Population Dynamics in Fryslân: Exploring the Future Demographic Landscape through Projections and Variants

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Abstract

Fryslân has undergone notable demographic transformations characterised by the presence of an aging population and population decline observed in specific regions of the province. Organisations, governments, and municipalities must be cognisant of the demographic composition of the area in which they operate. This, to anticipate for future demand and needs for public services such as hospitals and schools but also for companies to anticipate market demand or to determine potential areas of investment. This thesis was conducted for the Planbureau Fryslân and focusses on determining the population developments for Fryslân until 2050. Seven Frisian demographic variants until 2050 were created; Medium, Green, Gray, Decline, Growth, High Migration, and Low Migration. All demographic variants present different situations regarding the development of the demographic components fertility, mortality and migration. Additionally, this study is based upon a report published by the NIDI and CBS "Eindrapport Verkenning Bevolking 2050" and translates the national variants into Frisian variants. Results show that the Frisian demographic future shows large variation, both decline and growth are possible pathways. Moreover, high fertility or elevated migration patterns would result in increased demand for primary educational services and across all demographic variants, the proportion of potential working individuals relative to the total population is projected to decline, indicating a smaller future workforce compared to the present. Irrespective of developments in fertility, mortality, or migration, the Frisian population is aging. Informal care services will face heightened pressure in the future, with the highest impact expected in variants of high life expectancy or low migration. The findings of this thesis contribute to the broader understanding of demographic changes in Fryslân, and the variants can be used to build scenarios with further implications for regional development.

Keywords: Projection, fertility, mortality, internal migration, international migration, demography

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Chapter 1: Introduction

Demographic changes have been characterising the Netherlands, including the fertility transition resulting in fertility rates beneath 2.1 and causing the population of the Netherlands currently to grow due to migration rather than a natural increase (CBS, n.d.; Riele & Loozen, 2017). To effectively manage population flows and to ensure appropriate policy development and implementation, governments must be aware of the demographic compositions of populations both nationally and regionally. Moreover, not solely contemporary demographic compositions are important, future projections of demographic compositions also require careful consideration as they contribute to the planning of public services, economic planning, resource allocation and policy development (Park & LaFrombois, 2019).

Therefore, population projections—a technique for assessing future population compositions based on assumptions impacting mortality, fertility, and migration flows—are used by governments as well as municipalities and other organizations (Preston et al., 2001). They are essential for organizations and governments to plan and allocate resources for future development projects such as schools, hospitals and infrastructure. These projections can help policymakers make informed decisions about where to allocate resources and how to plan for future demographic changes. Additionally, projections are important for economic and social planning: regional projections help businesses anticipate future market demand and workforce availability. This facilitates informed decisions making about where to locate or expand operations. Thirdly, projections help policymakers anticipate future needs for public services, such as healthcare and social welfare. It enables policymakers to understand demographic trends and their impact on social issues such as ageing, migration and urbanization (Swanson & Tayman, 2012).

However, it should be remembered that population projections are rife with uncertainty as the future is never entirely foreseeable and population compositions are heavily dependent on external factors. For instance, pandemics such as COVID-19 causes unexpected contemporary increases in mortality rates, as do external situations such as wars or famine. Moreover, as population projections are made on a smaller geographical scale, the level of uncertainty tends to increase due to limitations in data availability, a reduced sample size, and complex migration patterns.

This thesis aims to develop a population projection for the province Fryslân, one of the twelve provinces of the Netherlands. On a national level, projections are yearly created by the public statistical office of the Netherlands, the CBS. In 2021, a more detailed projection report was published developed by the Netherlands Interdisciplinary Demographic Institute (NIDI) in cooperation with the CBS examining more thoroughly and extensively different demographic variants and its implications on the labour market, healthcare system but also housing market (de Beer et al., 2021). However, these projections rely on the national context rather than focusing on regional variations, even though regions can exhibit substantial differences. This underscores the significance of regional projections for more precise regional planning and decision-making. Consequently, Planbureau Fryslân (PF), a local research agency based in Fryslân, aspires to adapt these national demographic scenarios to the context of Fryslân. The aim of this thesis will therefore be to translate the eight national demographic variants (Medium variant, Grey variant, Green variant, Decline variant, Growth variant, High Migration variant, Low Migration variant) into Frisian demographic variants.

In addition to the advantages previously mentioned regarding the development of population projections for municipalities, companies, and governments, this thesis holds additional potential academic and societal significance. The final output consists of Frisian-specific assumptions encompassing seven demographic variants, these assumptions can serve as vital inputs for scenario building. Moreover, national as well as regional projections exist but the Frisian projections are not yet translated into words.

For instance, the impact of future demographic compositions on the potential labour force, demand for educational services or old-age care are topics which will be examined within this thesis. Furthermore, mainly medium variants have been created and this thesis will extend those into additional variants representing different future demographic pathways.

1.1 Problem statement and research questions

Planbureau Fryslân initialised a project aiming at obtaining insights into the future Frisian population by translating the seven demographic variants created in the national projections report developed by the NIDI and CBS into Frisian variants (de Beer et al., 2021). Currently, different institutes as ABF Research, CBS and the Provincie Fryslân provide regional projections for Fryslân however those are mainly based on a medium projection and do not provide different demographic variants. This thesis aims to explore potential future demographic trajectories for Fryslân, given specific assumptions on fertility, mortality and migration. These different demographic variants aim to provide insights into the effects of both high and low fertility on the Frisian population size and composition. Furthermore, they aim to provide understanding regarding the demographic characteristics associated with either an aging or youthful population in Fryslân, as well as the demographic consequences of high or low migration patterns.

The main research question is "*What are the feasible population developments for Fryslân until 2050?"* Additionally, the subsequent sub-questions have been developed to help address the main research question: "How have the demographic components of fertility, mortality, international and internal migration in Fryslân developed in the recent decades, and to what extent do they differ from national trends? (RQ1)", and "What can be inferred from the past trends in fertility, mortality and migration about possible future demographic pathways for each of these components? (RQ2)".

Chapter 2: Literature review

The subsequent section will address existing literature about the Frisian demographic context and highlights its deviations in comparison to the Netherlands. Firstly, this section will highlight the main differences between Fryslân and other parts of the Netherlands in terms of societal, cultural, and economic aspects. Subsequently, this chapter will delve into an academic review of existing literature, focusing on three key demographic components: fertility, mortality, and migration. Finally, the concept of population projections will be discussed and the different existing Frisian projections will be reviewed.

Contributing and originating to disparities in demography between the Netherlands and Fryslân is the Frisian culture, language and identity. For instance, a study conducted by van der Star and Hochstenback (2021) found that the Frisian language enhanced feelings of Frisian identity for people in Noord-Fryslân contributing to feelings of place attachment. The Frisian language, however, has been decreasingly spoken as a native language in contemporary ages and the main language spoken within education, churches and political establishments these days is Dutch (Fishman, 2014). Nonetheless, people in the province of Fryslân report a higher sense of affinity and proudness towards the province compared to people living in other regions in the Netherlands (Planbureau Fryslân, 2021a). Moreover, from a historical perspective, Fryslân its ethnic composition is less diverse than that of other regions of the Netherlands (van der Plank, 1987; Liefbroer et al., 2001; Jennissen et al., 2018). This may be explained by the fact that Fryslân is less populated than urbanised regions in the Netherlands and has comparatively fewer economic prospects, making it less attractive to immigrants.

Additionally, compared to other provinces in the Netherlands, Fryslân has a low growth in economic sense (together with Groningen and Drenthe). Tammens (2022) concluded upon the fact that the GDP of Fryslân has grown with 47% in the period of 1995-2019 making it one of the three provinces with the lowest growing economies of the Netherlands. Moreover, Fryslân is considered a peripheral and rural region (De Beer et al., 2017). This may influence its economic prosperity as research has shown that peripheral regions are often characterised by lower levels of entrepreneurship and innovation as well as the small number of human capital available (Mayer & Baumgartner, 2014). The fact that Fryslân is a peripheral region simultaneously impacts the degree of urbanisation which is described within research from the European Union (2020) to be lower in Fryslân compared to the European average. According to Dühr (2009), even if the Northern Netherlands, especially Fryslân, are regarded peripheral from a national standpoint, they feel more strongly related to other regions in North-East Europe due to a shared cultural past. With the Northern Development axis, there is a political aim to spatially align the Northern Netherlands with Scandinavia, Northern Germany, and the Baltic States which could economically benefit the region (Dühr, 2009).

2.1 Fertility

Several studies have found that socio-economic factors (income, education, employment) are significantly related to fertility rates (Galloway et al., 1994; Dribe & Scalone, 2010; Cummins, 2013; Clarks, 2007). As stated by Gustafsson, Kenjoh, and Wetzels (2017), women who are highly educated or who have a high income tend to postpone their childbirth and have fewer children compared to those with lower levels of education and income. Nevertheless, other studies contradict the statements about a negative relationship between development and fertility and conclude upon a J-shaped relationship in which from a certain threshold of development the relationship reverses (Myrskylä et al., 2009). A study by Luci-Greulich and Thévenon (2014) concluded upon a positive effect between economic development and fertility in OECD countries among which the Netherlands. Fryslân has historically had higher fertility numbers compared to the Dutch average, as will be further elaborated upon in the next chapter.

In Fryslân, women have relatively lower levels of education, and the province is characterised by a rural location (Planbureau Fryslân, 2019). This might contribute to an above national average fertility rate. Furthermore, the mean age at childbirth is another concept to consider which is related to postponement of childbearing. In recent years, Fryslân its mean age at childbirth has been lower than the Netherlands' standard, being 30.9 years old as of 2021 versus 31.8 years old for the country as a whole. (see Appendix A). Indicating that Frisian women tend to have their first child at younger ages, resulting in a longer period of time during which they can have children, which may also contribute to a higher fertility rate. Research by Chipman and Morrison (2013) concluded that women living in economically disadvantaged areas are less likely to postpone childbearing and therefore have children at younger ages. Contrarily, highly economic developed areas are associated with higher birth rates at older ages.

Moreover, when considering the sex ratio, Fryslân has since 1996 almost an equal share of females and males within the population (see Appendix B). When comparing these results with the national context, it becomes evident that the gender distribution in the population is slightly skewed, with a marginally higher number of females than males. Nevertheless, these differences are relatively minor. Furthermore, when taking reproductive ages into account, Fryslân had 105 men for every 100 females in 2021, while the Netherlands as a whole had 102 males for every 100 females between the ages of 15 and 50.

Additionally, as explained by Boschman (2012), young adults who currently do not have immediate intentions of starting families frequently decide to relocate to larger urban centres. This migration behaviour plays a role in increasing the fertility rate in Fryslân. Termed "selective" migration behaviour, it results in the retention of both older individuals and families with children in the region. The level of religiosity in a region is another factor influencing fertility rates, with areas with more religious residents often having more children. This is mainly driven by religious ideas around sexual and reproductive behaviour, family size, and marriage (Zhang, 2008). Over the period 2010 until 2015 the share of religious people in the Netherlands was higher compared to Fryslân (see Appendix C).

2.2 Mortality

According to data from the CBS Statline (2022b), Fryslân consistently has a higher gross mortality rate than the national average for the Netherlands. This difference can be partly explained by the age-structure of the province as data from the PF and CBS show that Fryslân has an above national average proportion of individuals aged 65 years and older (Hansen, 2023; CBS Statline, 2022d). In line with this, data derived from RIVM Statline (2022a) reveals that since at least 1996, Fryslân has consistently exhibited a higher death rate per 1000 individuals compared to the national figures. However, upon examination of the age-standardised mortality rates for individuals aged 65 years and above, the standardised mortality rates show no significant deviation from the national standardized mortality rates. In certain age groups, there is even a slight tendency for them to be marginally lower (RIVM Statline, 2022a).

