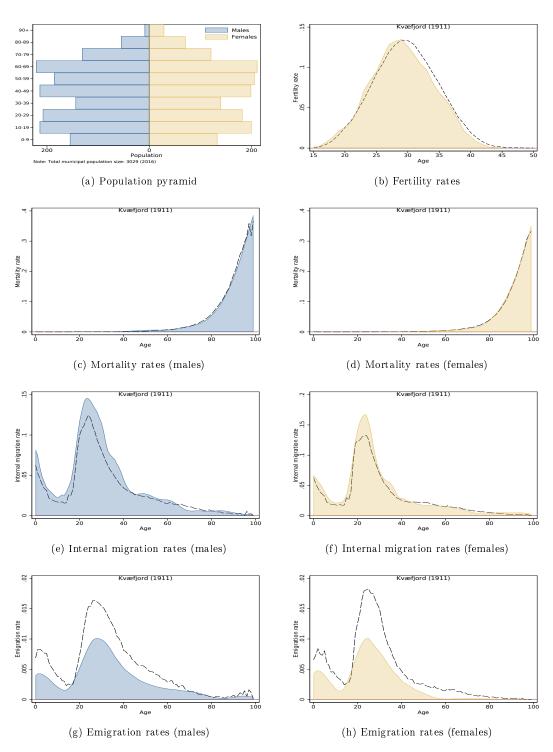


Figure D335: Municipal demographic characteristics

Skånland (1913)

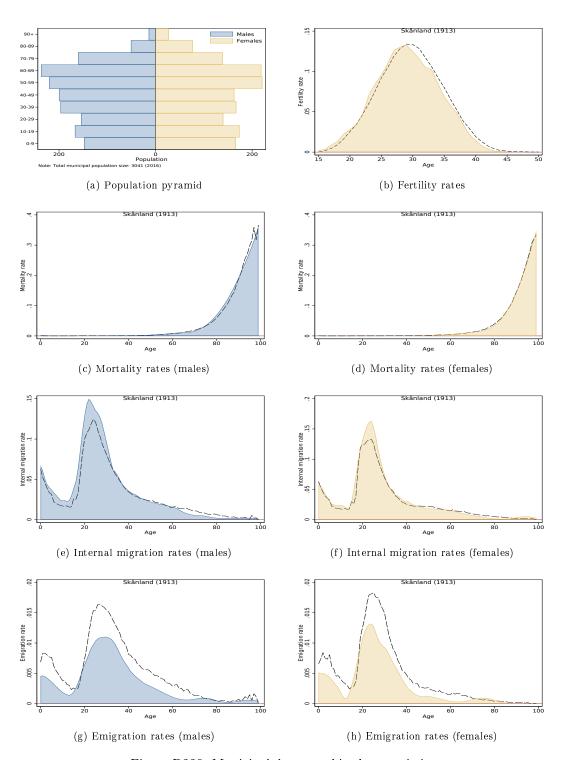


Figure D336: Municipal demographic characteristics

Ibestad (1917)

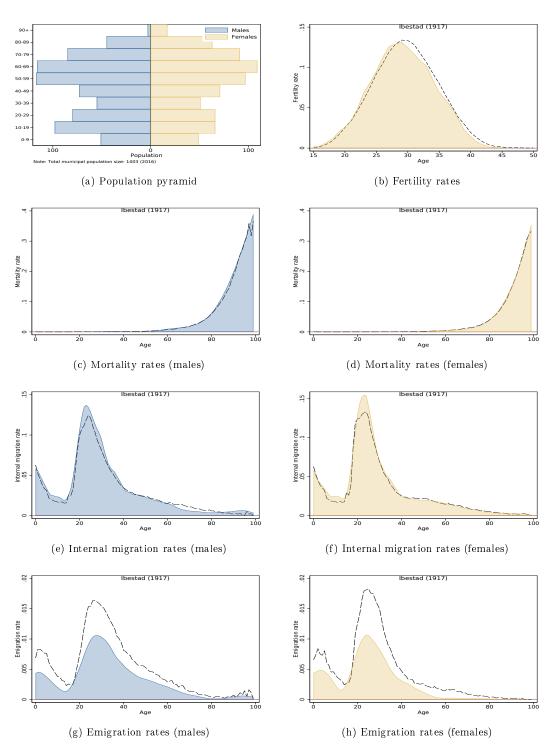


Figure D337: Municipal demographic characteristics

Gratangen (1919)

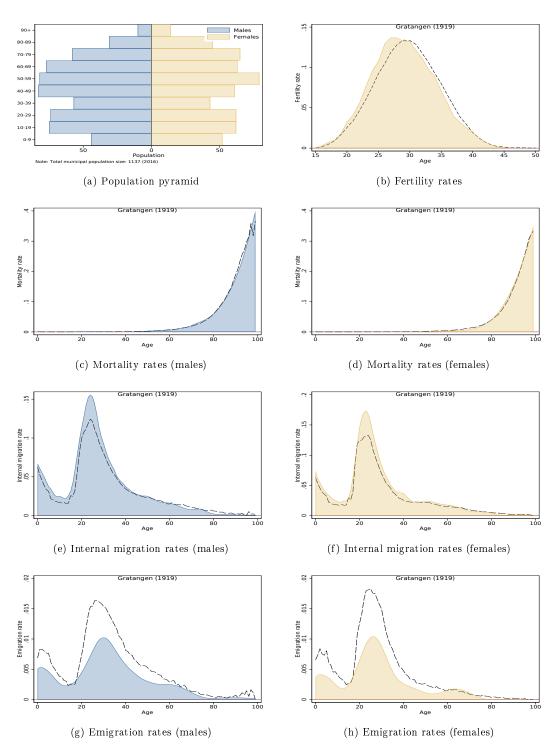


Figure D338: Municipal demographic characteristics

Lavangen (1920)

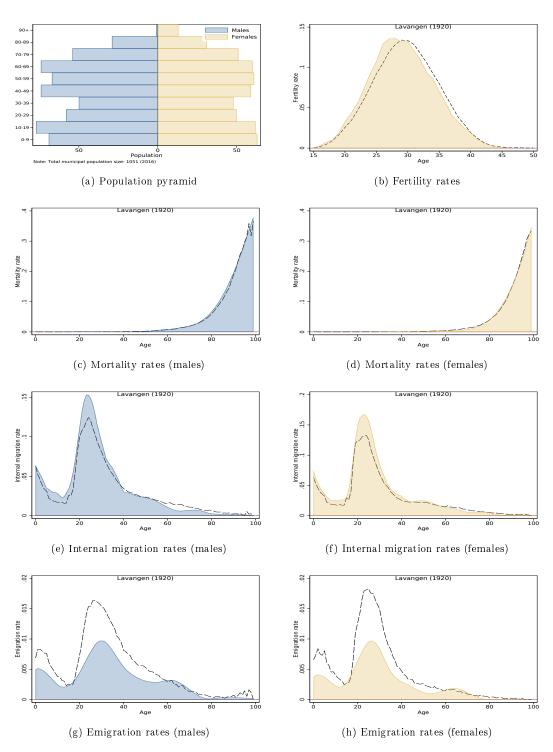


Figure D339: Municipal demographic characteristics

Bardu (1922)

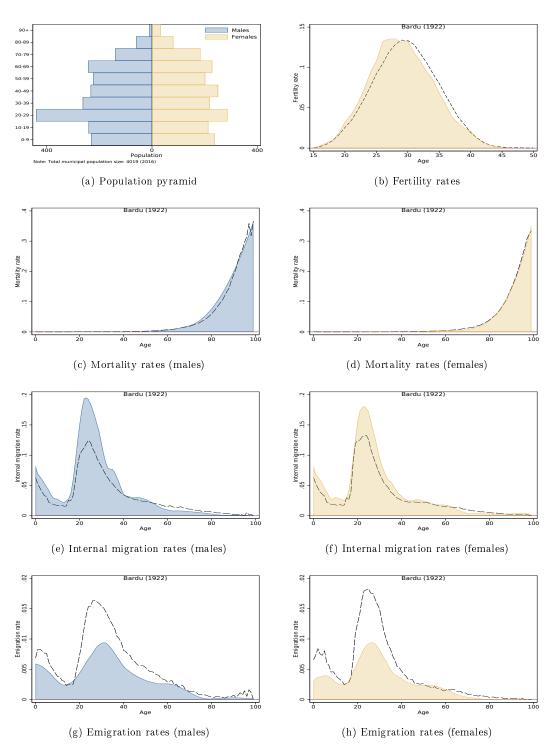
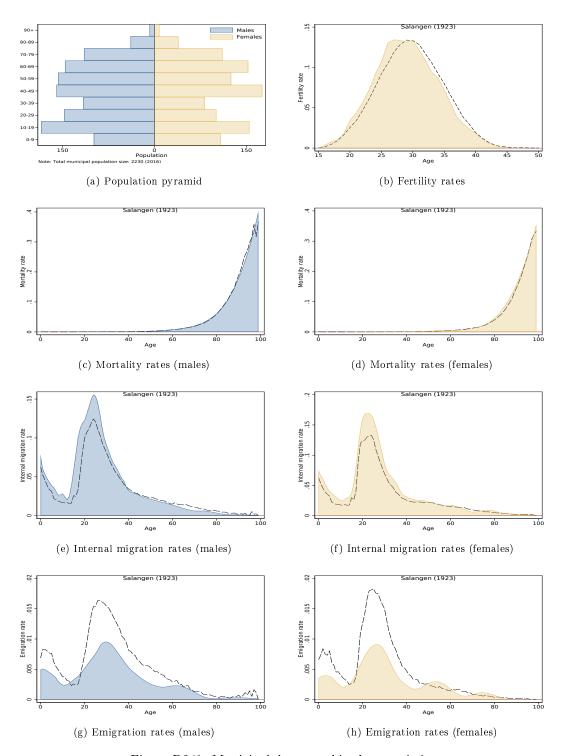


Figure D340: Municipal demographic characteristics

Salangen (1923)



 $Figure\ D341:\ Municipal\ demographic\ characteristics$

Målselv (1924)

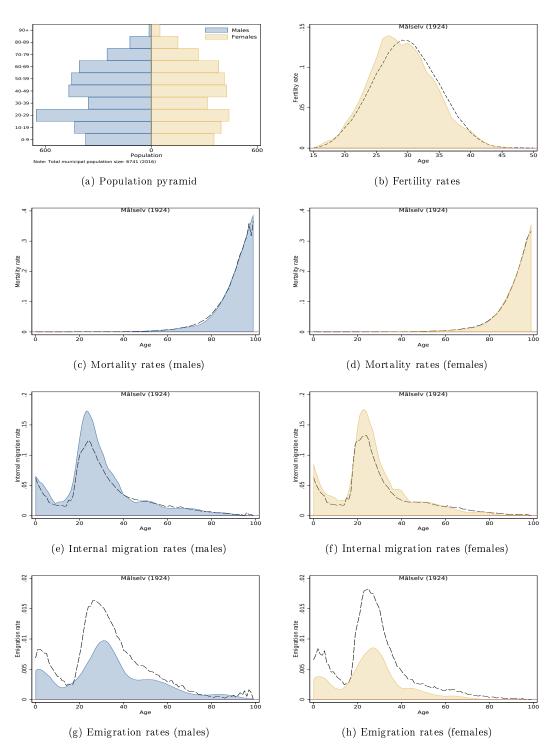


Figure D342: Municipal demographic characteristics

Sørreisa (1925)

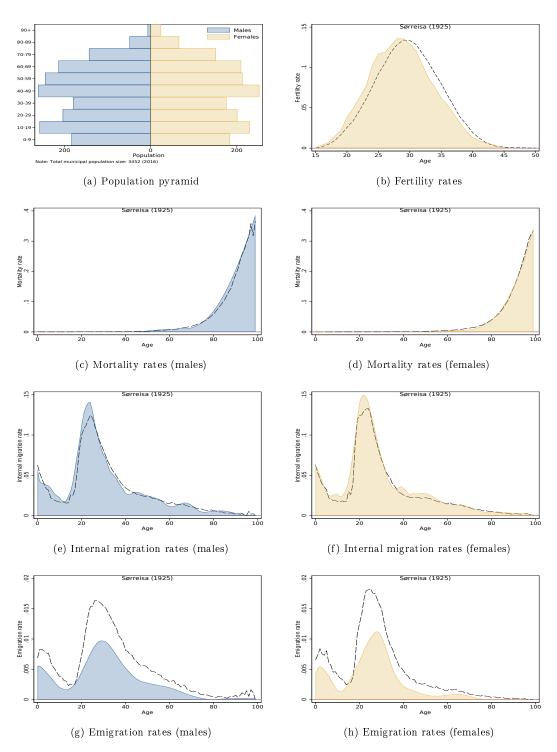


Figure D343: Municipal demographic characteristics

Dyrøy (1926)

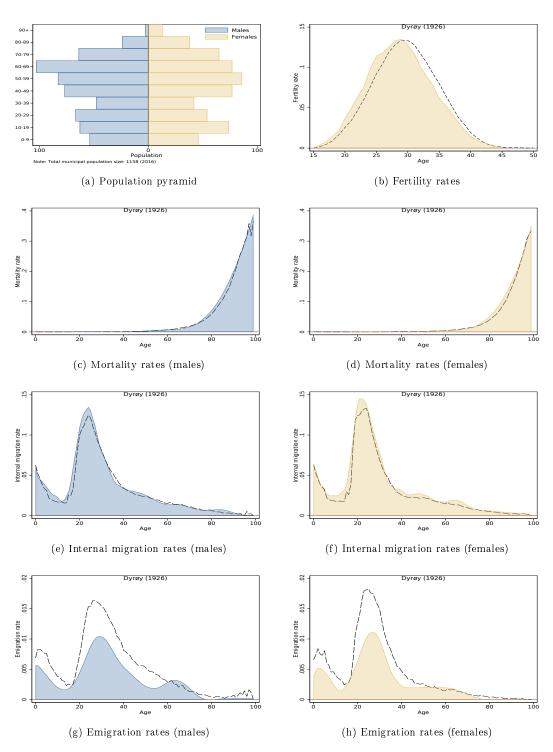
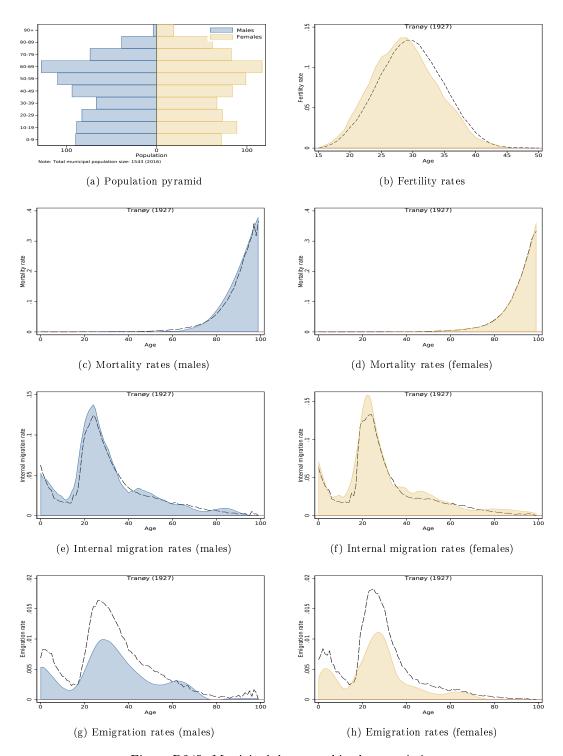


Figure D344: Municipal demographic characteristics

Tranøy (1927)



 $Figure\ D345:\ Municipal\ demographic\ characteristics$

Torsken (1928)