Moreover, mortality rates have also shown to be dependent upon socio-economic factors such as education and income (Nelson & Hannold, 1980). Over the period 2015 to 2022, Fryslân has a lower average disposable income compared to the Netherlands (see Appendix D). The extent of social assistance services offered in the area has also been identified by various academics as well as the CBS as having an impact on mortality rates (Loke & de Jong, 2013; Shahidi et al., 2019). Fryslân is a province characterised by a relatively high number of individuals receiving social assistance benefits. However, there has been notable improvement in this situation when comparing the periods 2017 and 2022 (CBS, 2022a).

Nevertheless, it should be highlighted that the disparities in mortality rates between the Netherlands and Fryslân are minor, and that the overall health status is considered good (Kooiker, 2021). Kooiker (2021) refers to the disparity between the lower socio-economic situation in Fryslân and the high

levels of wellbeing as the Frisian paradox. Due to its more rapidly ageing population, the Northern Netherlands has actively engaged in healthy ageing programs aiming at postponing the onset of morbidity such as the Healthy Ageing Network Northern Netherlands (HANNN). When further considering health a study conducted by the RIVM concluded that Fryslân has an above average number of deaths caused by cardiovascular diseases compared to the Netherlands with reasons still to be determined (Bies, 2018).

Another mortality indicator to consider is the life expectancy at birth (e0). According to van Poppel et al. (2005), Fryslân had a 10-year higher e0 than Utrecht and Zeeland until the mid-19th century. The growth in e0 in Fryslân has been occurrent since the beginning of the 19th century and continued to increase until the end of the 19th century. Within less than a century e0 in the province has increased with approximately 20 years (van Poppel, 2005). Currently, life expectancy at birth in the Netherlands still differs regionally but the GGD Fryslân reported a life expectancy at birth for the period 2017 to 2020 of 81.7 years old in Fryslân which is equal to the national average (CBS, PBL, RIVM & WUR, 2023). Moreover, in the context of healthy life expectancy (HLE) data sourced from VZinfo, a publicly accessible website established by the National Institute of Public Health and the Environment (RIVM), it was observed that in Fryslân in 2020, HLE ranged from approximately 67.5 to 69.4 years, whereas in the Netherlands as a whole, it stood at 66.9 years (Giesbers, 2022). The HLE is the average number of years a person is expected to live in good health, and it combines the risk of mortality with the current health situation. VZinfo uses the Sullivan method to calculate the HLE which subdivides the e0 in healthy and unhealthy years of life based on prevalence of (un)healthiness obtained from the Gezondheidsenquête of the CBS (VZinfo, n.d.).

In general, e0 is sensitive to lifestyle habits including smoking behaviour but also incidental development such as flue epidemics and cardiovascular diseases. In Fryslân, 51% of the inhabitants has overweight which is slightly above the national 49% (Marinus, 2022) . It is expected that this share will increase in the upcoming years which possibly results in more health problems among the Frisian population. Furthermore, the share of smokers within Fryslân has decreased over the past few years but lays still slightly above national average (18% in Fryslân, 17% in the Netherlands) (Marinus, 2022).

2.3 Migration

The demographic component of migration can be subdivided into four different components including immigration, emigration, internal in-migration and internal out-migration. Before further contextualising these components into the Frisian context, definitions of both internal and international migration will be provided. Since the data on migration will be obtained from the CBS, their definition of international and internal migration will be applied. Therefore, international migration “refers to people who moved to the Netherlands (immigration) or inhabitants who leave the Netherlands (emigration)” (CBS, n.d.-a). When applying this definition to the context of this thesis, it can be defined as “people who resided in another country than the Netherlands and moved to Fryslân (immigration) or inhabitants who leave Fryslân to countries outside the Netherlands (emigration)”. Moreover, internal migration refers to “each move within the Netherlands” (CBS, n.d.-b). However, applying this definition to the Frisian context would not be accurate as it is aimed to capture internal moves which do change the Frisian population size. Therefore, within this thesis internal migration is defined as “moves within the Netherlands that either originate from Fryslân (out-migration) or have the destination in Fryslân (in-migration).

Furthermore, Fryslân has experienced many decades of net internal out-migration while simultaneously having positive international migration, however not enough to compensate for the internal out-migration, contributing to population decline. Since 2019, Fryslân has positive internal migration flows causing the population to grow again but many young adults still leave the province to pursue labour and educational opportunities in other regions (de Vries, 2022). Nonetheless, as reported by the Planbureau Fryslân (2021), there has been a slight reduction in the out-migration of young adults.

This shift is attributed to factors such as changes in the student financing system and the expansion of employment prospects within the region. This demonstrates the ability of policy to influence demographic compositions, both nationally and regionally. Furthermore, Fryslân has experienced periods of population decline in different villages. Additionally, research conducted by the PBL showed that small villages within Fryslân are expected to experience more population decline in the future (CBS, 2015; Molema, 2021). On the other hand, places which had more than 15,000 inhabitants grew with almost 4% in the period 2010 to 2020 (Planbureau Fryslân, 2021a).

In the past, Fryslân exhibited lower levels of ethnic diversity in comparison to other regions in the Netherlands with respect to international migration (van der Plank, 1987; Liefbroer et al., 2001; Jennissen et al., 2018). However, there has been a notable shift in this trend. Different migration groups are now settling in Fryslân, leading to increased diversity in the local population. Approximately half of the inhabitants with a migration background in Fryslân are of Western origin, while the other half is of non-Western origin. As of 2020, the largest migrant groups in Fryslân are Germans, followed by Indonesians and Surinamese individuals. Additionally, the fourth largest group consists of refugees from Syria (Planbureau Fryslân, 2021b). An increase in labour migrants can also be observed, driven by the entrance of Central and East European countries into the Schengen Area. Despite this inflow, it remains uncertain whether these labour migrant groups will choose to remain in Fryslân permanently or depart after a certain period.

2.4 Projections

The concept of population projections can be defined as estimating the volume and structure of indivdiuals who will continue to be alive in the future based on the current population and plausible assumptions about age-specific death rates, birth rates, and population movement rates (Keyfitz, 1968). Population projections provide what-if scenarios based on developed assumptions about the future. Several scholars throughout the years have examined the methodology of population projections aiming at analysing the applicability, accuracy and efficiency of different projection methods (Wilson & Rees, 2005; Smith et al., 2006; Bohnert, et al., 2015). Nevertheless, as population projections include assumptions and calculations about the future, a great deal of uncertainty will always be involved making it the aim of the researcher to develop a model which is able to combat this uncertainty as best as possible. In addition, as stated by Gietel-Basten (2022), it should also be the aim of researchers to report projections not as one predetermined road to the future but rather as different pathways with one being the most likely scenario to occur.

When considering the regional context, several instances create projections on a regional level; CBS together with Planbureau voor de Leefomgeving (PBL), the Provincie Fryslân and ABF Research. The projections built by ABF Research are consistent with the national projections provided by the CBS and takes into consideration differences between municipalities and the housing market trends (ABF Research, n.d.). ABF Research uses a model called Primos which makes projections at the sub-municipal level of homogenous residential environments. They also insert a housing construction program within their projection model, often obtained from the municipality, and calculate with that the future population and household developments. Pearl relies on the assumptions about the national projections in combination with assumptions on municipality level about migration, fertility and mortality as well as households dynamics and housing construction plans at the municipal level (CBS, 2022b). Additionally, the projection developed by the Provincie Fryslân uses a model which assumes similar trends for fertility and life expectancy as on the national level but changes the migration input based upon historical trends[1]. The assumptions made by the Provincie Fryslân on internal migration and international migration

[1] Personal information obtained from M. Smulders, consultant policyresearch for the Provinsje Fryslân

(excluding asylum migration) are thus based upon past developments. Asylum migration trends exhibit many variations, leading to the consideration of specific factors influencing its trajectory. Consequently, the projection of asylum migration by the Central Bureau of Statistics (CBS) for the Netherlands is used within the projection model of the Provincie Fryslân, with particular attention given to the share relevant to the province of Fryslân. Therefore, the main difference between Pearl, Primos and the Provincie Fryslân, is that the Provincie Fryslân projects mainly based upon trends in migration while the other instances insert housing construction programs within their projection models[1].

As visible in Figure 1, marginal differences exist between the projection of the Province Fryslân and Pearl in which Pearl projects a more rapid decline from 2020-2025 compared to the projection of the province. Subsequently, the pace of decline will decrease from 2025-2035 and then decline slightly faster from 2035-2050. Nevertheless, Pearl expects a greater decline in population compared to the province (approximately 10,000 people). Primos on the other hand, predicts a significantly higher population number for Fryslân for the period 2020 - 2050 compared to the other two instances with a final population of 2050 of 624,720 inhabitants. Note that within Figure 1, the historical data (period 1995 until 2020) are derived from CBS Statline.

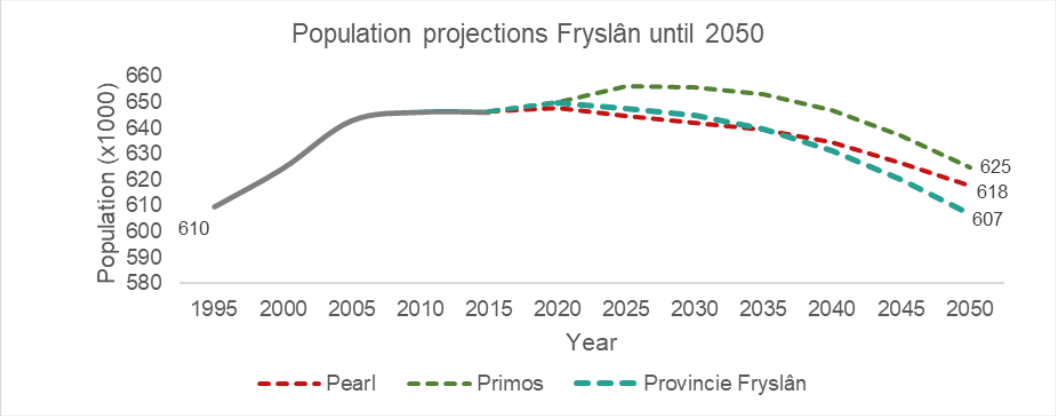

Figure 1. Fryslân population projection until 2050 by Pearl, Primos and Provincie Fryslân. Data CBS obtained from CBS Statline. (2023a). *Regionale prognose 2023-2050; bevolking, intervallen, regio-indeling 2021.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85173NED /table?ts=1691052851573. Data Primos obtained from ABF Research. (n.d.). *Primos JIVE.* https://primos.abfresearch.nl/jive. Data Provincie Fryslân was obtained from Friesland Databank. (2020). *Factsheet Friese Bevolkingsprognose 2020.* https://friesland.databank.nl/report/Fact sheet%20Friese%20Bevolkingsprognose%202020.pdf

Chapter 3: Conceptual model

Figure 2 presents the conceptual model which has been created based upon the conducted literature review and guides the structure of this thesis. Fryslân was taken as geographical context and the three major demographic components required for conducting the population projection; fertility, mortality, and migration will be examined in terms of historical trends and composition. It should be noted that different from national projections, regional projections cope with not only international migration but also internal migration. Subsequently, the historical data will be used to develop assumptions which will be done based upon expert judgements. Expert judgement within this thesis refers to the authors own interpretation based upon the obtained knowledge about the possible Frisian developments in fertility, mortality and migration. The developed assumptions will be implemented within the DEMOVAR projection model resulting in seven population variants describing the feasible future pathways for Fryslân until 2050.