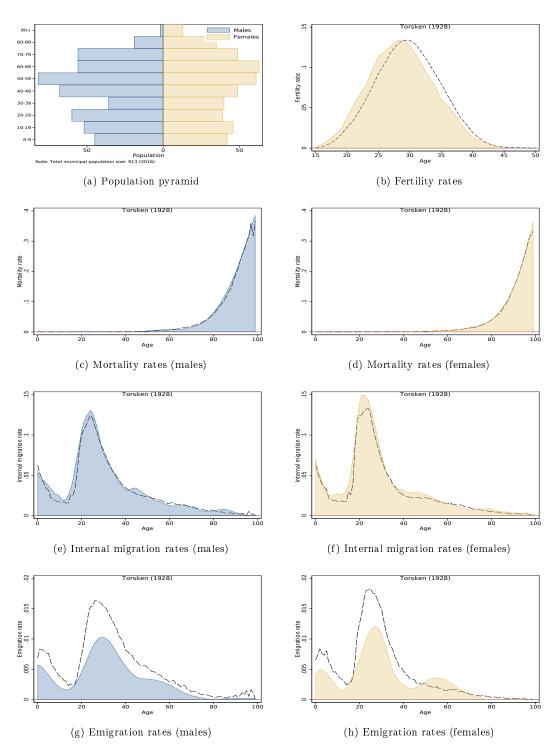


Figure D346: Municipal demographic characteristics

Berg (1929)

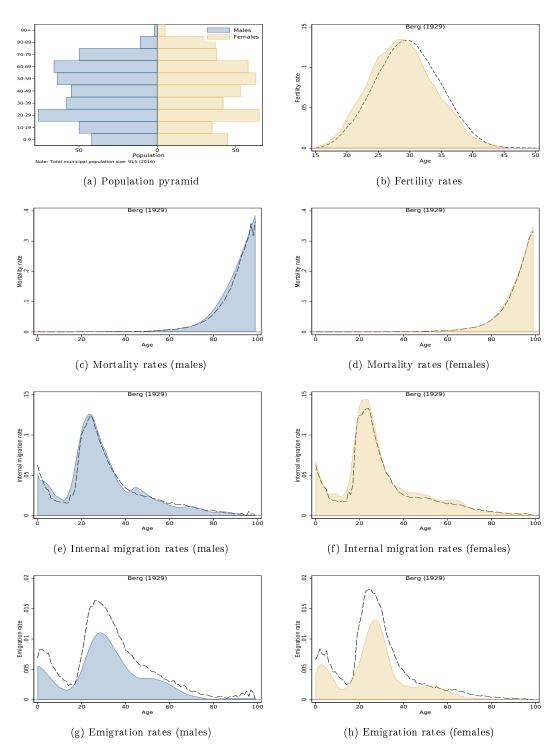


Figure D347: Municipal demographic characteristics

Lenvik (1931)

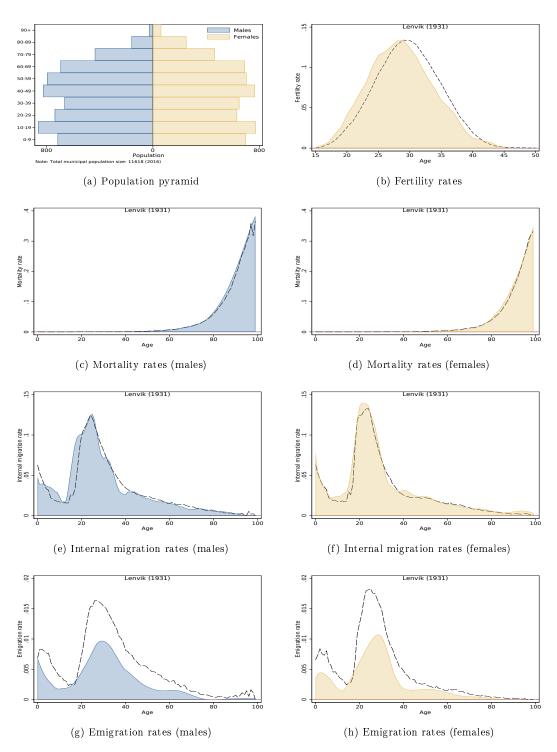
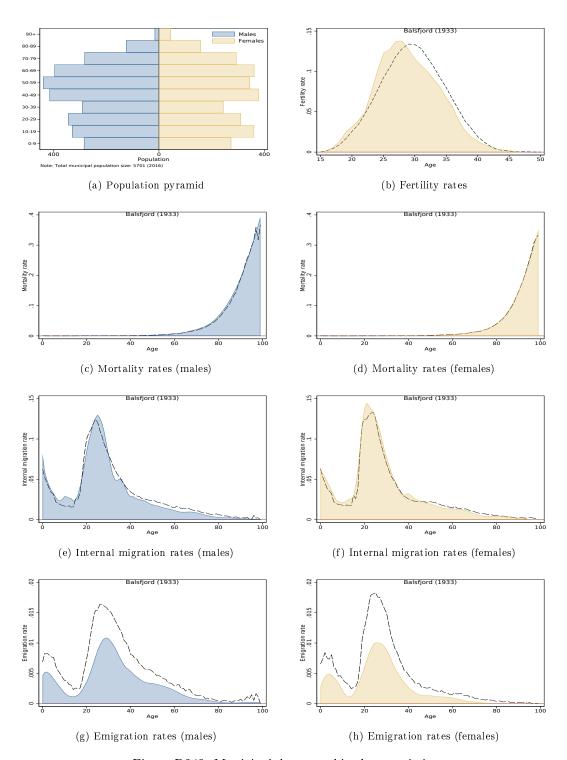


Figure D348: Municipal demographic characteristics

Balsfjord (1933)



 $Figure\ D349:\ Municipal\ demographic\ characteristics$

Karlsøy (1936)

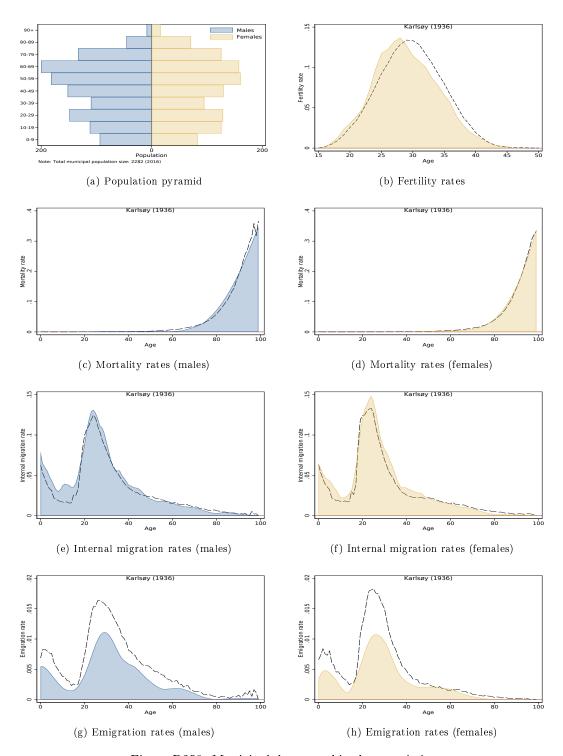


Figure D350: Municipal demographic characteristics

Lyngen (1938)

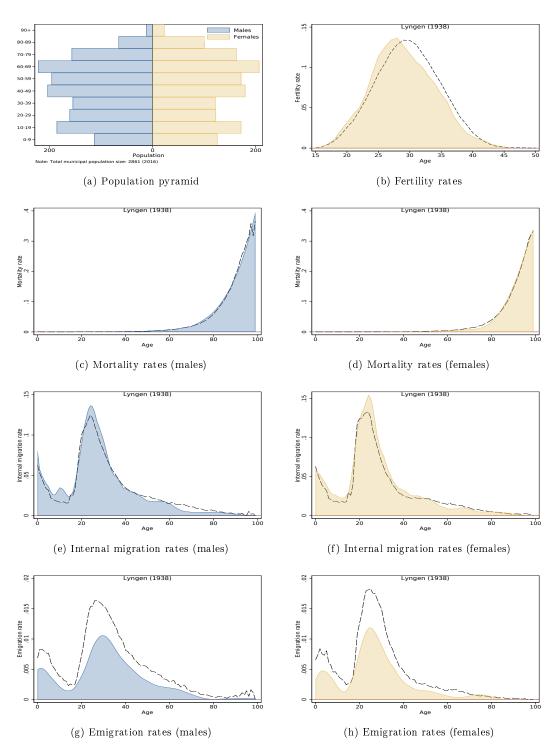


Figure D351: Municipal demographic characteristics

Storfjord (1939)

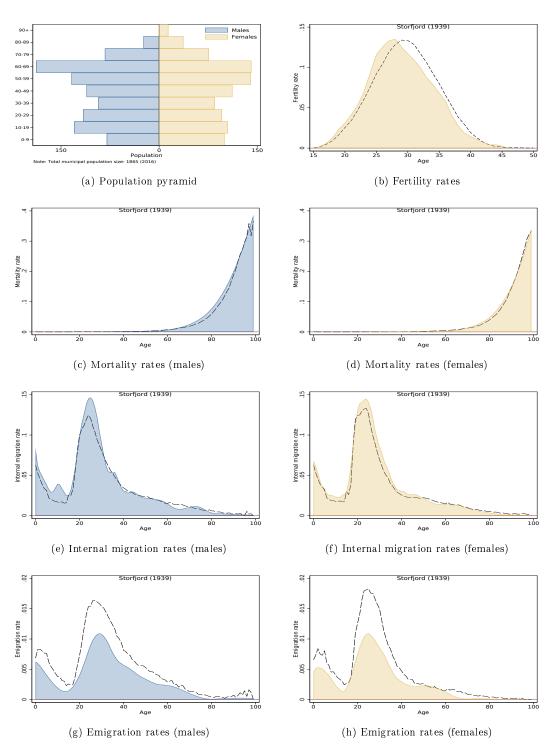


Figure D352: Municipal demographic characteristics

Gaivuotna Kåfjord (1940)

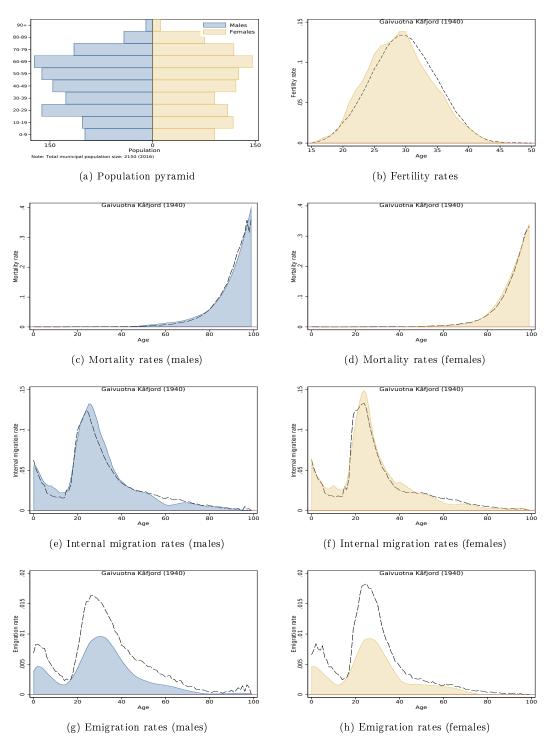


Figure D353: Municipal demographic characteristics

Skjervøy (1941)

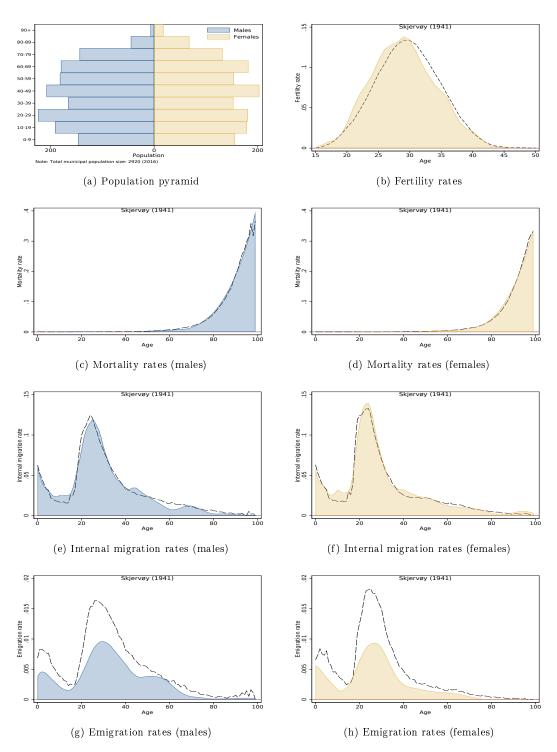


Figure D354: Municipal demographic characteristics

Nordreisa (1942)

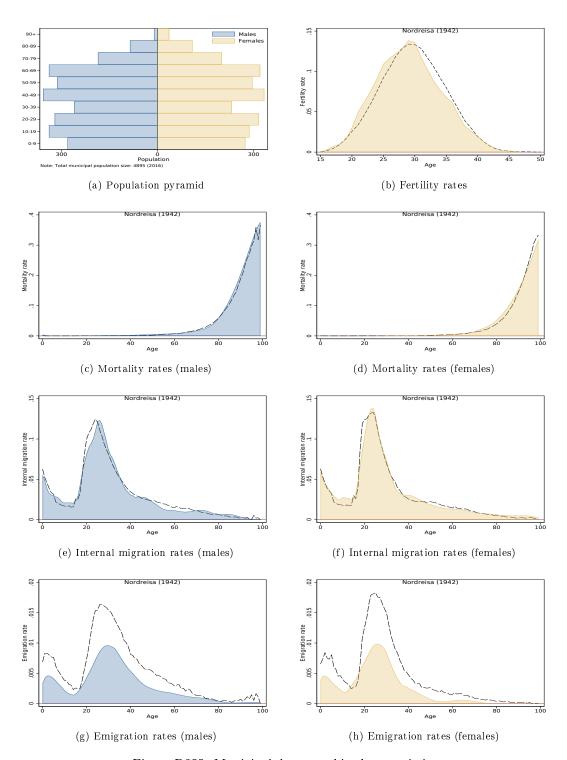


Figure D355: Municipal demographic characteristics

Kvænangen (1943)

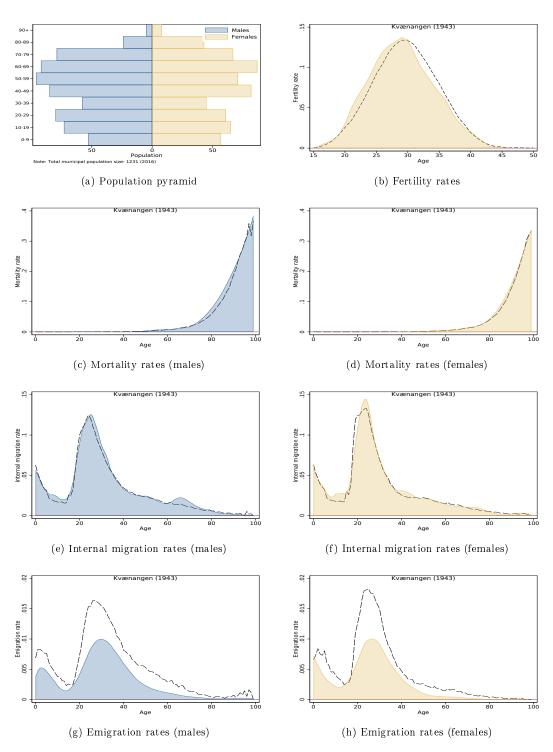
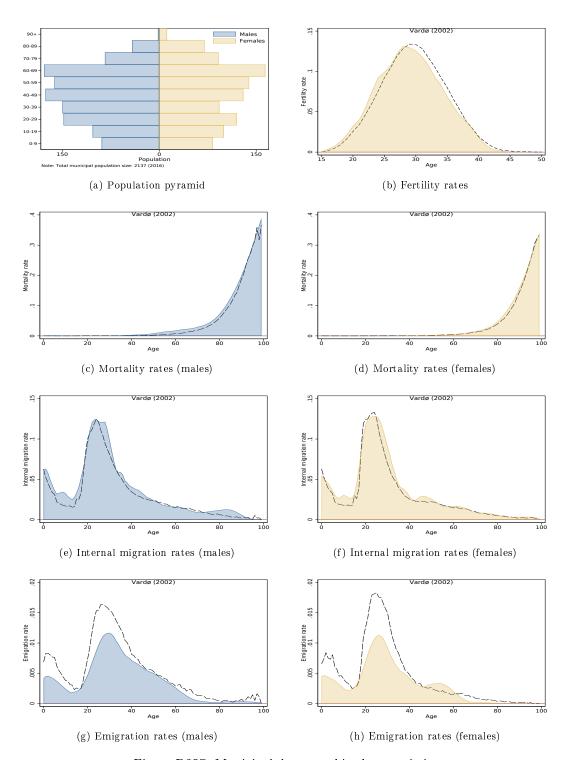