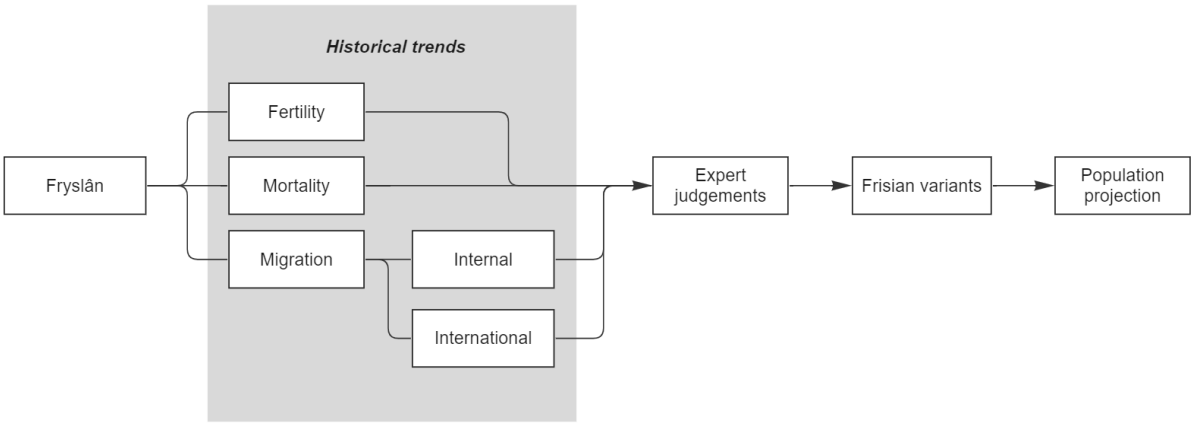

Figure 2. Conceptual model. Source: Author

Chapter 4: Methodology

A quantitative approach was taken in order to answer the research questions using secondary data derived from the official statistics bureau of the Netherlands (CBS), FP, the RIVM and Eurostat. The CBS is the largest statistical office in the Netherlands providing data on the Dutch society on national, regional, provincial, and municipal level. It was chosen not to obtain the acquired data from the database of the Provincie Fryslân as the required data presented within their database also originates from the CBS.

The main aim of this thesis was to develop seven demographic variants which describe possible future developments for Fryslân until 2050 inspired by the report of de Beer at al. (2021) in which eight demographic variants were developed describing the Dutch demographic developments until 2050. Due to the inability of the DEMOVAR model employed in this thesis to distinguish between asylum and labour migration, two variants—a high migration variant and a low migration variant—were developed. As opposed to the national version's three migration variants (low migration, high labour migration, and high asylum migration). This resulted in this thesis providing seven demographic variants instead of eight as provided within the report of the NIDI/CBS (de Beer et al., 2021). Nevertheless, the demographic variants follow the same structure as within the report:

1) *Medium variant*: This demographic variant assumes an average development in TFR, life expectancy and migration. This variant is based upon the Pearl regional projection (2020-2050) made by the CBS/PBL and presents the most probable projection (CBS, 2022b).
2) *Growth variant:* Within the growth-variant all demographic components exhibit high values meaning that fertility, life expectancy and migration numbers are high resulting in a substantial increase in population.
3) *Decline variant:* The decline-variant presents the opposite situation compared to the growth-variant. Thus, all demographic components contribute to low or even negative population growth.
4) *Green variant:* The green-variant depicts a situation in which the TFR is high while life expectancy is considerably low resulting in a young population.
5) *Grey variant:* This variant presents a situation with a great share of elderly in the population caused by the low fertility and high life expectancy.
6) *High Migration variant:* Within this variant, an average development is expected for the components of fertility and life expectancy. Migration numbers, however, are high.
7) *Low Migration variant:* Similar to the high migration-variant, the low migration-variant assumes an average growth in life expectancy and fertility but migration numbers are considerably low.

The methodological approach taken to conduct this thesis started with analysing historical trends of the demographic components fertility, life expectancy and migration. For all components the trends analysed were based upon data of Fryslân and the Netherlands for as far back in time as publicly available. Therefore, for the TFR the period 1988-2021 was considered, for the life expectancy the period 1996-2020 was considered and migration patterns were analysed from 1960-2022. Besides attempting to explain patterns, the Frisian context was also compared to the Dutch context. Subsequently, based upon the trend analysis and expert judgements, assumptions were created for all the seven demographic variants. Within this thesis expert judgements refer to the interpretation of the author based upon the obtained knowledge within the field and context.

Moreover, the quantified assumptions were implemented within the DEMOVAR model resulting in various population projections analysed in chapter 7. The projection model itself is based upon the cohort-component method (CCM). The DEMOVAR model was developed by prof. dr. L.J.G. van Wissen

and used within the Population Projections and Sustainability course offered by the University of Groningen. The methodology of the projection model is based upon the book of Preston et al. (2001) but modified to include separately inflow and outflow of international and internal migration. The subsequent sections will further elaborate upon how the different aspects of fertility, mortality and migration are dealt with within the DEMOVAR model. Furthermore, this section will elaborate upon the operationalization of the research questions and the ethical considerations relevant to this study.

4.1 DEMOVAR model

According to Preston et al. (2001), the dominant method for population projections is the cohort-component method (CCM). This assertion was further supported by an evaluative study of Wilson and Rees (2005) that took into account regional and national projections. The cohort-component method categorises the existing population into cohorts by age and sex distribution. Then, it estimates the number of individuals in each cohort in distinct intervals in time based on assumptions about births, deaths and migration. This technique is based on the premise that population growth and change can be studied through the investigation of people as they transition through various age groups throughout time (Preston et al., 2001).

The CCM is a discrete-time model meaning that, as opposed to continuously model change over time, change is measured at a specific point in time using a fixed time interval. For this thesis, five-year age groups were used as well as five-year time intervals. The standard equation used to describe the population change within the CCM is:

$$N_{(t+5)} = N_t + B_{(t,t+5)} - D_{(t,t+5)} + In_{(t,t+5)} + Im_{(t,t+5)} - Ou_{(t,t+5)} - Em_{(t,t+5)} \quad (1)$$

In which N_{t+5} refers to the population at the end of the interval, starting with a baseline population at time t (N_t), adding up the number of births ($B_{(t,t+5)}$) within this interval, subtracting the number of deaths ($D_{(t,t+5)}$), then adding up the number of in-migration ($In_{(t,t+5)}$) plus immigration ($Im_{(t,t+5)}$) minus out-migration ($O_{(t,t+5)}$) minus emigration ($Em_{(t,t+5)}$). Additionally, matrix notation can be used to express the mechanics of CCM in a concise manner which in this thesis will be done using the Leslie matrix (equation 2).

$$N_{(t+5)} = LN_{(t)} \quad (2)$$

In which *L* refers to the Leslie matrix with information on the chances of surviving and having a child. When including two sexes into the matrix the equation can be specified as:

$$\begin{bmatrix} N^F(t+5) \\ N^M(t+5) \end{bmatrix} = \begin{bmatrix} F^F + S^F & 0 \\ F^M & S^M \end{bmatrix} * \begin{bmatrix} N^F(t) \\ N^M(t) \end{bmatrix} \quad (3)$$

Within equation 3, *F* refers to the sex-specific fertility matrix and *S* refers to the sex-specific survival matrix. As previously specified, population dynamics are also impacted by migration which therefore requires to be extended into the matrix. Additionally, the projections made in this thesis were based on a province causing the population to be subjected to both internal migration and international migration. Equation 4 presents how both migration forms are dealt with within the model. Outflux is included in the model as outflux probabilities, where the outflux probability *E* is the sum of the outmigration probability and the emigration probability. Half of the outflux (*E*) leaves the starting population *N(t)* at the beginning of the interval and the remaining population is exposed to the risk of fertility and mortality (*L*(t)). Subsequently, at the end of the period the population is again subject to the risk of leaving the population.

Similar to out-flux, half of the in-flux (w) is assumed to move into the population at the start of the period and half at the end of the period. Those entering the province at the beginning of the period are subject to the risk of fertility and mortality. In an extended Leslie formulation this results in:

$$N_{(t+5)} = (I - {}^{1}/_{2}\,E(t))^{2}\,L(t)N(t) + {}^{1}/_{2}\left(I + \left(I - {}^{1}/_{2}\,E(t)\right)L(t)\right)\;\; w(t, t+5) \tag{4}$$

Compared to international migration, internal migration might have a different impact on population dynamics. For instance, changes in Fryslân its economic prospects or the housing market possibly stronger impacts internal migration. The forces driving internal migration, considering its impact on population change, is better captured when separately considering influx and outflux as opposed to net migration. This, due to the fact that if there are significant disparities in the numbers of people migrating in and out, net migration may not adequately reflect the underlying movement patterns and the age distribution of in-migrants possibly differs from out-migrants.

4.2 Operationalisation

The operationalisation of the two sub-questions that collectively allow for the resolution of the primary research question are shown in Table 1. The first sub-question was answered through the examination of trends using data obtained from the CBS and the RIVM. Secondly, the Frisian assumptions guiding the demographic variants were formulated based on the examination of historical contexts as well as the assumptions made in the NIDI/CBS report of de Beer et al. (2022). Moreover, within the DEMOVAR model, extrapolation was performed based on regression and expert judgement to create the demographic variants.

Table 1: Operationalisation of research questions

Research Question	***Operationalisation***
RQ1 How have the demographic components of fertility, mortality, international and internal migration in Fryslân developed in the recent decades, and to what extent do they differ from national trends?	Descriptive statistics using register-data CBS and data from RIVM Statline
RQ2 What can be inferred from the past trends in fertility, mortality and migration about possible future demographic pathways for each of these components?	Extrapolation based on regression and expert judgement

4.3 Ethical considerations

Research ethics are an important component of research and requires careful consideration throughout the study. It involves a set of beliefs and principles that direct research conduct and safeguard the rights and welfare of all persons engaged. This thesis employed secondary data, which means that the data was acquired from a third party. Thereby, it was important to guarantee that the information used and the research in general were conducted in a fair and unbiased manner. This was done by ensuring that data was not manipulated or misrepresented to obtain preferred outcomes. This also refers to the dissemination of the research findings. The outcomes will be reported in an accurate and truthful manner with findings supported by data.

Chapter 5: Trend analysis

This chapter investigates historical trends in migration, life expectancy, and fertility in order to comprehend how the demographic components have changed over time and to identify the events or circumstances that have had an impact on those trends. Additionally, the Frisian trends will be contrasted with the demographic trends in the Netherlands.

5.1 Population Dynamics

Prior to examining the specific trends of the demographic concepts in Fryslân, a general understanding of the population dynamics is required, along with a comparative analysis to national dynamics. Figure 3 presents the population growth rate of Fryslân and the Netherlands from 1995 until 2022. Fryslân presents a relatively more fluctuating trend compared to the Netherlands, but both regions demonstrate population growth. To understand why Fryslân experienced faster growth compared to the Netherlands between 1999 and 2002, and the subsequent periods, an analysis of not only fertility but also migration is required, as presented in Figure 4. Fryslân encountered certain periods of population decline, notably in 2005, wherein net migration numbers were negative, highlighting the province's pronounced reliance on migration for population growth or decline (see Figure 4). Furthermore, since 2008, Fryslân has been mirroring the Netherlands' population growth rate, with recent years (since 2020) witnessing notably higher growth rates. This surge can be attributed, in part, to the inflow of Ukrainian refugees seeking refuge in the Netherlands, among other destinations. Approximately 80,000 Ukrainian refugees came to the Netherlands in 2022 from which about 3,000 to Fryslân (Rijksoverheid, n.d.; Omrop Fryslân, 2023).

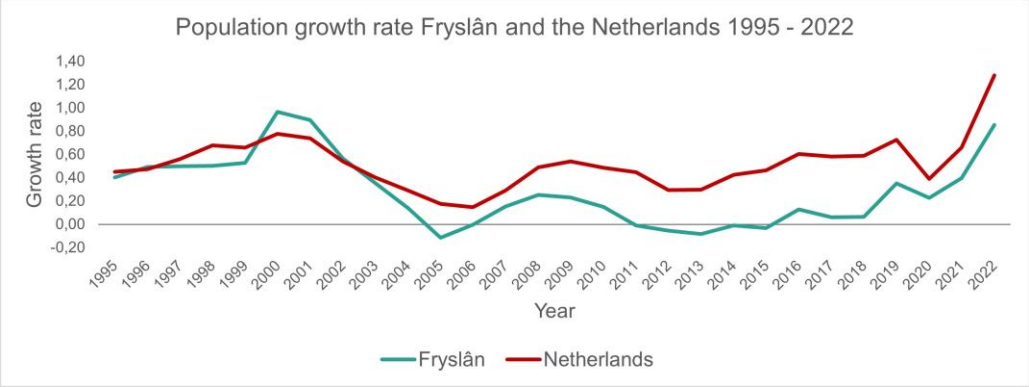

Figure 3. Population trends 1995-2023 Netherlands and Fryslân. Data obtained from CBS Statline. (2023b). *Bevolkingsontwikkeling; Regio per maand.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37230ned/table?ts=1684850760388

According to Hoogeboom (2016), the era from 1970 to 2000, is characterised as a time in which significant changes in demographic behaviour altered population numbers, often known as the second demographic transition. Throughout this period, there was a significant decrease in the number of children born, while the number of households exhibited a notably faster increase compared to the overall population growth. This surge in household growth can be attributed to a rise in the number of single-person households and divorces. Hoogeboom (2016) states that this change in conduct is one of the major reasons for the decrease in population growth during this time period. Furthermore, as depicted in Figure 4, since 2015, population growth has primarily been attributed to migration figures, whereas natural population growth has been on a declining trend. This underscores the significance of migration in the context of future projections.

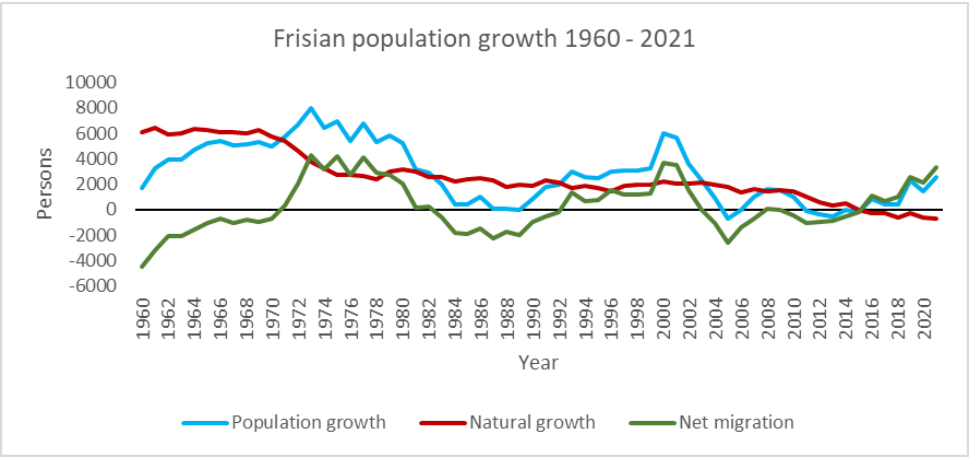

Figure 4. Population growth, net migration and natural growth of Fryslan 1960-2020. Data obtained from Planbureau Fryslân. (2023). *Demografische overgang in Fryslân.* https://www.planbureaufryslan.nl/monitoren/bevolking/

When considering the population composition of Fryslân as of 2020 (see Figure 5), it becomes apparent that the composition of the Frisian population corresponds to the Dutch composition but Fryslân has fewer inhabitants within the working ages and higher proportions of elderly. The visible peaks from the ages of 45 until 70 years old are representative of the baby boomers and their children.

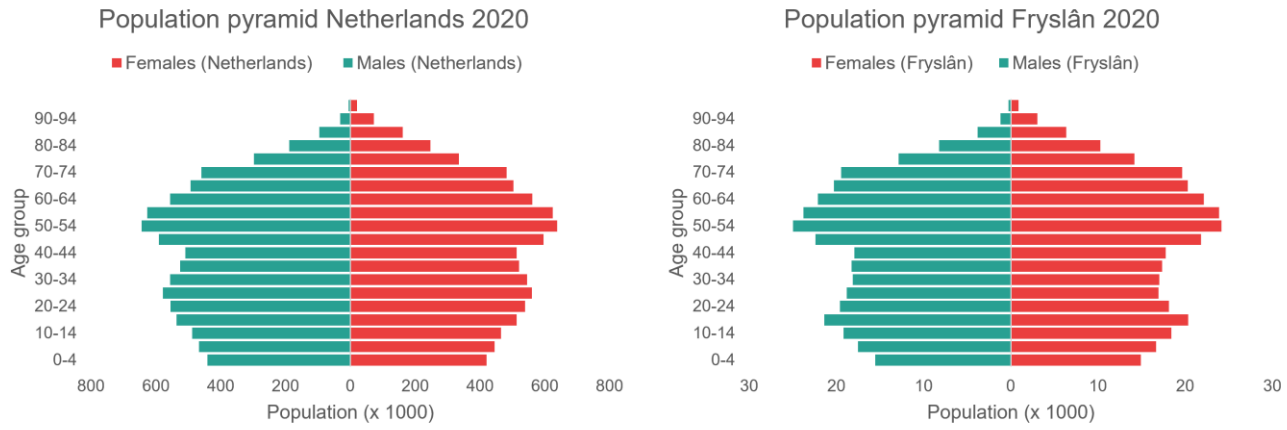

Figure 5. Population pyramid of the Netherlands and Fryslân 2020. Data obtained from CBS Statline. (2022f). *Bevolking; geslacht, leeftijd, nationaliteit en regio, 1 januarai.* https://opendata.cbs.nl/statline#/CBS/nl/dataset/84727NED/table?ts=1681212951106

5.2 Trend analysis fertility

Fertility is examined by considering the Total Fertility Rate (TFR), which is a period measure that contains periodic information on total number of children a women is expected to have throughout her lifetime (Schoen, 2004). Figure 6 shows that Fryslân has traditionally had a structurally higher TFR than the Dutch average. The time trend of the TFR in Fryslân demonstrates a largely parallel pattern to the Dutch national average, suggesting that changes in policies or significant events influencing TFR at the national level are also reflected at the regional level in Fryslân.

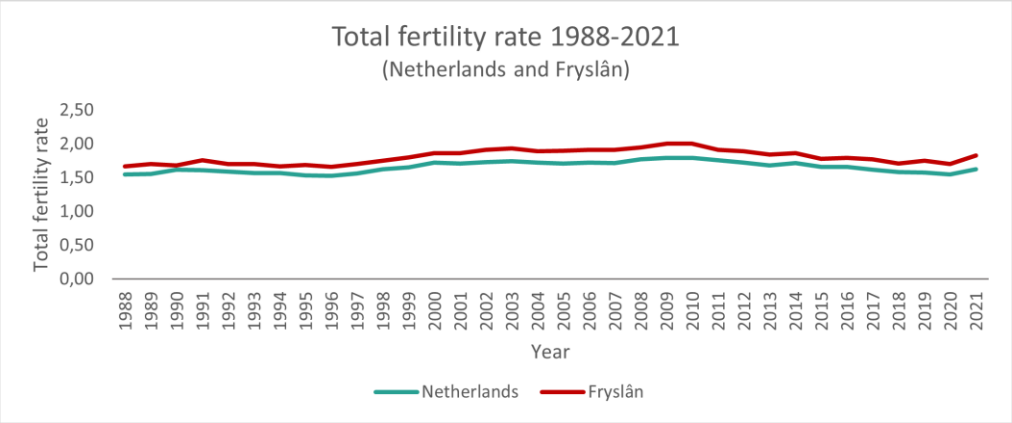

Figure 6. Total fertility rate of Fryslân. Data obtained from CBS Statline. (2022e). *Geboorte; kerncijfers vruchtbaarheid, leeftijd moeder, regio.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37201/table?ts=1690998419135

Between 1960 and 1996, Fryslân witnessed a rapid decline in TFR, dropping from approximately 3.2 children per woman to 1.5 children per woman in 1996. This trend can be explained by a combination of various factors and events that influencing fertility behaviour. First, the Dutch welfare system, which is built on Keynesian economic principles, idealised married women staying at home while also encouraging safety nets against unemployment and disability from 1960 onward. Additionally, policies were implemented to raise the level of education obtained in the Netherlands, and a healthcare programme was introduced (Wielers & Mills, 2011). During this period, the Netherlands can be described as having robust social norms and values pertaining to informal caregiving and family formation, which contributed to high but diminishing levels of fertility. The declination during this period is driven by the introduction of contraceptives which was swiftly accepted by society (Hardon, 2003). The paternalistic policies dominating the Dutch labour market at time caused high inflexibility and with that, also recognition about the inability of the welfare system to deal with long-term unemployment after the economic crises within the period 1970 to 1980 also contributing to the drop in fertility.

The subsequent period, can be characterised by economic stability, an increase in female labour participation and part-time employment. As stated by Visser (2002), the government created new laws in 1997 and 2000 to eliminate unequal salary in part-time positions and established a lawful "entitlement to part-time employment" whereby all workers were given the option to decrease their working hours. This enabled women to stay at home but simultaneously work part-time while receiving the same social-security benefits. It was apparent that fertility started to rise again slightly from 1996 onwards until 2010. In European context, the Netherlands was viewed to have a fertility paradox. This was attributed to the presence of moderate fertility rates despite a relatively high proportion of females in the labour force and strong traditional norms for fathers to be the primary source of income. Notably, the Netherlands did not have direct family policies in place (Mills, 2015). Additionally, from around 1990 the Netherlands introduced the so-called “basisbeurs” for higher educated students to stimulate higher education also contributing to the decision-making of having children in terms of affordability of education (Mills, 2015). Moreover, the Netherlands and Fryslân as well, have experienced an increase in international in-migration with people from non-western countries with higher total fertility rates compared to the Netherlands. Research by Beine, Docquier and Schiff (2009) showed that the fertility behaviour of immigrants does occasionally align with the fertility behaviour of individuals in the host country over time, but frequently, immigrants tend to have more children. Hence, the increase in international immigrants in the Netherlands and Fryslân could have contributed to both the modest rise in TFR observed between 1996 and 2010, and around 2020.