Figure D356: Municipal demographic characteristics

Vardø(2002)



 $Figure\ D357:\ Municipal\ demographic\ characteristics$

$Vads\phi(2003)$

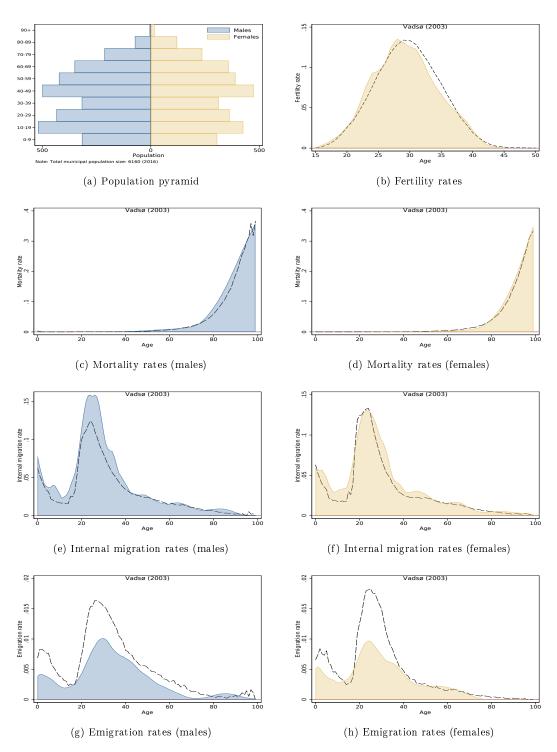


Figure D358: Municipal demographic characteristics

Hammerfest (2004)

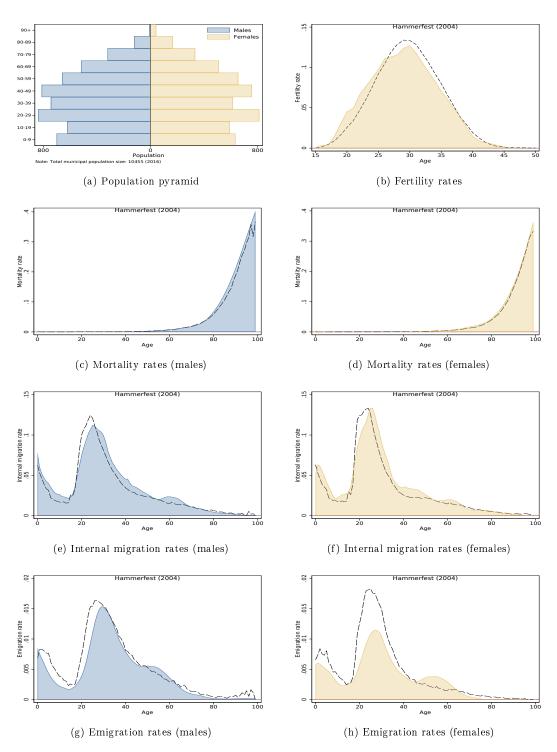


Figure D359: Municipal demographic characteristics

Guovdageaidnu Kautokeino (2011)

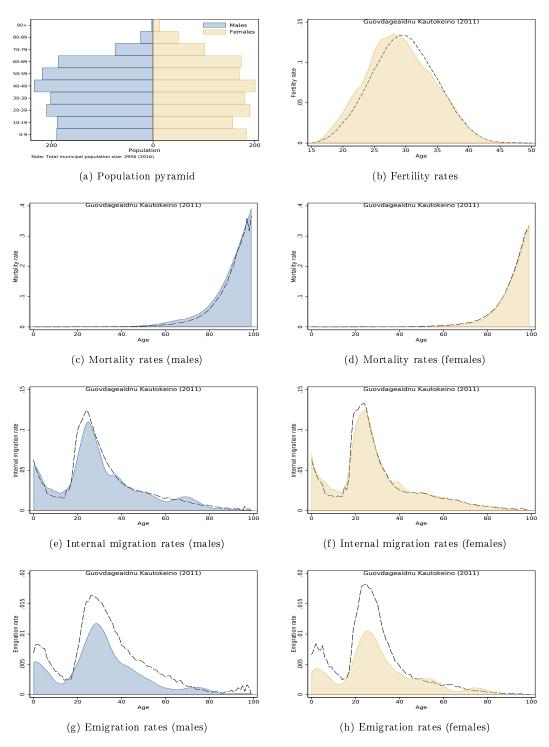
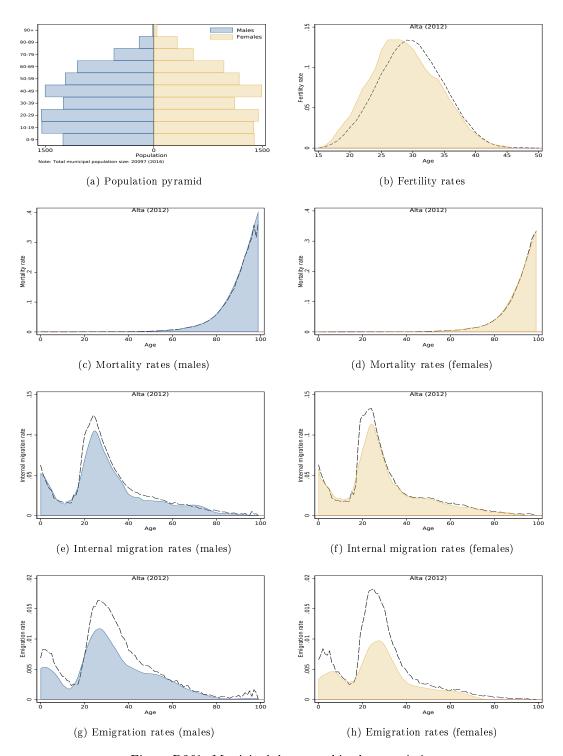


Figure D360: Municipal demographic characteristics

Alta (2012)



 $Figure\ D361:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2014-2016), while mortality and emigration rate estimates are based on five years of data (2012-2016).

Loppa (2014)

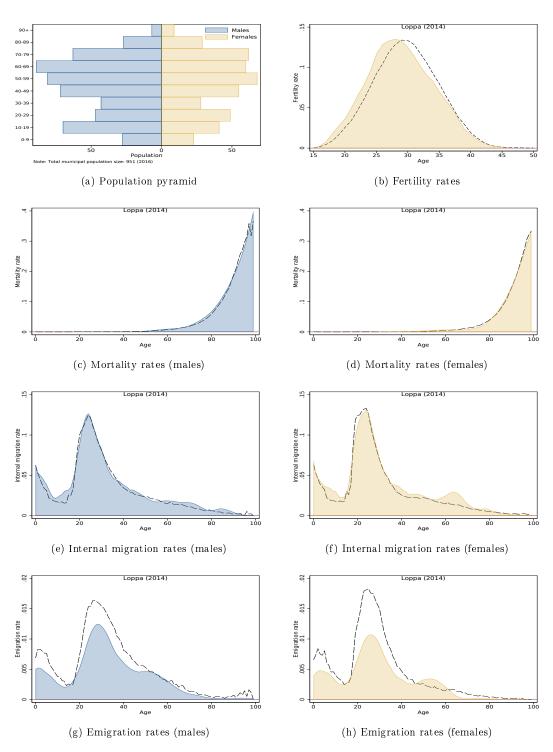


Figure D362: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2014-2016), while mortality and emigration rate estimates are based on five years of data (2014-2016).

Hasvik (2015)

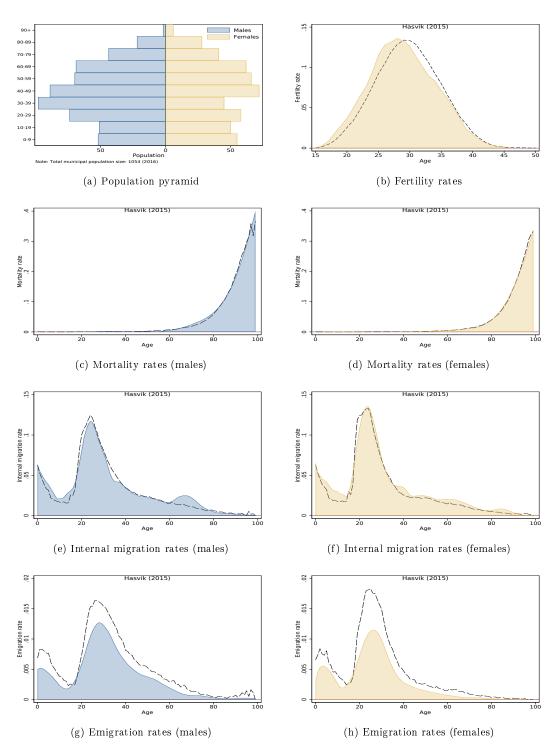
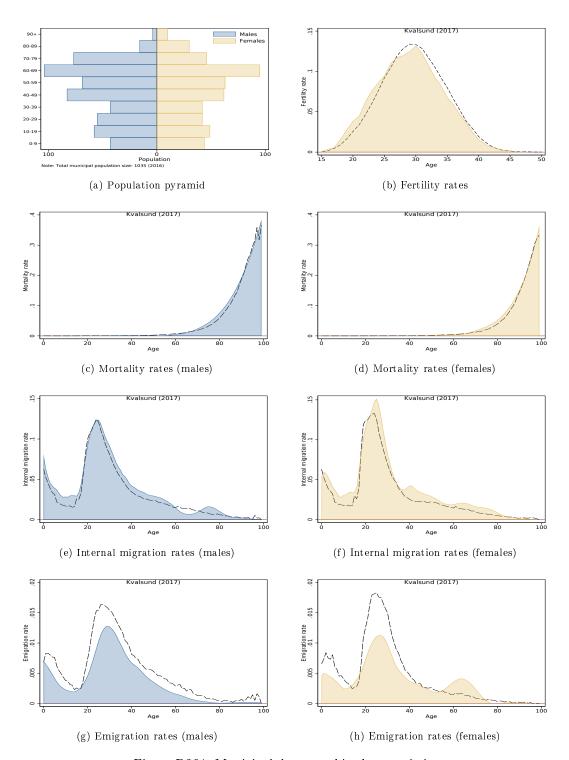


Figure D363: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2015-2016), while mortality and emigration rate estimates are based on five years of data (2015-2016).

Kvalsund (2017)



 $Figure\ D364:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2017-2016), while mortality and emigration rate estimates are based on five years of data (2017-2016).

Måsøy (2018)

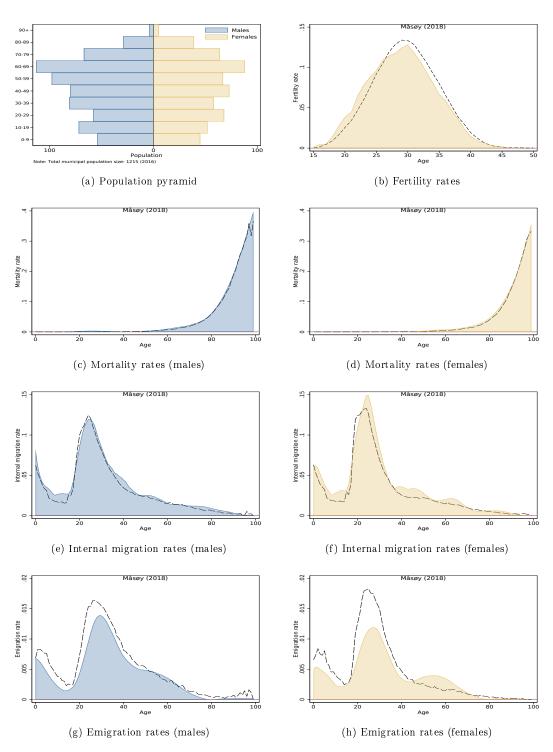


Figure D365: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2018-2016), while mortality and emigration rate estimates are based on five years of data (2018-2016).

Nordkapp (2019)

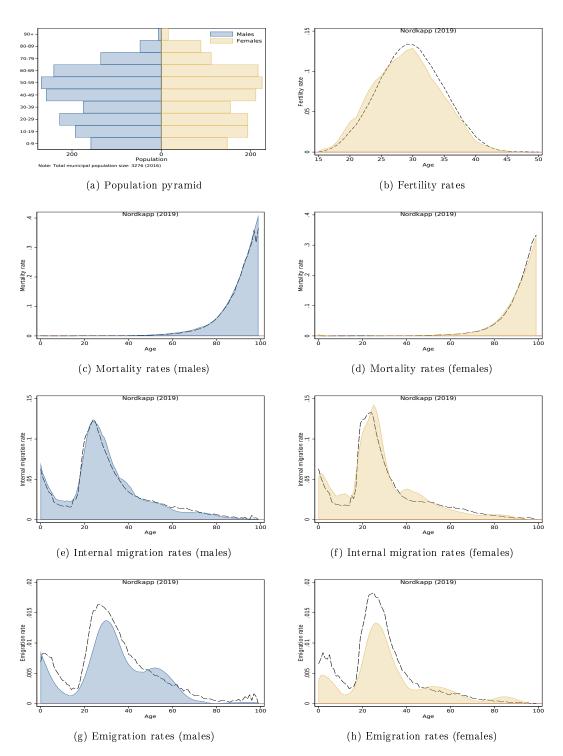


Figure D366: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2019-2016), while mortality and emigration rate estimates are based on five years of data (2019-2016).

Porsanger (2020)

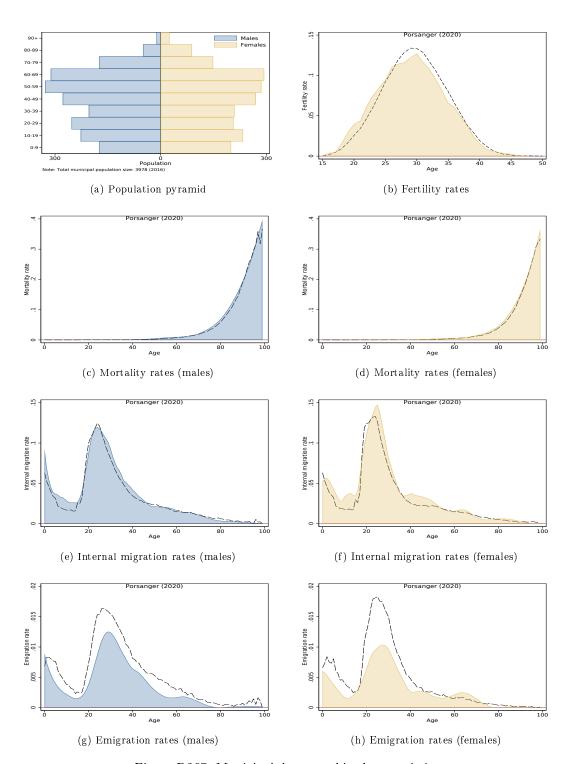


Figure D367: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2020-2016), while mortality and emigration rate estimates are based on five years of data (2020-2016).