However, starting from 2010, fertility rates in the Netherlands and Fryslân showed a slight decline again, potentially influenced by the financial crisis. In a related context, Goldstein et al. (2013) examined the relationship between the economic crisis in 2009 and 2010 and fertility rates. They revealed that countries significantly affected by the crisis experienced diminished fertility development compared to what would have been expected based on previous trends. Furthermore, since 2011, public financing for daycare was reduced several times, which made it more expensive to have children (Mills, 2015).

5.3 Trend analysis life expectancy

In order to investigate mortality trends, the trend analysis focused on the concept of life expectancy at birth (e0). This section aims to examine the trends in male and female life expectancy at birth, which provides a period measurement supposing that life expectancy is an accurate representation of the mortality circumstances during a specific year (Luy et al., 2020).

From 1996 onward, the e0 in Fryslân has largely followed the same pattern as the Netherlands (see Appendix E). In an attempt to clarify the variations in life expectancy for both sexes in Fryslân, the national trends were taken into consideration. These variations occasionally show fluctuations of around a year or half a year, but overall, they followed an upward trajectory. According to Loke and de Jong (2013), between 1970 and 2009, e0 increased by 7.7 years for men and 6.2 years for women. At least three years of this gain in e0 can be attributed to a decline in the rate of cardiovascular disease deaths (de Jong, 2004).

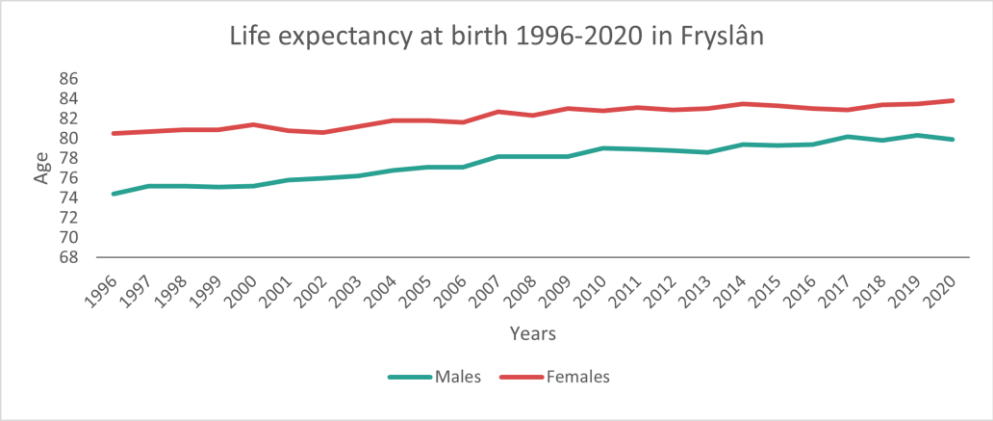

Figure 7. Life expectancy at birth in Fryslân 1996-2020. Data obtained from RIVM Statline. (2022b). *Levensverwachting op de leeftijd 0 en 65 jaar; geslacht, regio, 1996-2020.* https://statline.rivm.nl/#/RIVM/nl/dataset/50104NED/Table?ts=1681301839591

Additionally, the period from 2002 to 2012 exhibited a significant rise in life expectancy at birth (e0), as depicted in Figure 7. The CBS (2020) attributed this increase to developments in the care provided for the elderly. The Dutch government significantly increased spending on long-term care and per-person care between 2000 and 2015, but the reformation of the elderly care system in 2015, made it harder for elderly people to access care and increased their personal expenses (de Bresser et al., 2017). Furthermore, e0 between males and females in Fryslân differed in 1996 approximately six years and as of 2020 this difference is about four years indicating decreasing gender inequality in mortality. According to research by Luy (2003), one year of the difference in e0 between men and women can be attributed to biological differences between the sexes, and the other years of variation in e0 are mainly driven by gender-differentiated behaviour. Demonstrating that the disparity in e0 between sexes is unlikely to be eliminated in the future.

5.4 Trend analysis internal migration

Population age distributions are impacted by migration patterns, and Figure 8 shows the trends for Fryslân from 1960 to 2021. The figure illustrates that Fryslân predominantly witnessed periods with a net out-migration, where the number of people leaving the region exceeds the number of individuals moving in. Note that the provided numbers within Figure 8 also includes intra-provincial moves in Fryslân. While these internal moves are not directly relevant for the projections to be conducted, they do facilitate a more comprehensive historical analysis. Unfortunately, migration data between provinces is available only for the period 2011 to 2021, limiting the scope for a more extended historical examination of internal in- and out-migration. Nevertheless, for net internal migration, the intra-provincial moves cancel out causing that those numbers are possible to study on a longer time scale using the data including intra-provincial moves. Appendix F provides a comparison between both types of internal migration, concluding that both exhibit similar trends. As a result, it was feasible to analyse internal migration using the data that includes moves between municipalities.

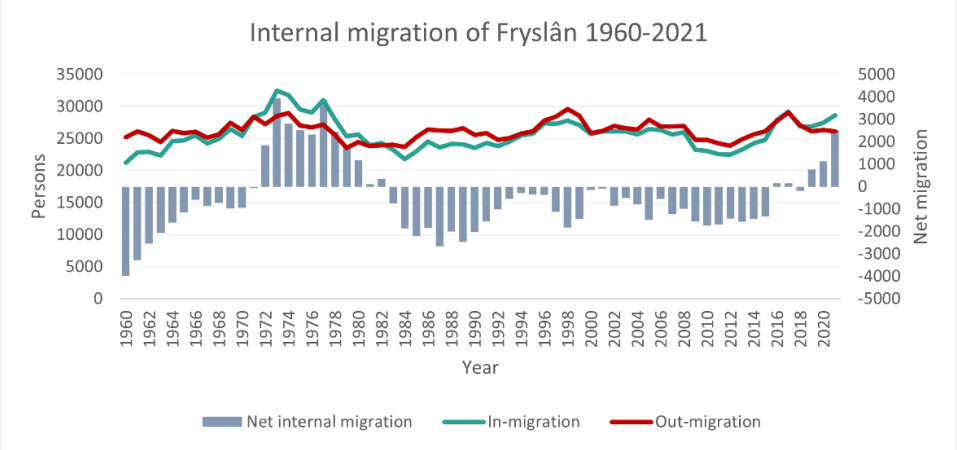

Figure 8. Internal migration trends Fryslân 1960-2021. Data obtained from CBS Statline. (2023a). *Bevolkingsontwikkeling; levend geborenen, overledenen en migratie per Regio.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37259ned/Table?ts=1686333838658

Around the period 1950 East Fryslân was recognised as a development region mainly due to its high numbers of unemployment, even young adults were educated about migrating to more prosperous parts of the Netherlands (Hoogeboom, 2016). During the same period, the Dutch government shifted its perceptions about Fryslân which traditionally focussed on its economic dependence on the agricultural sector and implemented a policy aiming at industrial development in Fryslân to create employment. From 1960 until 1970s the Netherlands experienced economic growth and even in outflow-areas the unemployment numbers were low. Note, that until approximately the 70s in Fryslân, and other regions, inhabitants received migration subsidies for migrating out of the problem areas to the cores. By focusing solely on developing urban areas and cutting support for smaller ones, the decision-makers intensified concerns that the province its rural identity was deteriorating (Hoogeboom, 2016).

The 1970s and 80s were characterised by the economic crises and during this period, Fryslân had higher numbers of internal inflow compared to internal outflow. Hoogeboom (2016) explains that this trend originated from the de-urbanisation stimulated by the government to prevent a problem in which individuals exclusively reside in urban centres. Nevertheless, the economic crises caused a shift in perception on the economic policy in the Netherlands and from 1984 onwards Fryslân had higher numbers of outflow again. By developing and supporting the regions distinctive regional skills, peripheral regions were encouraged to increase their own economic activity and attract citizens as a result of decentralised

regional policy. Within this context the regional collaboration of North-east Friesland emerged. Fryslân experienced in the past many periods of decline and the central government implemented measures to mitigate its effects rather than to combat it. The adverse impact of demographic decline on the region has re-emerged discussions about the government its role in supporting the economic development of peripheral areas (Hoogeboom, 2016).

Additionally, from 2019 onwards Fryslân copes again with higher number of internal inflow compared to the internal outflow. Buitelaar et al. (2021) conducted research about this trend which was visible in multiple peripheral regions. The research concludes that this trend possibly originates from unexpectedly low numbers of departure rather than high numbers of internal inflow. Moreover, Buitelaar et al. (2021) analysed possible influences of remote working on migration to rural areas but found that actual numbers do not support a positive effect. Furthermore, Brander and de Vries (2017) stated that in 2016 many asylum seekers in Fryslân received a permit to legally obtain housing in the Netherlands resulting also in an increase in in-migration numbers.

Furthermore, when considering the share of Frisian internal inflow relative to the total internal in-migration in the Netherlands, a decline is evident. Previously, around 4.5% of all internal migrants coming to the Netherlands relocated to Fryslân, while by the year 2022, this had decreased to approximately 3%. Nevertheless, the internal in-migration behaviour of individuals within the Netherlands in general has been increasing since 1978 as depicted by the blue line in Figure 9.

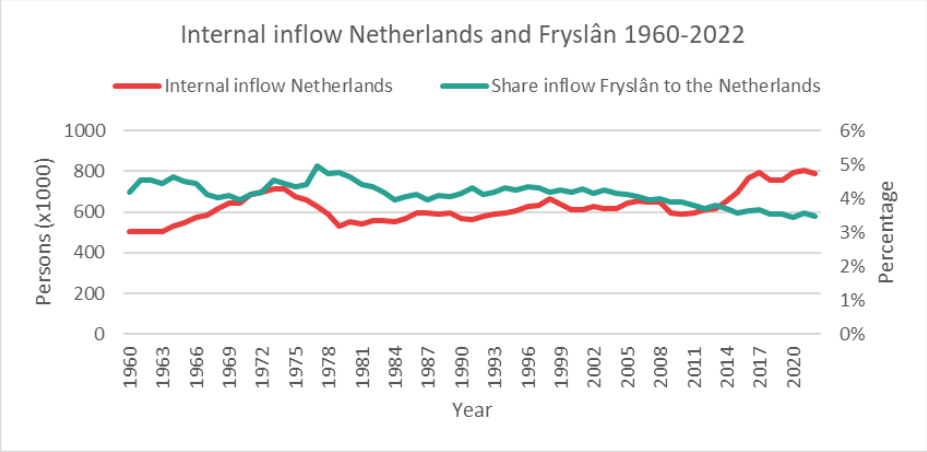

Figure 9. *Internal in-migration to the Netherlands and share to Fryslân.* Data obtained from CBS Statline (2023a). *Bevolkingsontwikkeling; levend geborenen, overledenen en migratie per Regio.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37259ned/Table?ts=1686333838658

Moreover, the likelihood of relocating from Fryslân has shown small fluctuations with approximately 2 persons per 1000 individuals since 2011 (see Figure 10). Over the period 2011 until 2017, Fryslân coped with an upward trend in individuals leaving the province reaching 19.5 individuals per 1000 inhabitants in 2017. The years afterwards, the risk of internal outflow remained between the 17 and 18 individuals per 1000 inhabitants.

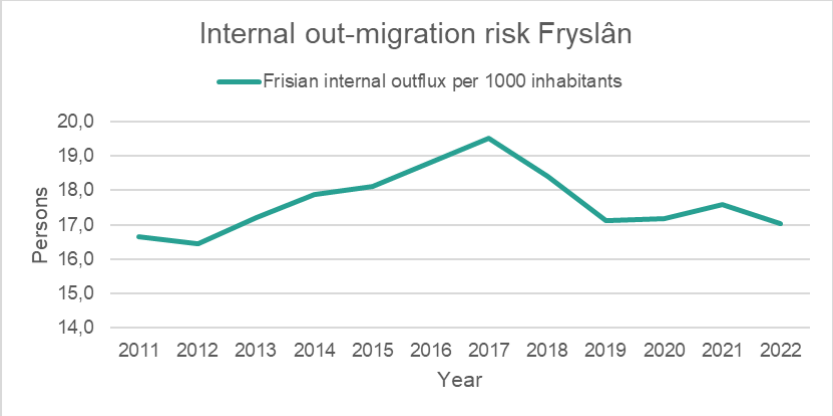

Figure 10. Internal outflow risk Fryslân and the Netherlands. Data obtained from CBS CBS Statline. (2023b). *Tussen gemeenten verhuisde personen.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81734NED/table?ts=1691824002149

Furthermore, Figure 11 presents the age distribution of migrants within Fryslân in 2022. Similar to the internal inflow, the largest proportion of migrants are within the age group 20 to 34 years old. Those ages are associated with important life course transitions as leaving the parental home, starting career or partnership status (Coulter & Scott, 2015). Thus, explaining the comparably high migration numbers within those age groups.

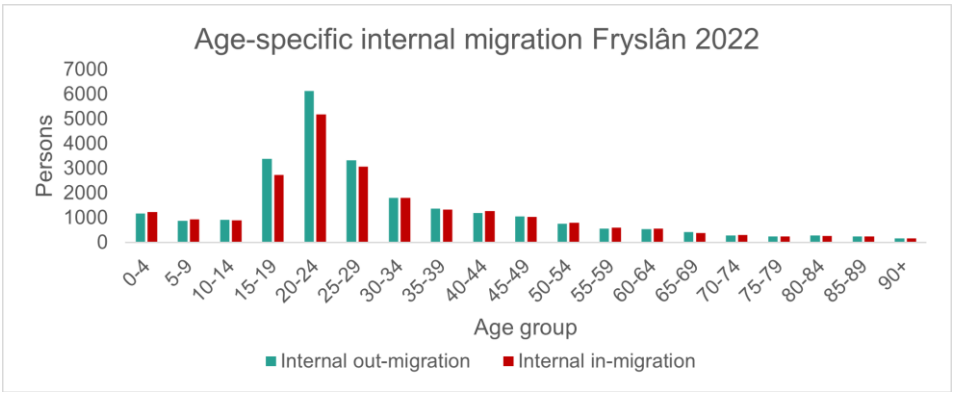

Figure 11. Age distribution of internal migrants Fryslân 2022. Data obtained from CBS Statline. (2023d). *Verhuisde personen; geslacht, leeftijd en regio per maand. https://opendata.cbs.nl/#/CBS/nl/dataset/84547NED/table?dl=8EE38&ts=1684756286080*

5.5 Trend analysis international migration

Historically seen, emigration from Fryslân has shown a relatively stable pattern (see Figure 12). However, starting from 2001, there has been a notable increase in international out-migration numbers, which continued until 2006. The NIDI conducted a study to investigate the underlying reasons for this trend, which was visible throughout the Netherlands. However, no specific explanation was found, and no emigration policies were set in place at that time (van Dalen & Henkens, 2008).

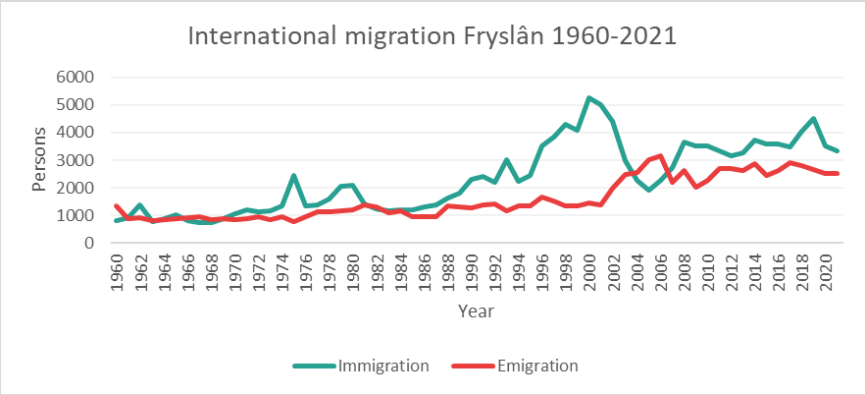

Figure 12. International migration Fryslân 1960-2021. Data obtained from CBS Statline. (2023c). *Bevolkingsontwikkeling; levend geborenen, overledenen en migratie per Regio.* https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37259ned/Table?ts=1686333838658

According to van Dalen and Henkens (2008), the years between 1960 and 2001 are considered to be an era of decolonisation during which the growth of the Dutch economy and global political developments were extremely important. This caused fluctuations in international immigration particularly noticeable in the Dutch context. Additionally, migrants establish themselves in major metropolitan centres more frequently, explaining why the number of immigrants from Fryslân, a peripheral region, was lower than the Dutch average (Ekamper et al., 2003). Additionally, the Dutch economy experienced significant prosperity at the close of the 1990s. This prosperity played a role in the surge of immigrants into the country, primarily consisting of individuals who had previously emigrated from the Netherlands and were now returning (Sprangers & Nicolaas, 2005).

Furthermore, there are notable spikes in immigration trends, which could potentially be attributed to specific events, such as the independence of Suriname from 1975 to 1980. This event likely played a significant role in the increase of immigrants to Fryslân and the Netherlands as a whole (Hoefte & Veenendaal, 2019). Moreover, from the period 1990 onwards, there was an increase in family reunifications in the Netherlands especially among many Turkish, Moroccan and Asian families (de Bruin & Nicolaas, 2009). Additionally, the Maastricht treaty in 1992 enabled free movement between EU countries and a study by Rojas-Romagosa and Bollen (2018) indicated that this treaty resulted in increased numbers of migrants within those EU countries. Furthermore, due to the distribution policy within the Netherlands around the years 2000 and 2001, many asylum seekers were assigned to places in the North of the Netherlands resulting in the high peak around those years. However, from that point onwards the inflow of asylum seekers has decreased in the Northern parts of the Netherlands and trends decreased substantially (Latten & Chkalova, 2007).

Compared to the national context, immigration and emigration in Fryslân is low (see Appendix G). While there was a general increase in international migrant flows in the Netherlands from 2000 onwards, the trends in Fryslân remained notably more consistent. Nonetheless, when considering the period from 1960 to 2022, the proportion of immigrants relocating to Fryslân, as opposed to the total migrant population in the Netherlands, is around 2% (see Figure 13). During the timeframe of 1996 to 2002, this percentage exceeded the average, peaking at 4% in 2000. As previously discussed, this period was marked by legislative changes such as the Maastricht Treaty, underscoring that during periods of significant immigration to the Netherlands, there is also an elevated inflow of immigrants to Fryslân.

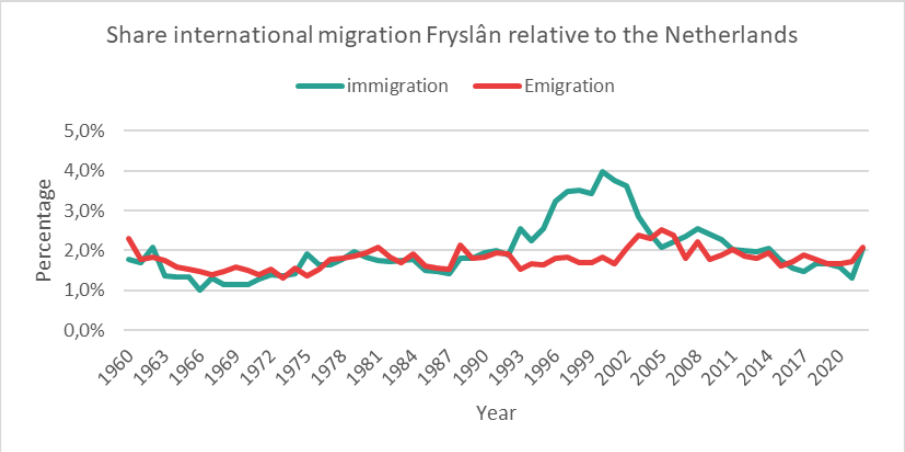

Figure 13. *Share international migration Fryslân relative to the Netherlands.* Data obtained from CBS Statline (2023a). *Bevolkingsontwikkeling; levend geborenen, overledenen en migratie per Regio. https*://opendata.cbs.nl/statline/#/CBS/nl/dataset/37259ned/Table?ts=

Additionally, when considering the period 1960 to 2022, the share of people migrating out of Fryslân to another country as opposed to the total number of emigrants in the Netherlands is approximately 1.78% and exhibits less fluctuated trends compared to immigration. Figure 14 illustrates the emigration risk for both the Netherlands and Fryslân. In comparison to the years preceding 2000, there was a slight upward trend in the emigration risk, amounting to about 4 persons per 1000 inhabitants.

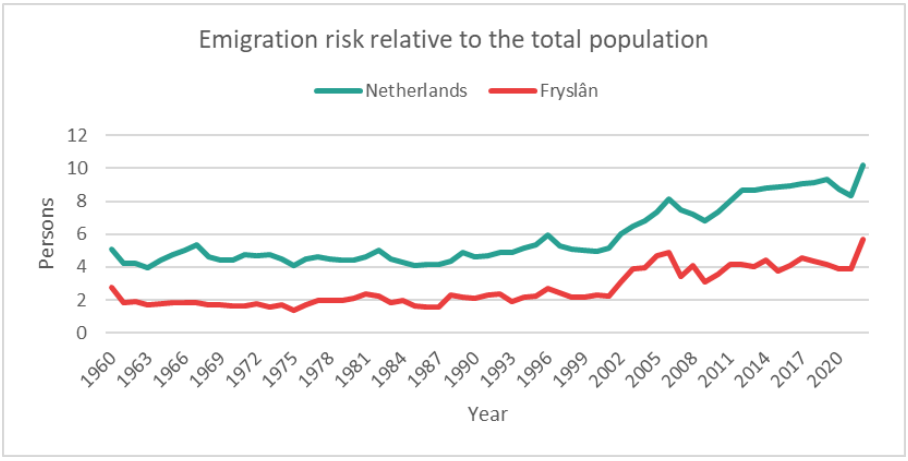

Figure 14. Emigration risk relative to the total population. Data obtained from CBS Statline (2023a). *Bevolkingsontwikkeling; levend geborenen, overledenen en migratie per Regio*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37259ned/Table?ts=1686333838658

Chapter 6: Assumptions

To develop the Frisian demographic variants, a benchmark projection was required which represents the most probable demographic developments until 2050. It was possible to use either the Pearl projection (CBS/PBL) or the projection of the Provincie Fryslân. The DEMOVAR model requires detailed information regarding age-specific fertility, mortality and migration. Hence, due to data unavailability, it was not possible to use the projection of the Provincie Fryslân. Additionally, the Pearl model projects based on assumptions regarding inter-municipal differences which therefore provides a narrower scope but information of the demographic components within this projection is solely available on an aggregated level and not age-specific level. Thus, it was chosen to use the Pearl regional projection 2020-2050 as a benchmark but many model input on fertility, mortality and migration required transformations to get from the total number to age-specific numbers (CBS, 2022c). In addition to that, Pearl projected lower population growth for the period 2020-2022 than actually observed. The DEMOVAR model used observed data for the period 2020-2022 causing the DEMOVAR Medium projection until 2050 to end up higher than the Pearl projection. Therefore, while the Pearl assumptions were used, with the exception of the period 2020-2022, the 2020-2022 projection from Pearl is very different from observed, resulting in a persistent difference in levels between Pearl and DEMOVAR (see paragraph 6.1.5 for more details). Thus, this thesis uses for the DEMOVAR medium variant the assumptions of the Pearl model from 2023 onwards while the Pearl model projects from 2020 onwards. This should be taken into consideration when interpreting the assumptions. Moreover, it should be noted that the data from the Pearl regional projection 2020-2050 was removed from CBS Statline due to errors within the Pearl model (CBS, 2023). This however, was determined after the DEMOVAR projections were developed and may have influenced the DEMOVAR medium variant.