Karasjok Karasjok (2021)

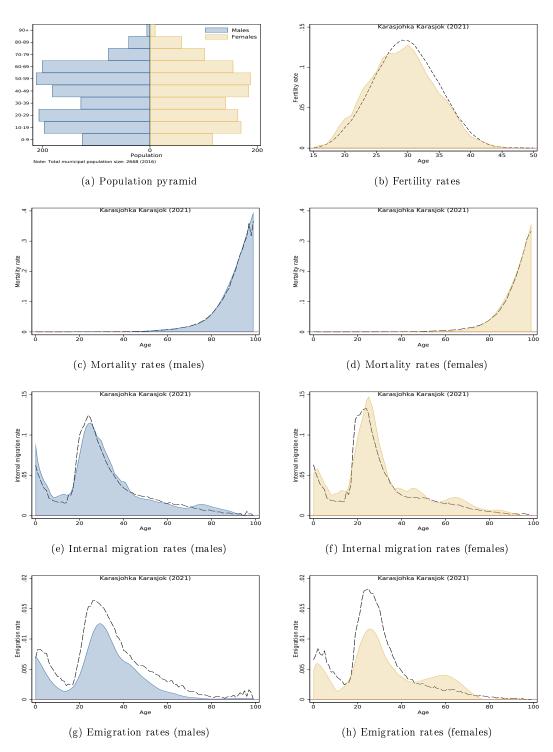
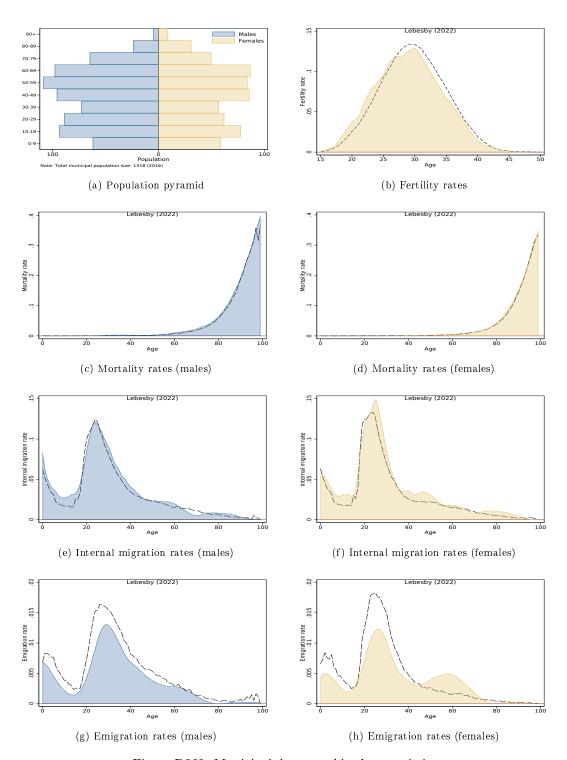


Figure D368: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2021-2016), while mortality and emigration rate estimates are based on five years of data (2021-2016).

Lebesby (2022)



 $Figure\ D369:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2022-2016), while mortality and emigration rate estimates are based on five years of data (2022-2016).

Gamvik (2023)

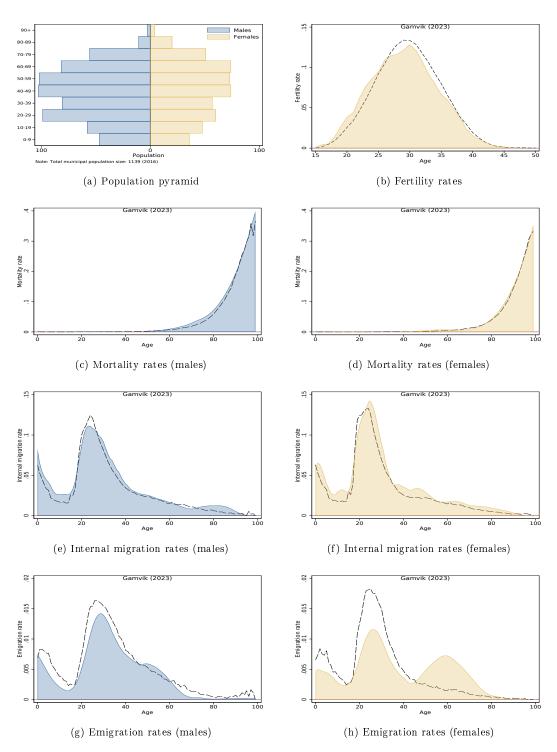


Figure D370: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2023-2016), while mortality and emigration rate estimates are based on five years of data (2023-2016).

Berlevåg (2024)

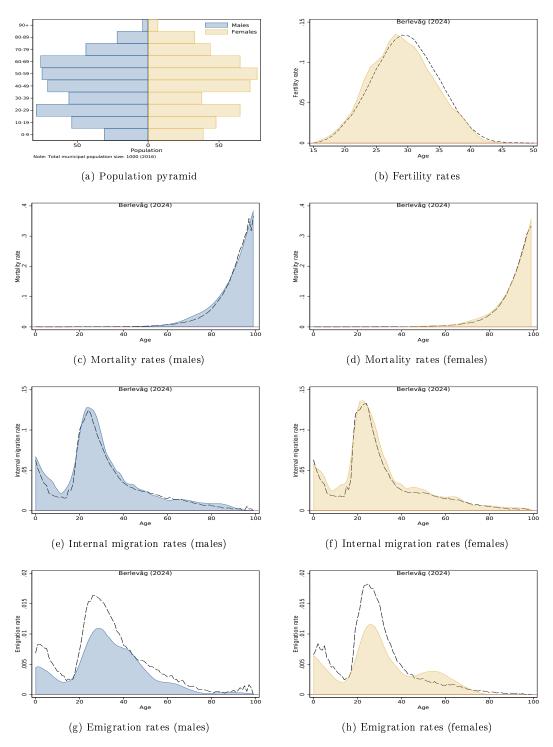
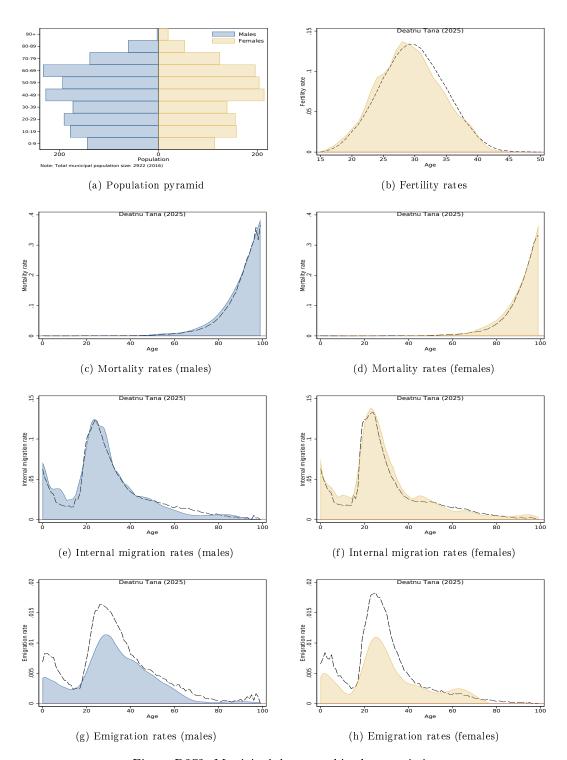


Figure D371: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2024-2016), while mortality and emigration rate estimates are based on five years of data (2024-2016).

Deatnu Tana (2025)



 $Figure\ D372:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2025-2016), while mortality and emigration rate estimates are based on five years of data (2025-2016).

Unjarga Nesseby (2027)

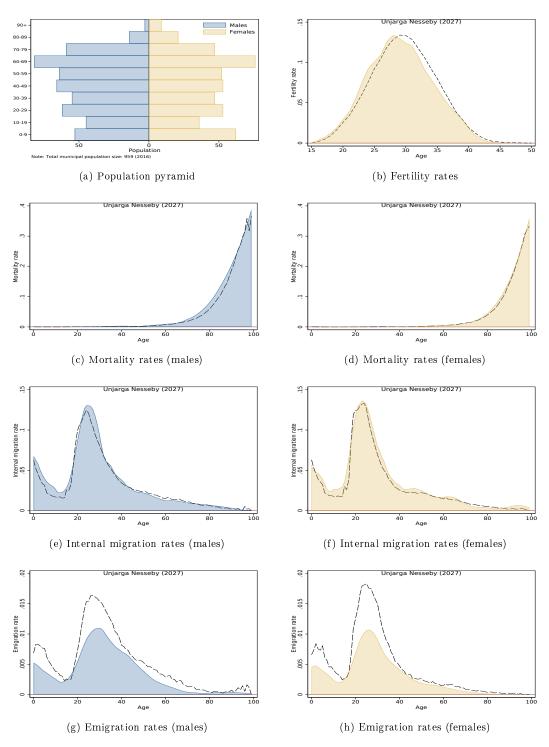


Figure D373: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2027-2016), while mortality and emigration rate estimates are based on five years of data (2027-2016).

Båtsfjord (2028)

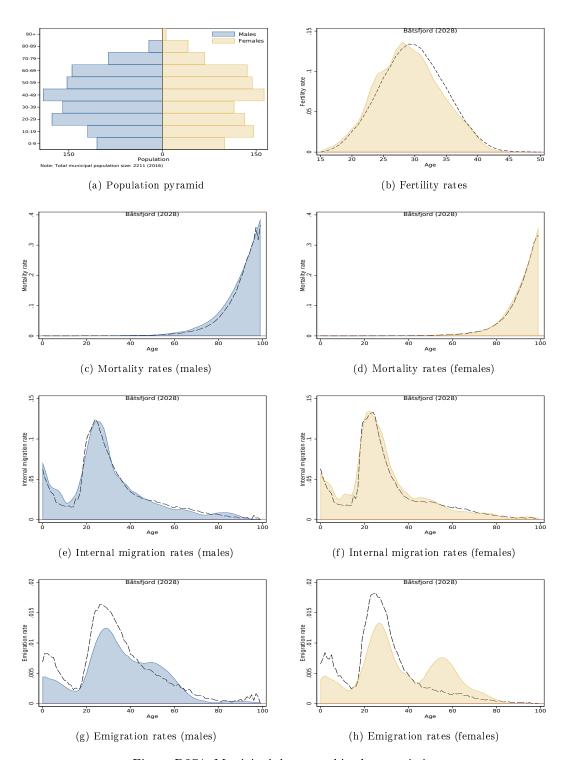
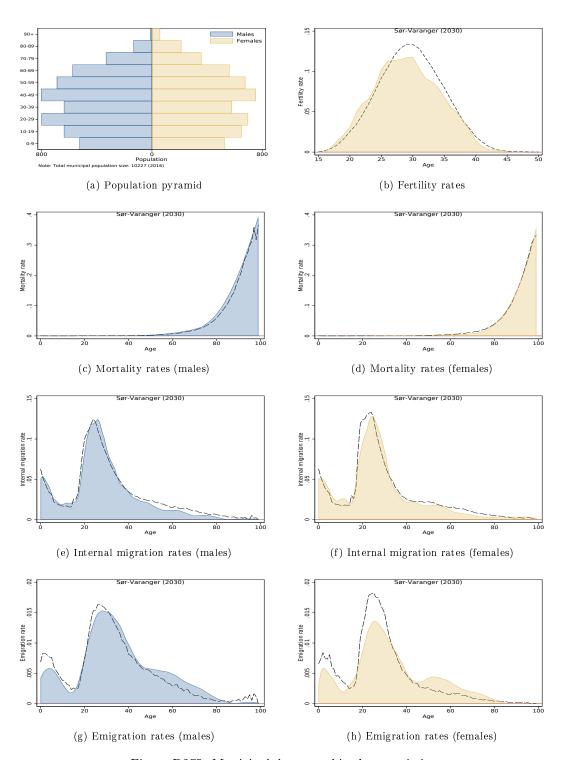


Figure D374: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2028-2016), while mortality and emigration rate estimates are based on five years of data (2028-2016).

Sør-Varanger (2030)



 $Figure\ D375:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (2030-2016), while mortality and emigration rate estimates are based on five years of data (2030-2016).

Trondheim (5001)

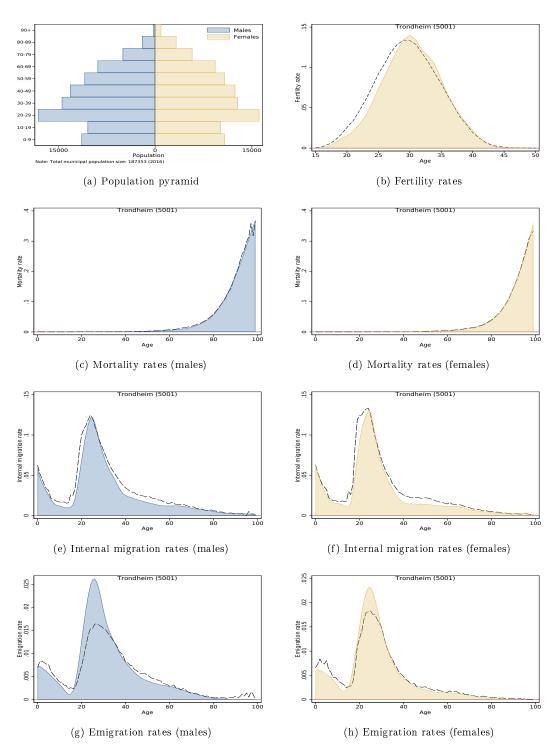
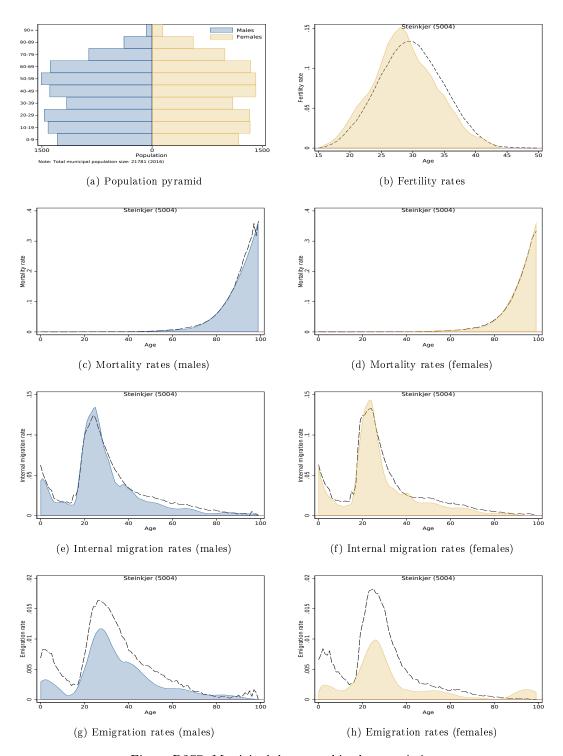


Figure D376: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5001-2016), while mortality and emigration rate estimates are based on five years of data (5001-2016).

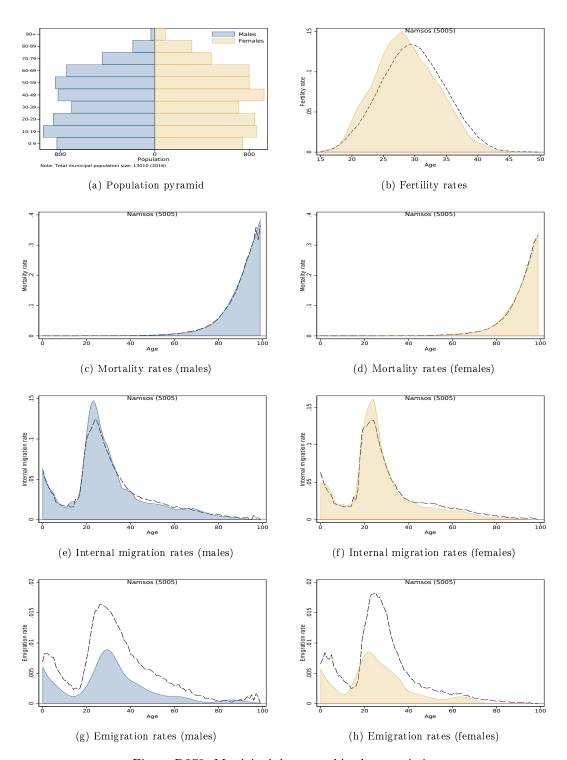
Steinkjer (5004)



 $Figure\ D377:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5004-2016), while mortality and emigration rate estimates are based on five years of data (5004-2016).

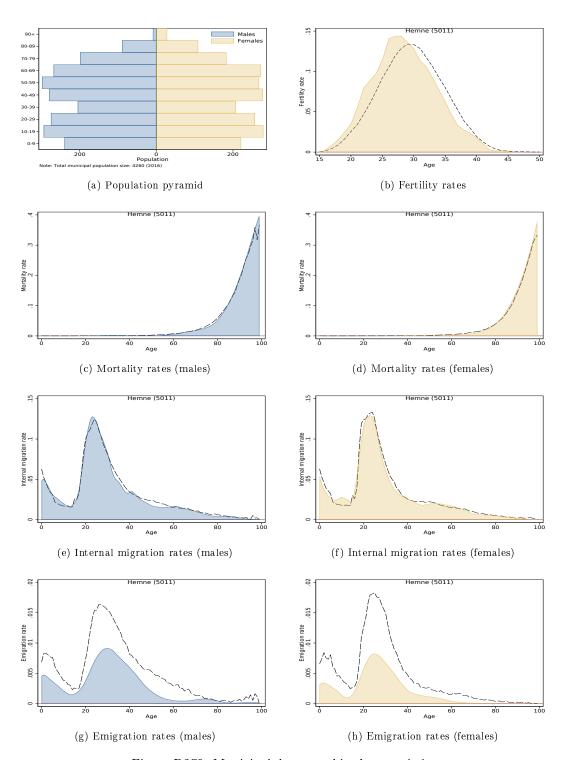
Namsos (5005)



 $Figure\ D378:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5005-2016), while mortality and emigration rate estimates are based on five years of data (5005-2016).