The subsequent chapter will first elaborate upon the assumptions made to create the DEMOVAR medium variant and provide a comparison with the Pearl projection. Secondly, the argumentations for assumptions for each demographic component will be provided as well as a short description of the technical assumptions applied to quantify the premises guiding the projections. Table 2 presents the assumptions that guide the medium variant based on data input from the Pearl regional projection 2020-2050.

Table 2. Assumptions Medium Variant DEMOVAR

Period	***TFR***	***e0 Male***	***e0 Female***	***Net internal migration***	***Net international migration***
2020-2024	1.80	80.58	84.14	4394	8553
2025-2029	1.81	81.44	85.01	-3500	3700
2030-2034	1.85	82.22	85.85	-1500	2800
2035-2039	1.88	82.97	86.69	-399	2399
2040-2044	1.87	83.69	87.48	2	2199
2045-2049	1.86	84.38	88.22	403	1999

6.1.1 DEMOVAR Medium variant – Fertility

Based on the trend analysis, it was found that the TFR in Fryslân follows a similar pattern to the Netherlands but consistently remains at a higher level (see Figure 6). A declining trend in TFR has been visible in Fryslân since 2010. Recent years have been characterised by postponement effects in fertility resulting in a lower TFR. It seems that since 2021, the TFR is rising again and that therefore the postponement effects are compensated for. De Beer (2012) states that the economic crisis in 2008

significantly impacted the decline in TFR even after periods of economic growth the TFR remained periodically in decline exhibiting that different factors were having an influence upon this development. For instance, the lifestyle shift of people in their twenties who delay significant life course events such as cohabiting, having children, leaving the parental home, increasing amount of study years and committing to permanent jobs. Moreover, the prices of buying houses have been rising and with the labour market becoming more flexible the uncertainty of income and labour has increased (Loozen & Kloosterman, 2019). Considering the abovementioned arguments, it is assumed that the TFR will increase to 1.88 in the period 2035 to 2040. People will compensate for the postponement effects resulting from a higher number of births among women in their twenties (CBS, 2022b). Afterwards, the TFR is assumed to slightly decrease again reaching a TFR of 1.86 in 2050.

Previously mentioned, the assumptions for the DEMOVAR medium variant were derived from the Pearl regional projection 2023-2050. However, the Pearl model does not provide direct information on age-specific fertility rates or the TFR itself. Therefore, calculations were performed to determine the TFRs for the period 2020-2050, which can be found in Appendix H. Additionally, Appendix H demonstrates that the medium variant of the projection is based on the assumption that the age distribution of births will remain similar to the average age distribution observed during the period 2015-2019. Moreover, to capture the overall TFR trends over a five-year period, the average period TFR was utilized, as it takes into account fluctuations across all five years.

6.1.2 DEMOVAR Medium variant - Mortality

The assumptions guiding the development of mortality are considered by studying the life expectancy at birth (e0) which has been rising for the past few decades for both men and women. In 1996, e0 was 74.4 years old for Frisian males which increased to 79.9 years old in 2020. For Frisian females, e0 was 80.7 years old in 1996 which increased to 83.8 years old in 2020. Within the medium projection, it is assumed that the upward trend in life expectancy will continue gradually. By 2050, it is projected that the average life expectancy at birth for women in Fryslân will reach 88.2 years, while for men it is estimated to reach 84.38 years.

Furthermore, it is assumed that the changes in life expectancy at birth (e0) for Fryslân are in line with the national trends, as the differences in e0 between Fryslân and the Netherlands are relatively small and fluctuate over time, but generally exhibit a similar pattern (see Appendix E). Since the Pearl projection does not provide data on e0 at the provincial level, the national projection 2020-70 has been used to project life expectancy at birth in the DEMOVAR medium variant.

6.1.3 DEMOVAR Medium variant - Internal migration

Similar to the other demographic components, the Pearl regional projection 2020-2050 has been used as a benchmark to project Frisian internal migration developments until 2050. The DEMOVAR model requires in-migration numbers to be inserted as absolute numbers while out-migration is inserted as risk of leaving the province. Additionally, the Pearl regional projection incorporates internal migration data that encompasses both inter- and intra-municipal movements. However, for compatibility with the DEMOVAR model, which focuses on capturing internal migration between provinces, recalculations of the internal migration numbers were necessary. Appendix F provides detailed information on this matter. As depicted in Appendix F, the difference between internal migration, including both inter-provincial and intra-provincial movements, and the internal migration exclusively including intra-provincial movements, amounts to an average of 14,649 individuals per year. This number needs to be subtracted from the migration numbers presented by the Pearl regional projection in order to align with the DEMOVAR model.

Table 3 presents the internal migration assumptions for the DEMOVAR model as well as the Pearl projection. Please note the difference between the Pearl assumptions on in-migration and out-migration for the period 2020 to 2024 and the DEMOVAR assumptions, in which the numbers within the DEMOVAR medium variant are significantly higher due to the fact that partly observed data is utilised while Pearl projects the whole period.

Furthermore, internal migration has proven to be considerably instable over the past few years and highly influenced by the economic cycle and the housing market. It is assumed that the number of residential moves will decline in the upcoming years and stabilize in the future. Furthermore, it is expected that migration among young adults for education, work or cohabitation will continue to exist no matter the housing supply (de Jong et al., 2019). The DEMOVAR medium variant therefore projects until 2050 a slight decrease in the risk of leaving the population for all age groups resulting in a total of 52,927 out-migrants in 2050. Additionally, internal inflow is also expected to decrease to 126,800-(5*14,694) = 53,330 individuals until 2050.

Table 3. Internal migration DEMOVAR medium variant and Pearl projection

Period	DEMOVAR internal inflow	DEMOVAR internal outflow	DEMOVAR net internal migration	Pearl internal inflow	Pearl internal outflow
2020-2024	60,699	56,300	4394	50,700[2]	52,300[2]
2025-2029	56,430	59,930	-3500	129,900	133,400
2030-2034	56,030	57,530	-1500	129,500	131,000
2035-2039	54,230	54,629	-399	127,700	128,100
2040-2044	52,830	52,828	2	126,300	126,399
2045-2049	53,330	52,927	403	126,800	126,400

6.1.4 DEMOVAR Medium variant - International migration

Similar to internal migration, international migration within the medium variant is based upon the Pearl regional projection. The DEMOVAR medium variant assumes that immigration numbers will gradually decrease over the upcoming period resulting in a net international migration of 1999 people until 2050. Within the medium variant it is assumed that the current surge in immigration is, to some extent, a result of the attraction created by the current scarcity of job opportunities. Consequently, this inflow of international migrants can be viewed as being influenced by the ebb and flow of economic cycles. Emigration risks are also expected to increase until 2035 but assumed to slightly decrease afterwards. Within this group of emigrants are particularly labour migrants who reside in Fryslân for a short period of time (de Jong et al., 2019). Additionally, immigration to Fryslân has increased in the past few years due to the Ukrainian war. This spike of immigrants is expected to be apparent in the upcoming years, but a large share is also expected to leave again after a few years thus contributing to the increase in expected risk of emigration. Please note the difference between the Pearl assumptions regarding immigration and emigration for the 2020 to 2024 period and the DEMOVAR assumptions. It's important to highlight that the numbers within the DEMOVAR medium variant are notably higher. This divergence arises from the

[2] Values are based on period 2023-2025, DEMOVAR values of period 2020-2050 are developed by adding observed 2020-2023 data obtained from CBS Statline (2023b). This contributes to the deviance between the DEMOVAR medium variant and Pearl projection. The first period causes already a difference of 6000 in internal migration and another 6353 in difference due to international migration. Thus, in total migration using the observed numbers for the period 2020-2022 leads to a strong difference between the DEMOVAR medium variant and Pearl within the first period of approximately 12,000 individuals (see paragraph 6.1.5 for more details).

fact that the Pearl assumptions significantly underestimated migration for the period 2020-2022 and failed to account for the highly unpredictable migration flows resulting, among other factors, from the Ukrainian war.

Table 4. International migration DEMOVAR medium variant and Pearl projection

Period	DEMOVAR immigration	DEMOVAR emigration	Pearl immigration	Pearl emigration
2020-2024	23,972	15,419	8900[2]	6700[2]
2025-2029	22,500	18,800	22,500	18,800
2030-2034	22,000	19,200	22,000	19,200
2035-2039	21,300	18,901	21,300	18,900
2040-2044	20,700	18,501	20,700	18,500
2045-2049	20,200	18,201	20,200	18,200

6.1.5 Discussion projections Fryslân

The Pearl regional projection was used as a benchmark to create the DEMOVAR Medium variant. To assess the accuracy of the DEMOVAR model and to investigate differences between the existing regional projections, all total projected populations of Fryslân are graphed in Figure 15. Note that, within the period 2020-2025, Fryslân has experienced extremely unpredictable migration flows caused by the Ukrainian war, COVID-19 and the housing market resulting in a population of approximately 659,000 inhabitants as of December 2022. As can be seen in Figure 15, the Pearl projection 2020 – 2024 has a lower starting population than the actual observed population which has an accumulative effect on the development of demographic trends until 2050. Pearl projected the full period 2020 – 2025 while the DEMOVAR model used observed data for the period 2020-2022 and projection for the years 2023 and 2024. As a result, the DEMOVAR model was able to capture the highly unpredictable migration flows within 2020 – 2022 while Pearl did not. Moreover, this explains the major difference between the DEMOVAR medium variant and the Pearl projection over already the first periods 2020-2030. From 2035 onwards, all projections follow a similar pattern and predict a population decline caused by an increase in mortality numbers and decrease in expected number of births as the population is ageing. Additionally, the projection of the Provincie Fryslân predicts a substantially higher population development compared to Pearl. It is important to distinguish that the disparity between Pearl and projection of the Provincie Fryslân lies in the fact that Provincie Fryslân its projection is based on migration patterns, whereas the Pearl model relies on planned housing programs. The Provincie Fryslân projects an increase of 8,000 inhabitants until 2030 while Pearl only projects an increase of 700 inhabitants.