Hemne (5011)



 $Figure\ D379:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5011-2016), while mortality and emigration rate estimates are based on five years of data (5011-2016).

Snillfjord (5012)

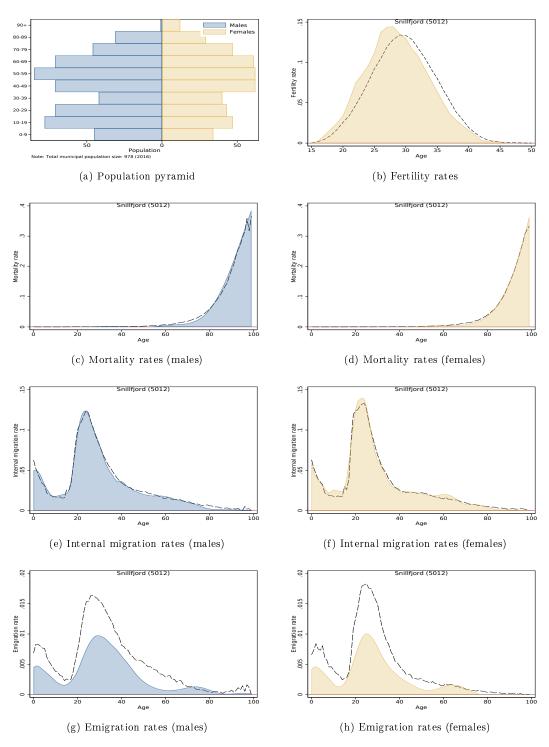


Figure D380: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5012-2016), while mortality and emigration rate estimates are based on five years of data (5012-2016).

Hitra (5013)

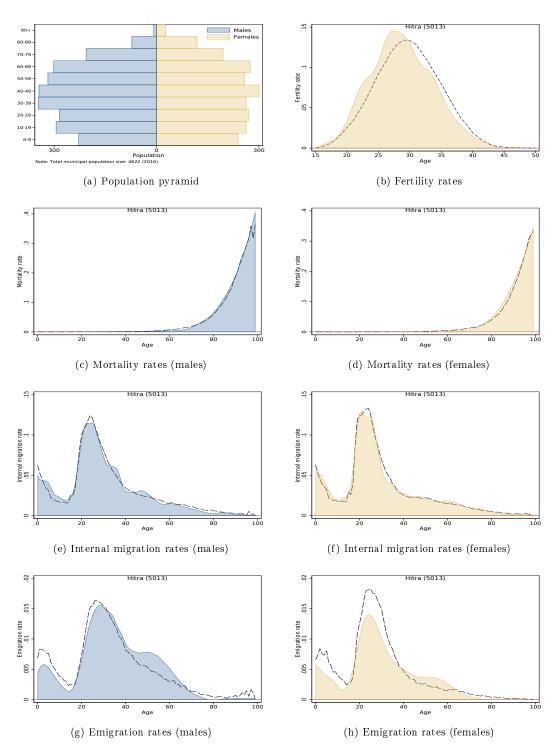


Figure D381: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5013-2016), while mortality and emigration rate estimates are based on five years of data (5013-2016).

Frøya (5014)

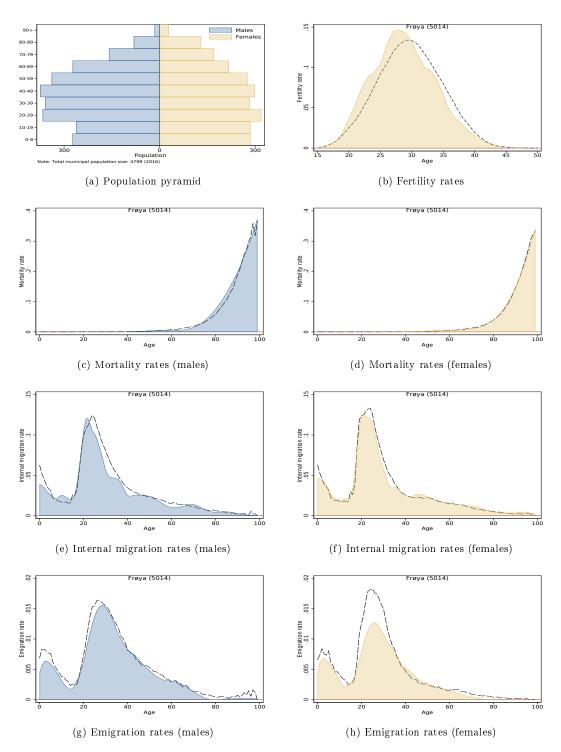
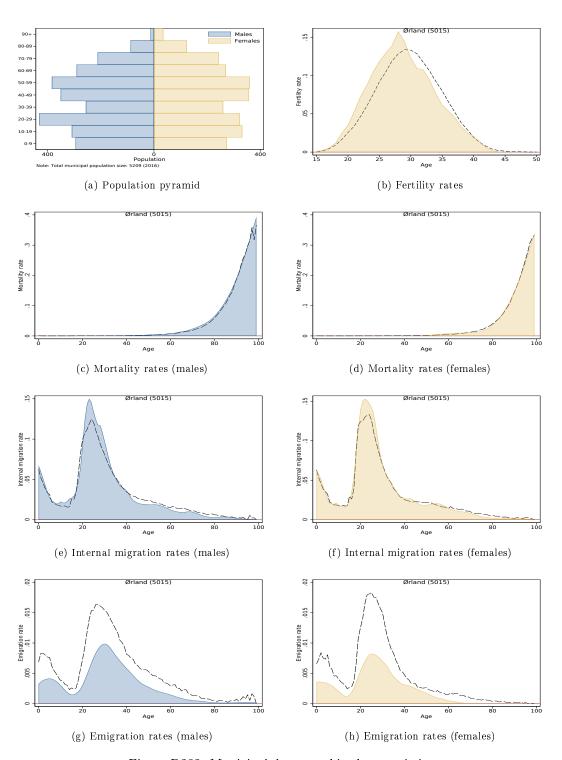


Figure D382: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5014-2016), while mortality and emigration rate estimates are based on five years of data (5014-2016).

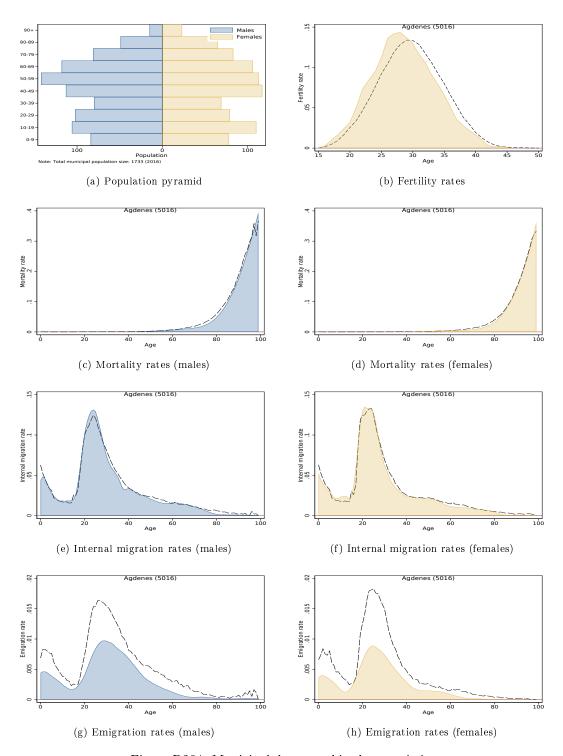
Ørland (5015)



 $Figure\ D383:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5015-2016), while mortality and emigration rate estimates are based on five years of data (5015-2016).

Agdenes (5016)



 $Figure\ D384:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5016-2016), while mortality and emigration rate estimates are based on five years of data (5016-2016).

Bjugn (5017)

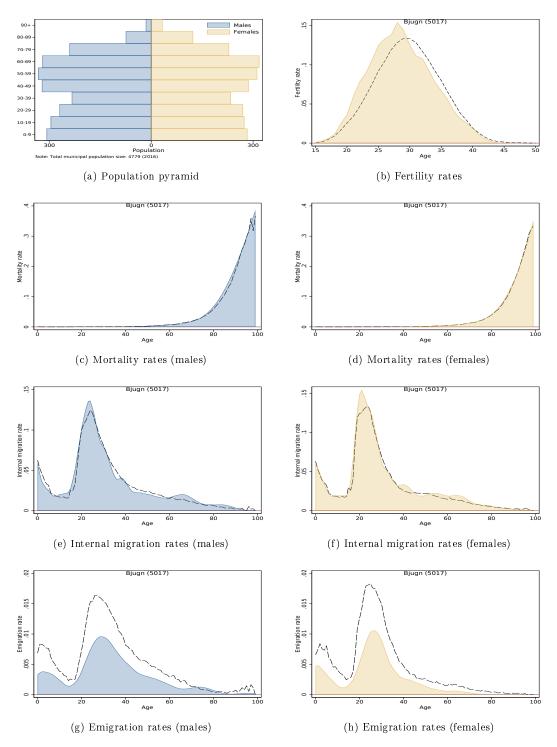


Figure D385: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5017-2016), while mortality and emigration rate estimates are based on five years of data (5017-2016).

Åfjord (5018)

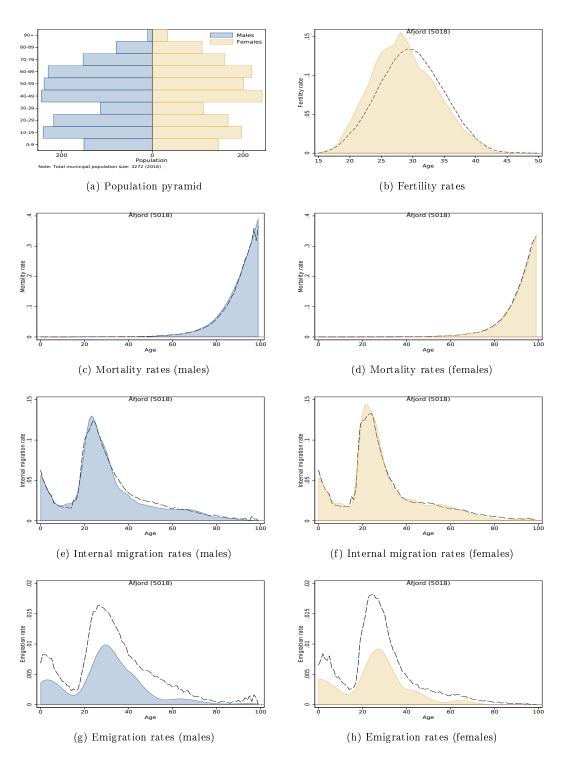


Figure D386: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5018-2016), while mortality and emigration rate estimates are based on five years of data (5018-2016).

Roan (5019)

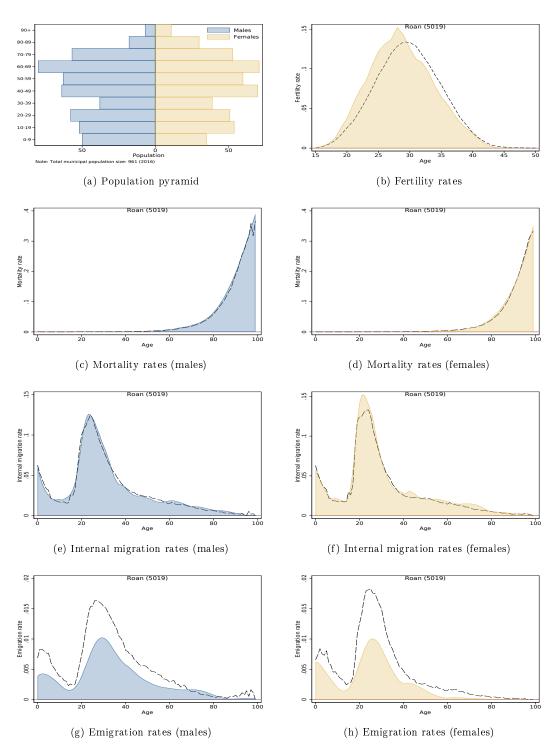
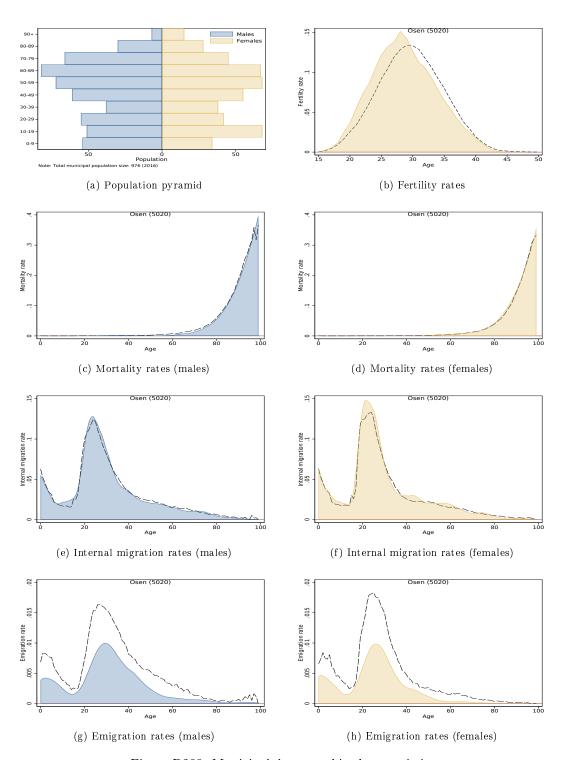


Figure D387: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5019-2016), while mortality and emigration rate estimates are based on five years of data (5019-2016).

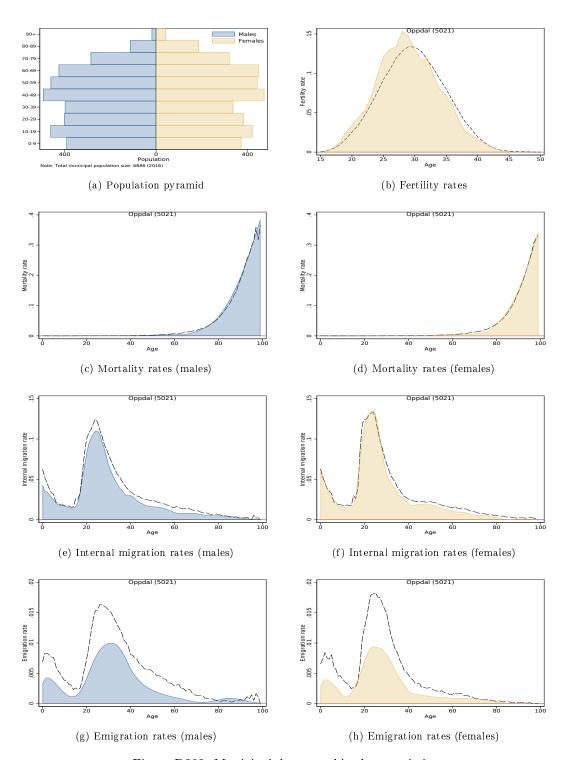
Osen (5020)



 $Figure\ D388:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5020-2016), while mortality and emigration rate estimates are based on five years of data (5020-2016).

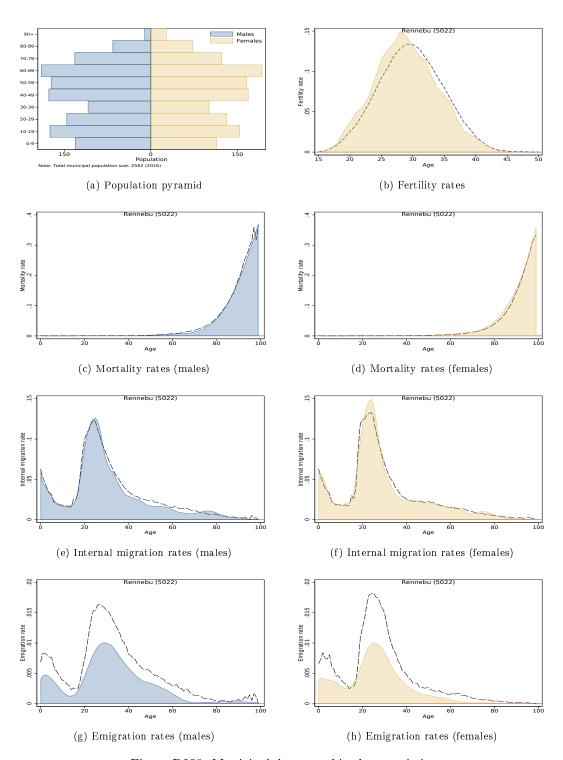
Oppdal (5021)



 $Figure\ D389:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5021-2016), while mortality and emigration rate estimates are based on five years of data (5021-2016).

Rennebu (5022)



 $Figure\ D390:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5022-2016), while mortality and emigration rate estimates are based on five years of data (5022-2016).

Meldal (5023)

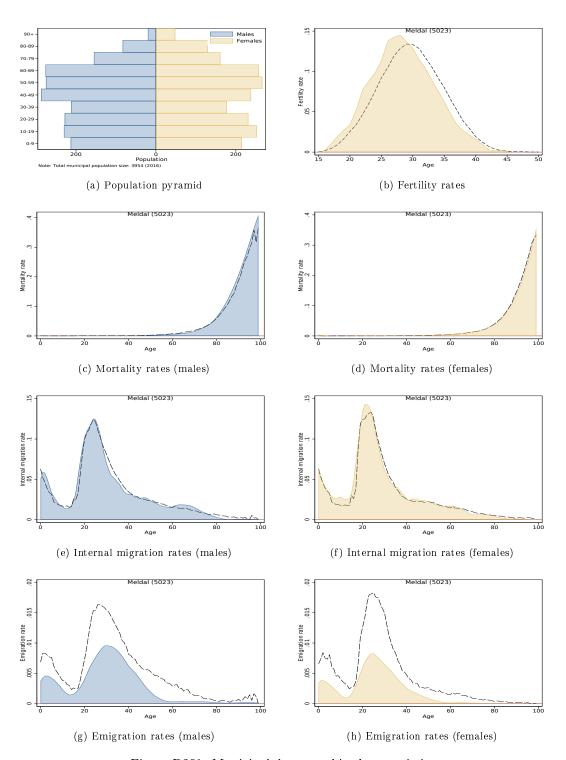


Figure D391: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5023-2016), while mortality and emigration rate estimates are based on five years of data (5023-2016).

Orkdal (5024)

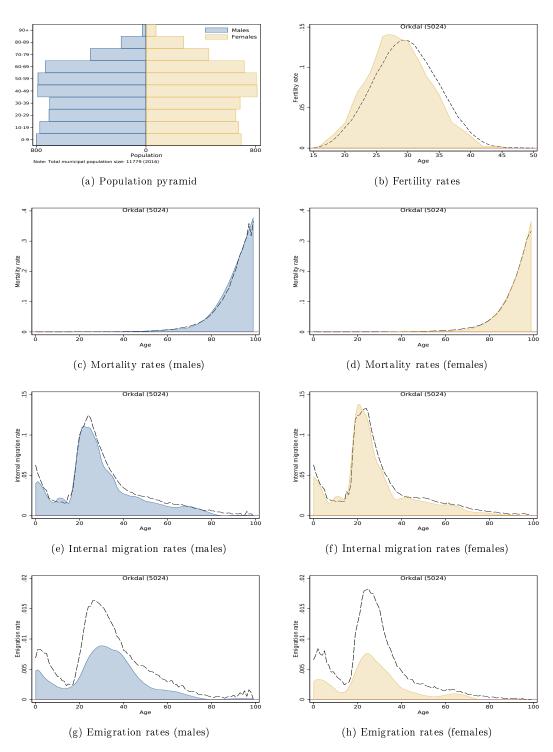


Figure D392: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5024-2016), while mortality and emigration rate estimates are based on five years of data (5024-2016).

Røros (5025)

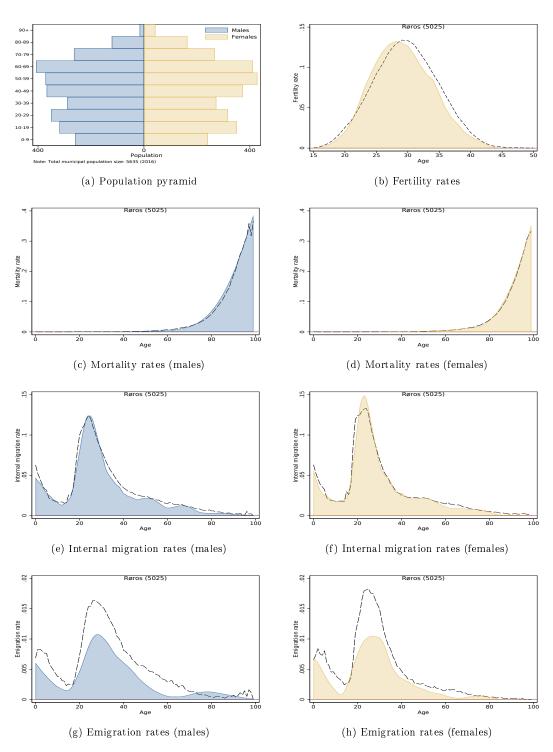


Figure D393: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5025-2016), while mortality and emigration rate estimates are based on five years of data (5025-2016).

Holtålen (5026)

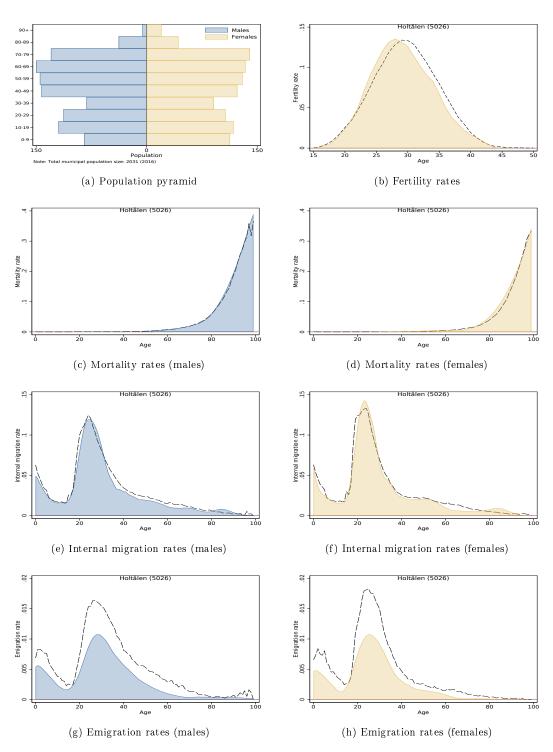


Figure D394: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5026-2016), while mortality and emigration rate estimates are based on five years of data (5026-2016).

Midtre Gauldal (5027)

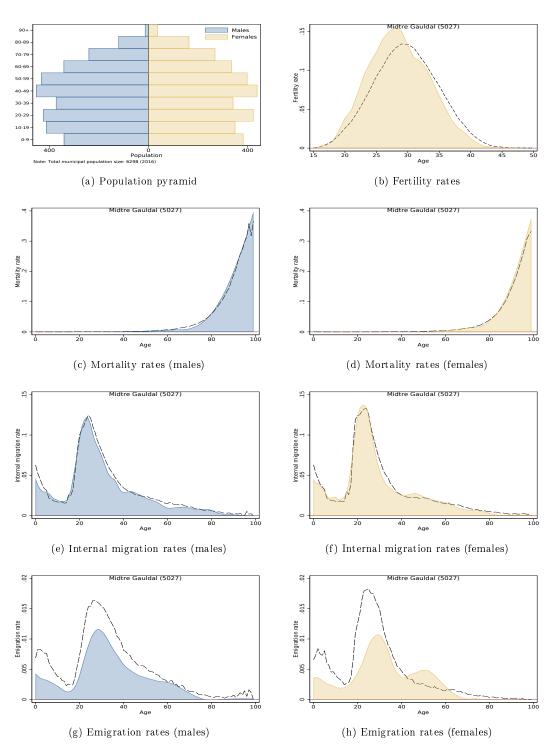


Figure D395: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5027-2016), while mortality and emigration rate estimates are based on five years of data (5027-2016).

Melhus (5028)

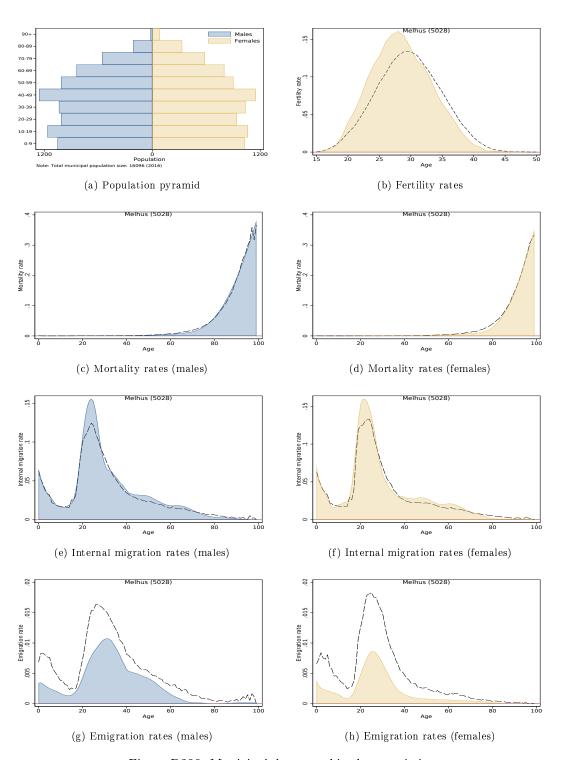


Figure D396: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5028-2016), while mortality and emigration rate estimates are based on five years of data (5028-2016).

Skaun (5029)

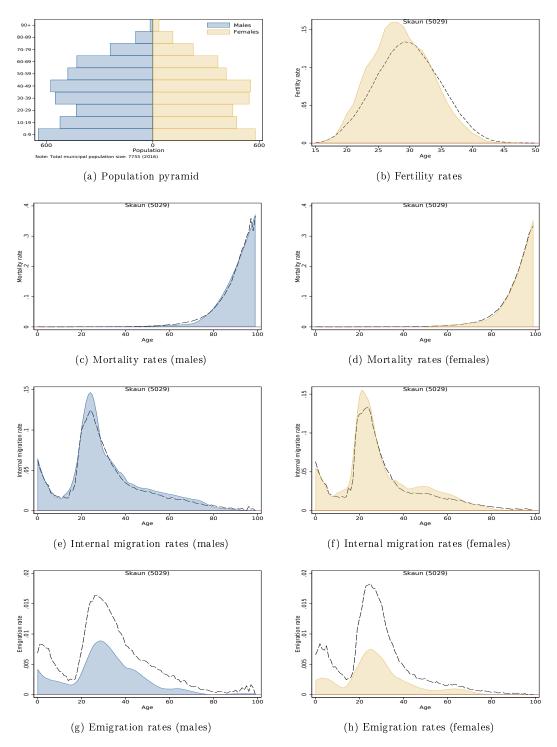


Figure D397: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5029-2016), while mortality and emigration rate estimates are based on five years of data (5029-2016).

Klæbu (5030)

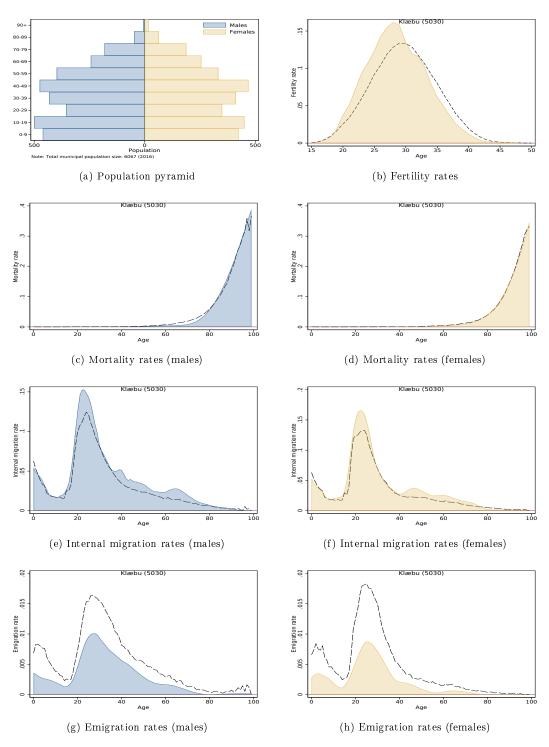


Figure D398: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5030-2016), while mortality and emigration rate estimates are based on five years of data (5030-2016).

Malvik (5031)

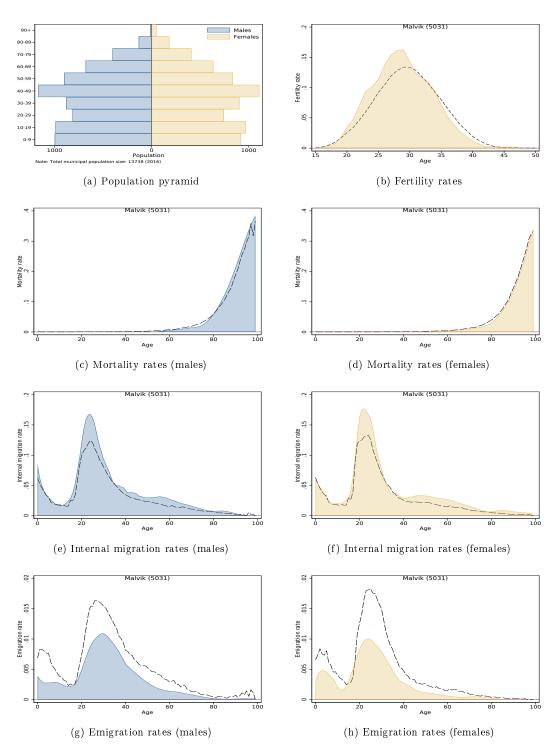


Figure D399: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5031-2016), while mortality and emigration rate estimates are based on five years of data (5031-2016).

Selbu (5032)

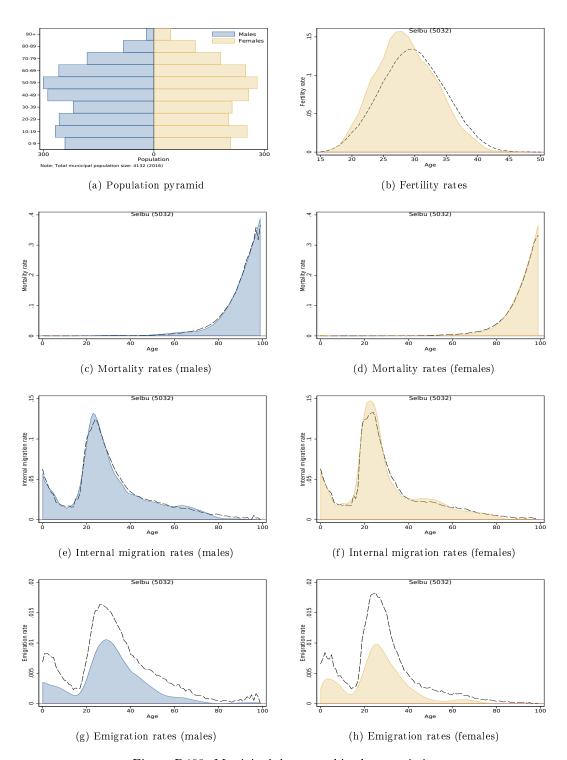


Figure D400: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5032-2016), while mortality and emigration rate estimates are based on five years of data (5032-2016).

Tydal (5033)

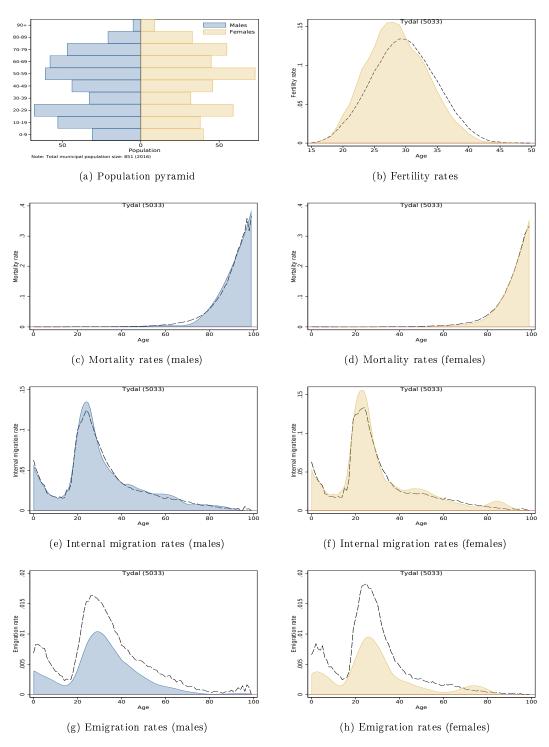


Figure D401: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5033-2016), while mortality and emigration rate estimates are based on five years of data (5033-2016).

Meråker (5034)

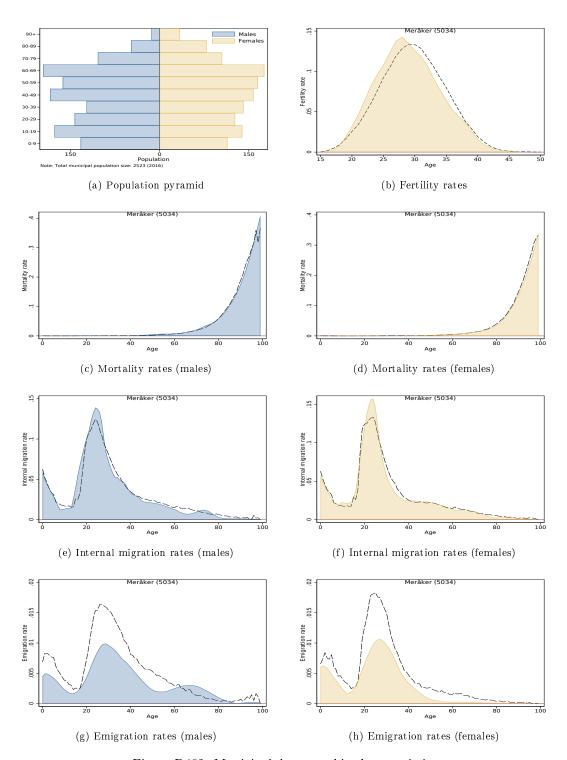


Figure D402: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5034-2016), while mortality and emigration rate estimates are based on five years of data (5034-2016).

Stjørdal (5035)

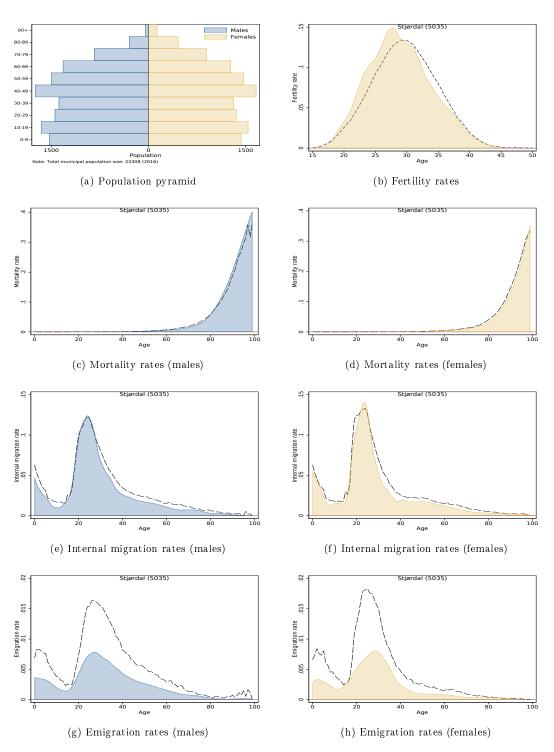


Figure D403: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5035-2016), while mortality and emigration rate estimates are based on five years of data (5035-2016).

Frosta (5036)

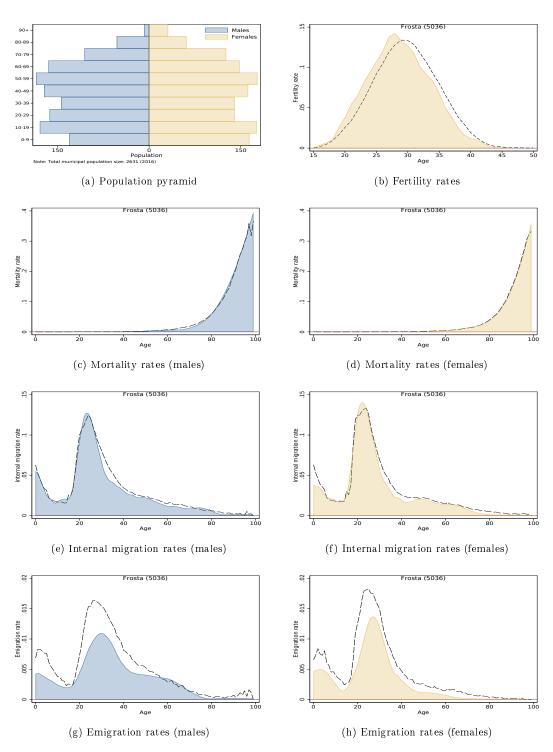


Figure D404: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5036-2016), while mortality and emigration rate estimates are based on five years of data (5036-2016).

Levanger (5037)

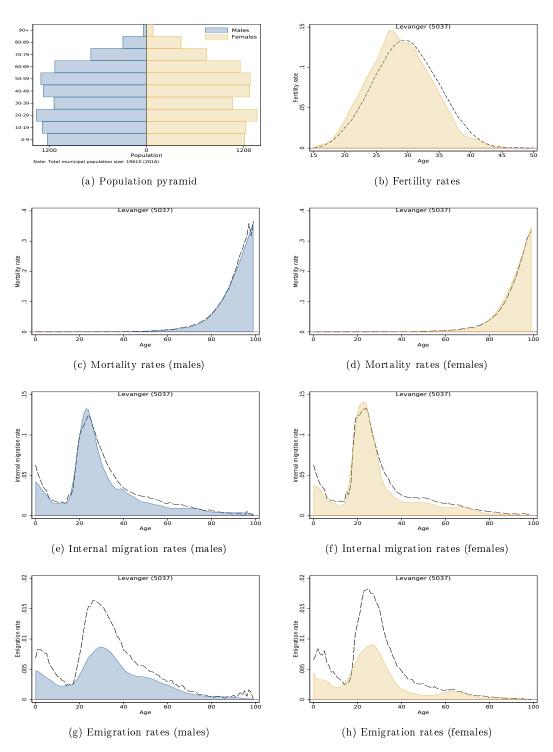


Figure D405: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5037-2016), while mortality and emigration rate estimates are based on five years of data (5037-2016).

Verdal (5038)

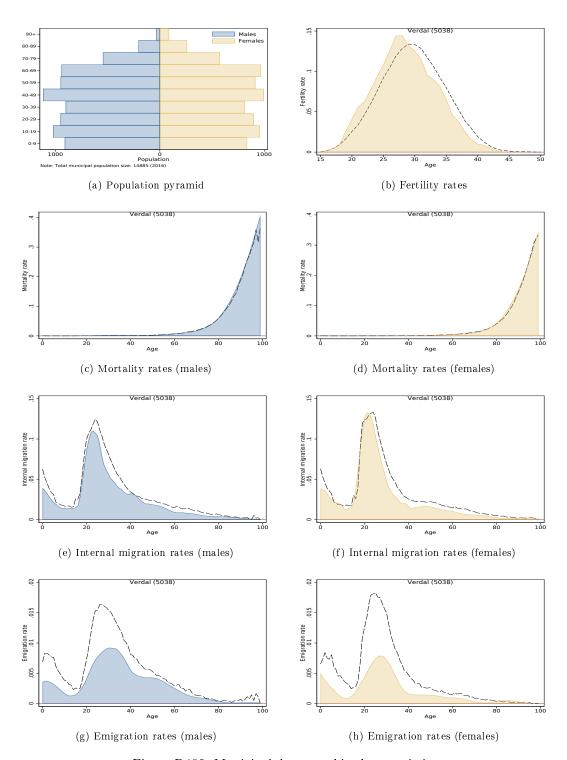


Figure D406: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5038-2016), while mortality and emigration rate estimates are based on five years of data (5038-2016).

Verran (5039)

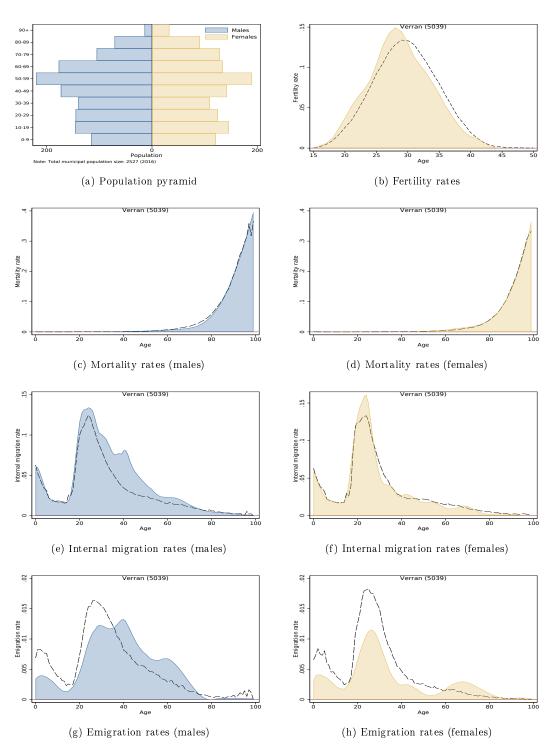


Figure D407: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5039-2016), while mortality and emigration rate estimates are based on five years of data (5039-2016).

Namdalseid (5040)

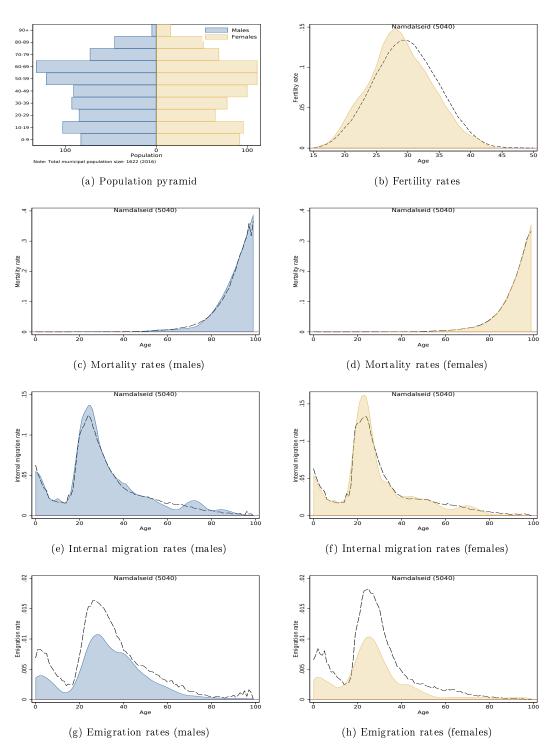


Figure D408: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5040-2016), while mortality and emigration rate estimates are based on five years of data (5040-2016).

Snåsa (5041)

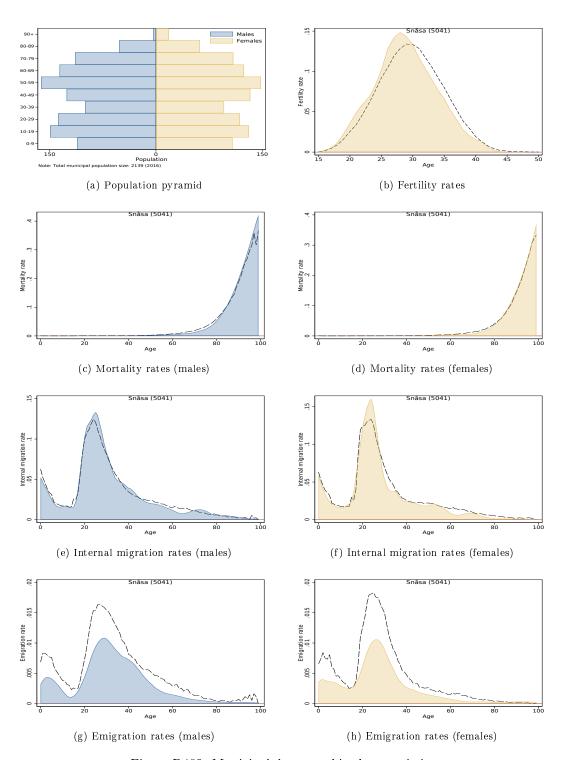


Figure D409: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5041-2016), while mortality and emigration rate estimates are based on five years of data (5041-2016).

Lierne (5042)

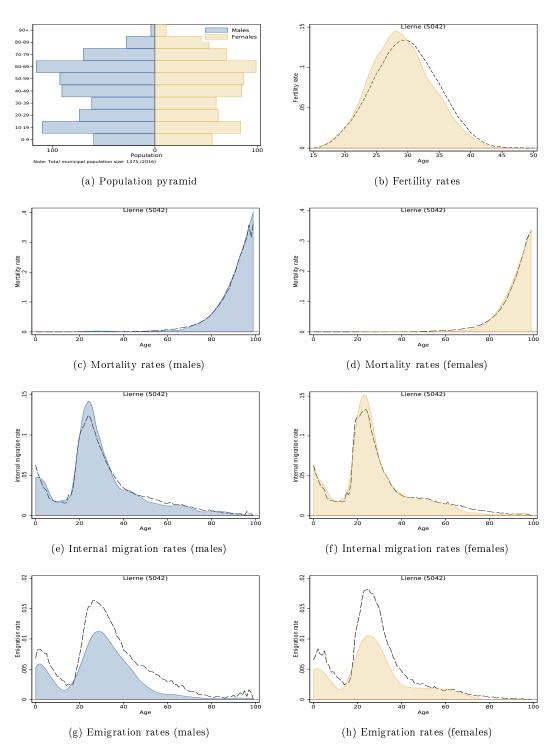


Figure D410: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5042-2016), while mortality and emigration rate estimates are based on five years of data (5042-2016).

Røyrvik (5043)

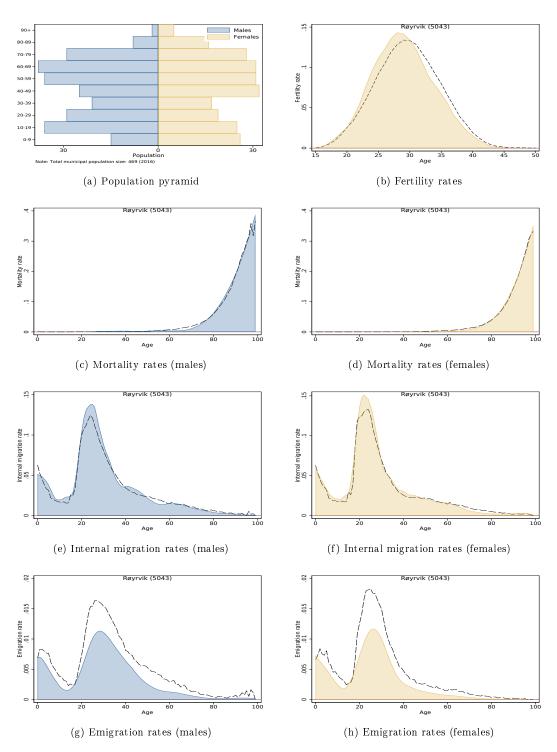


Figure D411: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5043-2016), while mortality and emigration rate estimates are based on five years of data (5043-2016).

Namsskogan (5044)

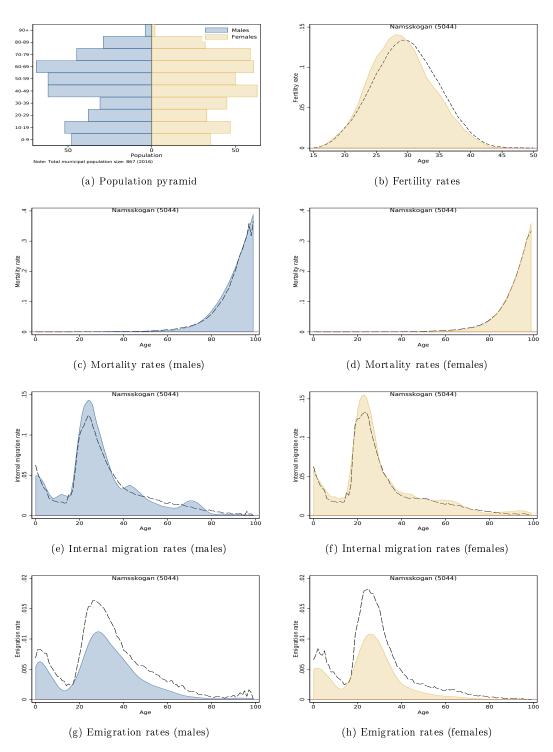
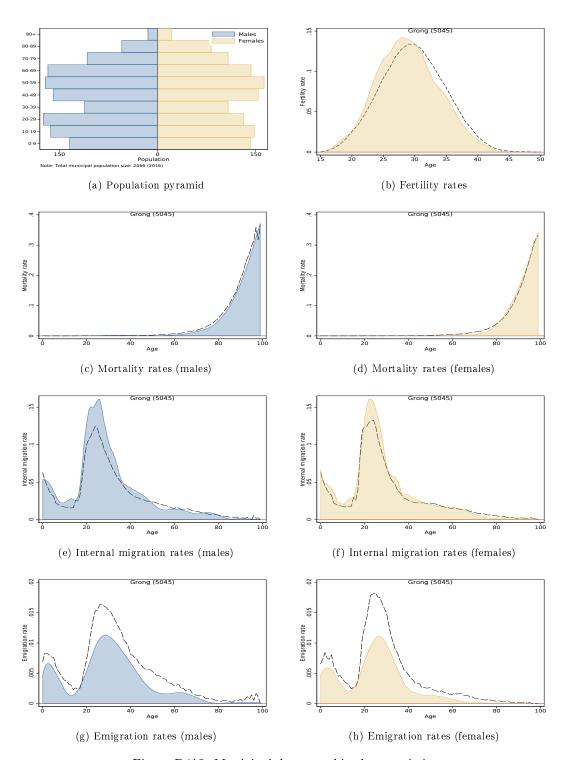


Figure D412: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5044-2016), while mortality and emigration rate estimates are based on five years of data (5044-2016).

Grong (5045)



 $Figure\ D413:\ Municipal\ demographic\ characteristics$

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5045-2016), while mortality and emigration rate estimates are based on five years of data (5045-2016).

Høylandet (5046)

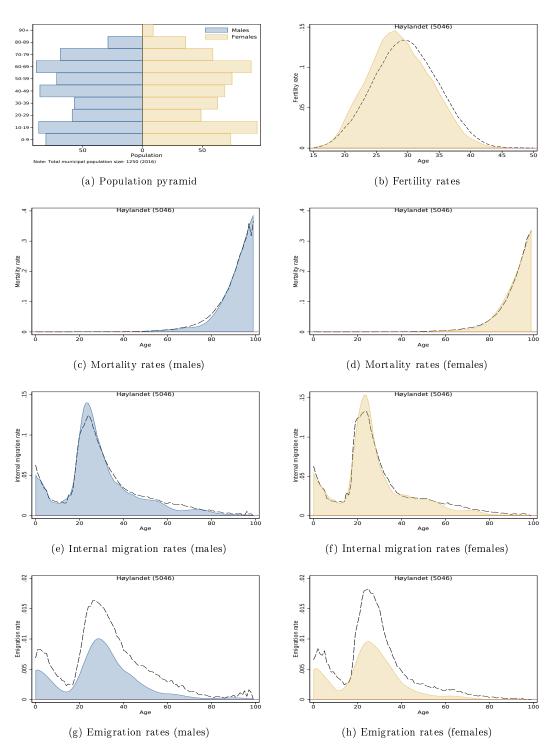


Figure D414: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5046-2016), while mortality and emigration rate estimates are based on five years of data (5046-2016).

Overhalla (5047)

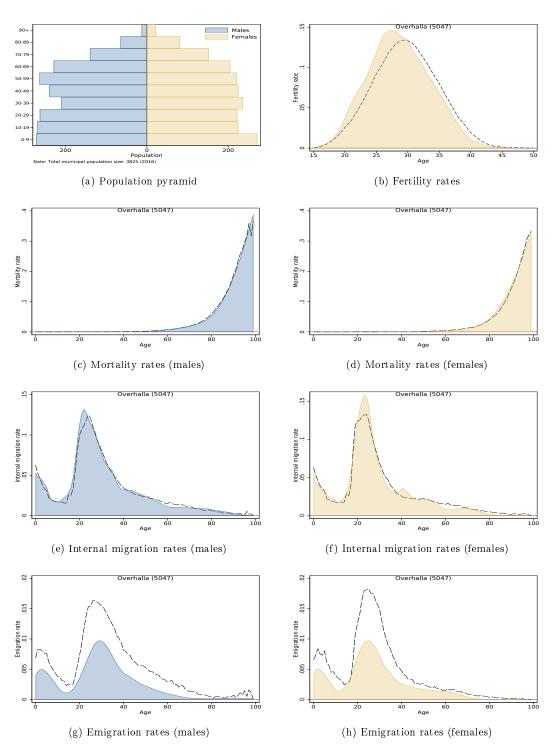


Figure D415: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5047-2016), while mortality and emigration rate estimates are based on five years of data (5047-2016).

Fosnes (5048)

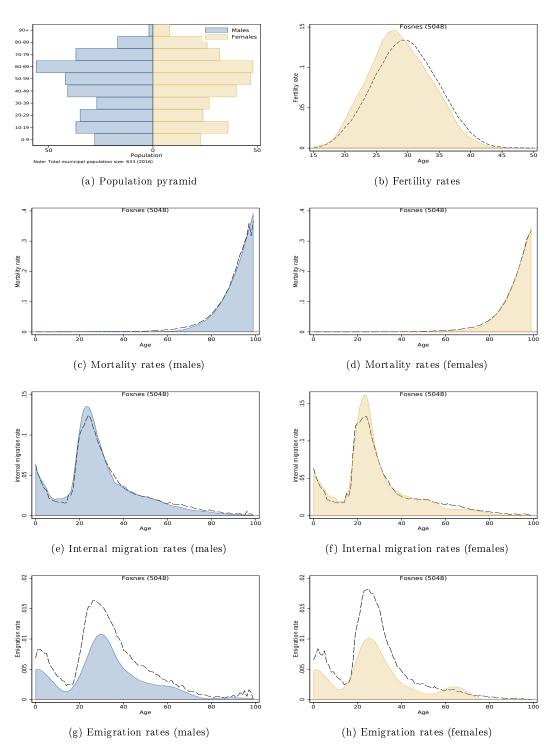


Figure D416: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5048-2016), while mortality and emigration rate estimates are based on five years of data (5048-2016).

Flatanger (5049)

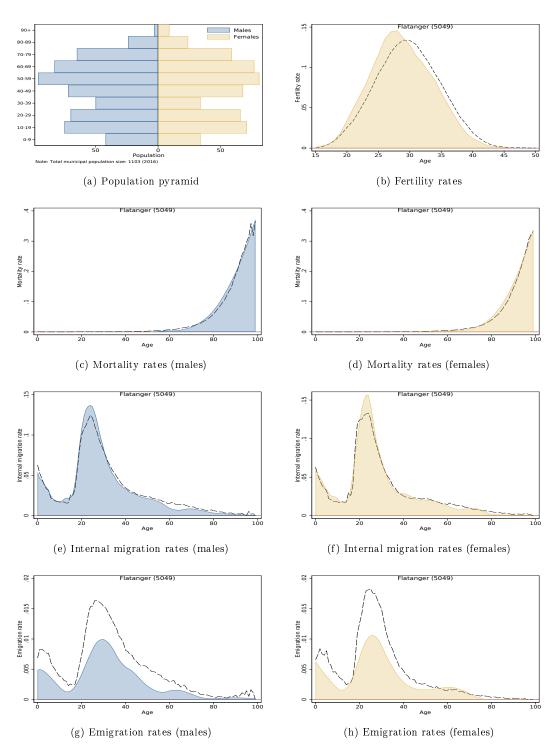


Figure D417: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5049-2016), while mortality and emigration rate estimates are based on five years of data (5049-2016).

Vikna (5050)

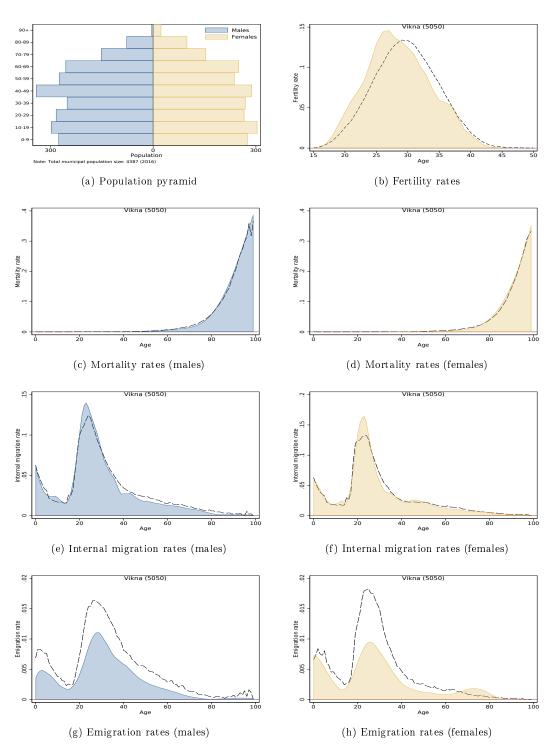


Figure D418: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5050-2016), while mortality and emigration rate estimates are based on five years of data (5050-2016).

Nærøy (5051)

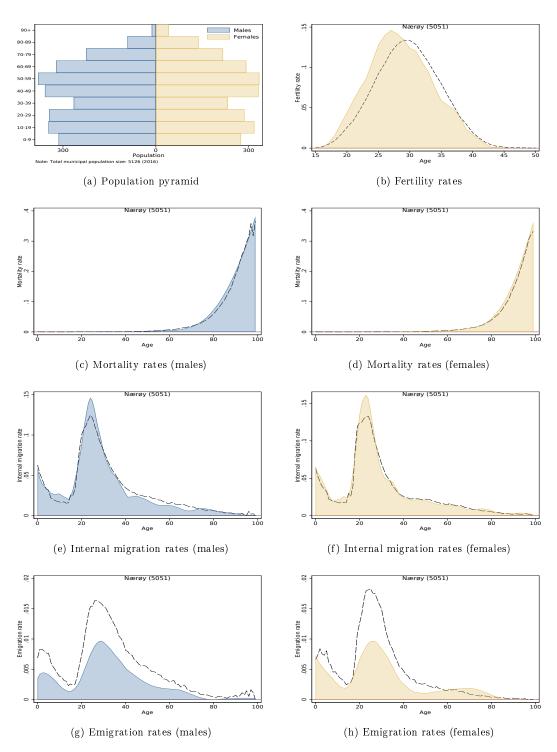


Figure D419: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5051-2016), while mortality and emigration rate estimates are based on five years of data (5051-2016).

Leka (5052)

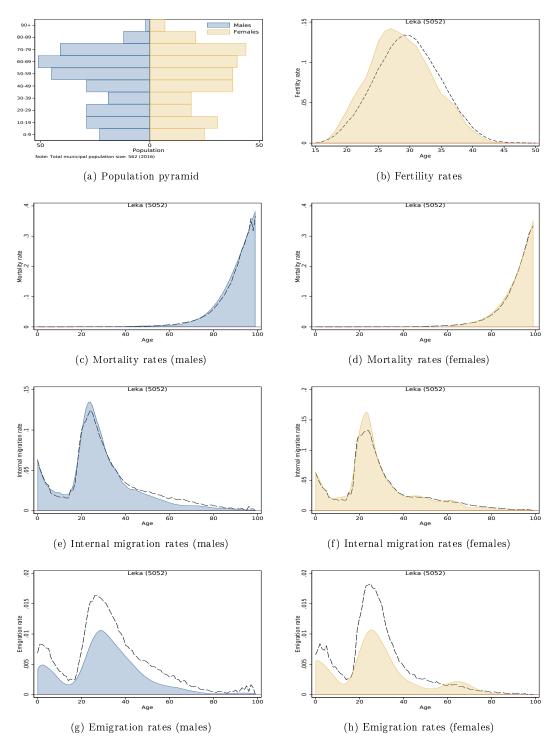


Figure D420: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5052-2016), while mortality and emigration rate estimates are based on five years of data (5052-2016).

Inderøy (5053)

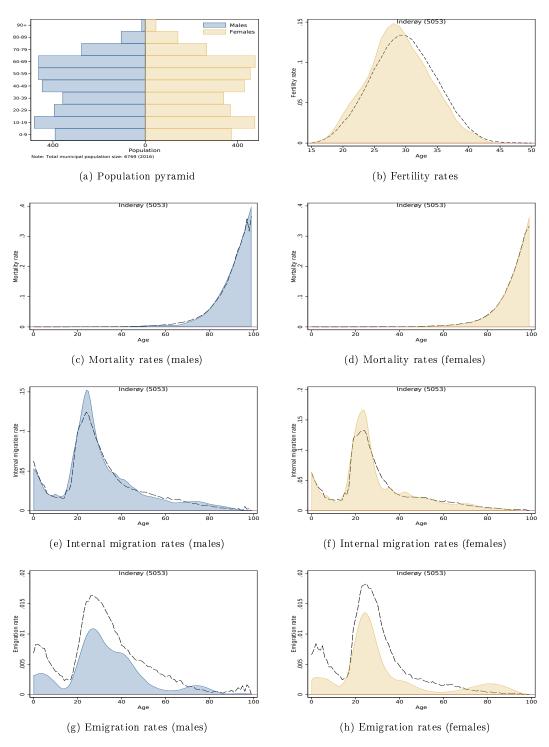


Figure D421: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5053-2016), while mortality and emigration rate estimates are based on five years of data (5053-2016).

Indre Fosen (5054)

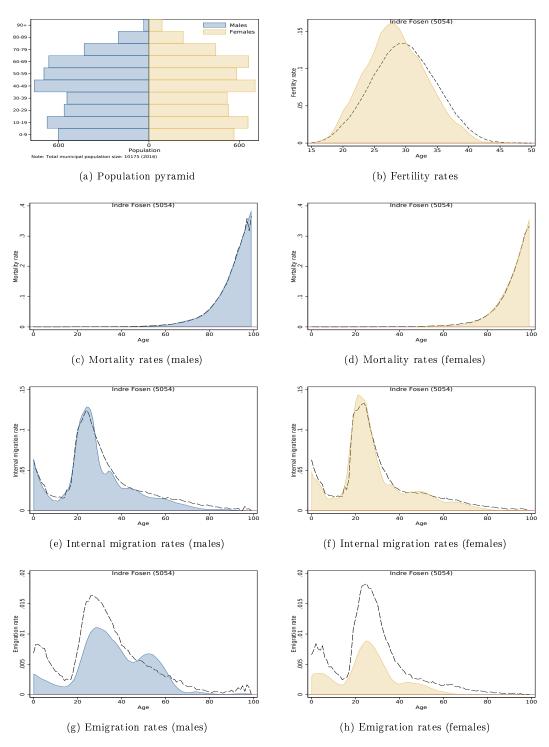


Figure D422: Municipal demographic characteristics

Note: These eight figures show the 10-year age structure for the municipality (a) and the smoothed empirical Bayes estimates of age-specific fertility rates (b) mortality rates (c and d), internal migration rates (e and f) and emigration rates (g and h), separately for men (blue) and women (yellow) where applicable. The national average rate (Figures b-h) is represented by the dashed black line. The population pyramid is based on the 2016 population, estimates for fertility and internal migration rates are based on three years of population data (5054-2016), while mortality and emigration rate estimates are based on five years of data (5054-2016).