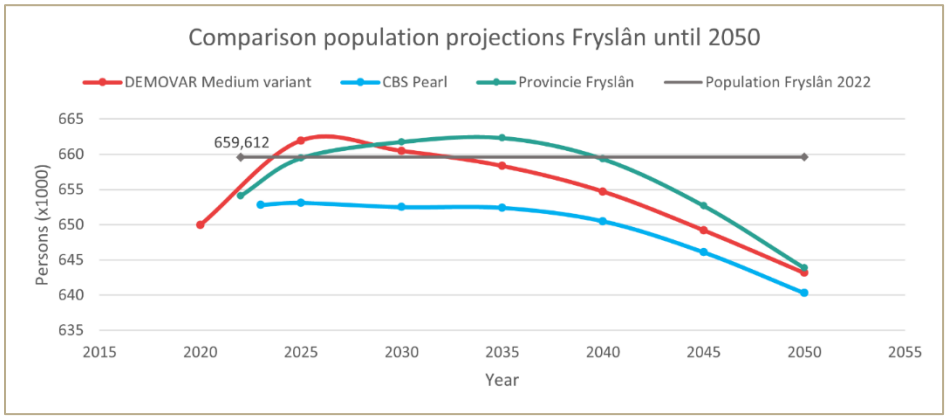

Figure 15. Comparison of different projections of Fryslân including DEMOVAR Medium variant. Data CBS Pearl obtained from CBS Statline (2023a). *Regionale prognose 2023-2050; bevolking, intervallen, regio-indeling 2021*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85173NED

/table?ts=1691052851573. Data Provincie Fryslân obtained from Provincie Fryslân. (2023). *Dashboard Prognose Bevolking en Huishoudens.* https://app.powerbi.com/view?r=eyJrIjoiNmNkZjM4ZjctYWE1Yi00OWJlLTljMDEtNzU1YmY1NTVkOGRkIiwidCI6IjQxNGRlYjViLWQ3ZGYtNGFlYS1hMDI1LTM4MGM5MGU0ZTcxNyIsImMiOjl9.

Moreover, Figure 16 provides a comparative analysis between the population compositions projected by the DEMOVAR Medium variant and the Pearl regional projection of Fryslân 2050. Overall, both demographic pyramids exhibit broadly similar shapes, yet the DEMOVAR Model predicts a higher proportion of individuals aged 25 to 35 years, while the Pearl Model projects a larger share of people aged 45 to 55 years. Nevertheless, the implications of these disparities are expected to be limited, given that both age groups fall within the active life stage, during which individuals are generally engaged in the labour market. It is worth noting that these variations in population distribution may also originate from dissimilarities in the starting population data. The DEMOVAR Model utilized observed data from the years 2020 to 2022, whereas the Pearl model comprehensively projected the developments over the period from 2020 to 2025. As previously mentioned, the Ukrainian war led to highly unpredictable migration flows, an aspect not accounted for in the Pearl model. Consequently, these disparities at the start of the projection are likely to persist until the end of the projection period.

Moreover, as previously mentioned, the Pearl regional projection was removed from CBS Statline due to errors within the Pearl model. The Pearl model misrepresented residential moving behaviour of individuals aged 65 and over which influenced the projection for all demographic components and thus the actual population composition might slightly differ from the one presented in Figure 16. This should be taken into consideration when interpreting the findings of the DEMOVAR medium variant.

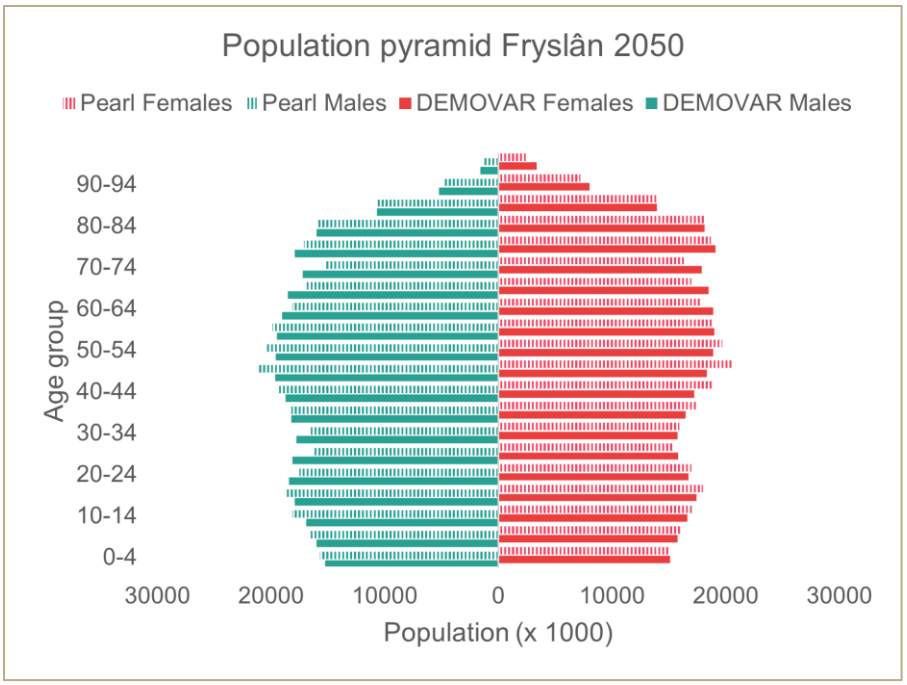

Figure 16. Population pyramid Fryslân 2050 comparing DEMOVAR with Pearl. Data Pearl obtain from CBS Statline. (2023a). Regionale prognose 2023-2050; bevolking, intervallen, regio-indeling 2021. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85173NED /table?ts=1691052851573

6.2 Assumptions demographic variants

The assumptions guiding the six demographic variants are based on the assumptions made within the NIDI/CBS report (de Beer et al., 2021). The subsequent section will elaborate upon those premises and Table 5 presents an overview of the assumptions providing the average development per five-year period until 2050. The values of the demographic components are calculated using different methods as will be explained in the following sections. Additionally, when making projections about future developments a level of uncertainty is always visible indicating the significance of examining possible future demographic pathways. Therefore, the Growth- and Decline variant emphasizes upon the uncertainty of the population growth, the Grey- and Green variant elaborates upon the uncertainty of age composition, and the High- and Low Migration variant considers the uncertainty concerning migration.

Table 5. Assumptions about TFR, Life expectancy at birth and net migration, average five-year period over the period 2020-2049

	2020[3]	DEMOVAR medium	Decline	Growth	Grey	Green	Low Migration	High Migration
Total fertility rate	1.7	1.84	1.64	1.99	1.55	2.07	1.83	1.88
Life expectancy at birth females	83.5	86.23	84.43	88.00	88.96	83.54	86.23	86.23
Life expectancy at birth males	79.9	82.55	80.98	84.49	85.51	80.09	82.55	82.55
Net internal migration	1126	-100	-2194	1347	-941	-258	-5467	2259
Net international migration	981	3608	4754	11,735	8060	7946	3147	10,489

6.2.1 Fertility

The TFR of Fryslân has proven to be structurally higher compared to the Netherlands. This was taken into account when developing the assumptions of the TFRs of the different demographic variants as presented in Table 6. Various methods were employed to determine the appropriate increase in TFR for each demographic variant in order to present a suitable pathway in fertility. Before getting into the details of the methods employed to obtain the TFRs of the demographic variants, it is noteworthy that those are based on the NIDI/CBS assumptions. In turn, the assumptions in the NIDI/CBS report are based on the 95% confidence intervals of fertility. For instance, in the Growth variant, the fertility assumption represents the upper bound of the 95% confidence interval, indicating that the chosen assumptions reflect plausible scenarios.

Table 6: Assumptions development TFR (average 2045-2050)

Variant	NIDI/CBS Dutch assumptions	DEMOVAR Frisian assumptions
Green	2.07	2.22
Growth	1.93	2.08
Medium	1.70	1.87

[3] As opposed to the demographic variants, the 2020 values are observed and not averages of five-year periods but single-year values.

Decline	1.48	1.61
Grey	1.31	1.44

The first method applied to determine a suitable increase was by considering the average dispersion between the Dutch TFR and the Frisian TFR over the period 1988-2021 which was calculated to be 0.15 (see Appendix H). This provides a TFR for the Green variant of 2.07 + 0.15 = 2.22 and for the Growth variant 1.93 + 0.15 = 2.08. As Figure 11 shows, the highest development in TFR is the Green variant assuming a TFR of 2.22 in 2050 which is above replacement level (2.1). Within the Green variant it is assumed that in the upcoming years the TFR will increase significantly. As opposed to the ageing population developments which are currently visible in Fryslân, the Green variant presents an opposite situation in which due to high fertility the population will become younger. Additionally, the Growth variant assumes a development in TFR to 2.08 in 2050. The Growth- and Green variant both are expected to increase the fastest over the period 2025-2035. Afterwards, the Growth variant only increases slightly while the Green variant is assumed to increase with a larger proportion. Additionally, similar to the medium variant it is assumed within those variants that the postponement effects are compensated for but in larger amounts. Frisian women have historically had children at younger ages compared to the national mean age at childbearing, within the Growth- and Green variant it is assumed that the Frisian mean age at childbearing will slightly decrease resulting in an extended period for women to have children.

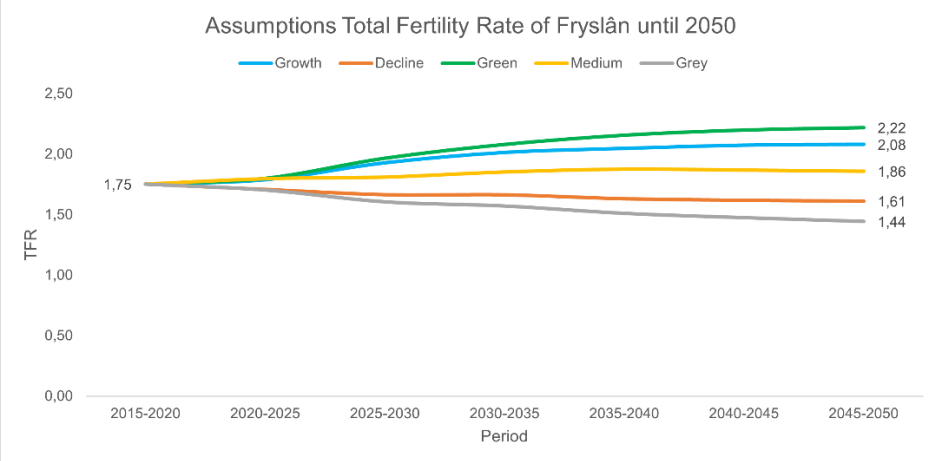

Figure 17. Assumptions five-year average TFR. Source: Author.

Furthermore, not all demographic variants are assumed to be best suited for the 0.15 increase, as some variants present fewer extreme developments than average. To determine the appropriate increase in TFR, an alternative method was employed. Firstly, the average TFR over the period 1988 to 2021 was calculated. Secondly, all TFRs below this average were considered “low” TFR developments. Subsequently, the average deviation between the Frisian TFR and the national TFR for these “low” TFR situations was calculated, resulting in an average deviation of 0.13 (see Appendix H). Hence, in the Decline variant, the TFR for Fryslân was calculated as 1.48 + 0.13 = 1.61 children per woman. Moreover, the TFR in the Grey variant is 1.31 + 0.13 = 1.44 children per woman. Both variants assume a low development in fertility and as opposed the Medium- Growth and Green variant, the postponement effects are not expected to be compensated; rather, they project an extension of such effects. This results in a delay in having children and an increase in mean age at childbearing. The postponement of childbirth by women and the increasing complexity of relationships among young adults leads to a greater number of young

adults remaining single. Additionally, a growing emphasis on career rather than family settlement is contributing to the decreased fertility observed in the Decline variant. It is important to note that for the Decline- and Grey variant, the national TFR from the NIDI/CBS report was taken and increased with 0.13, rather than 0.15. Consequently, within the Decline and Grey variants, the Frisian TFR converges slightly to the national TFR.

The fertility assumptions for the Low Migration and High Migration variants are not explicitly shown in Figure 13 or Table 5. This is due to the fact that their fertility developments are assumed to be comparable to the DEMOVAR medium variant. However, there are minor variations between the TFR of the migration variants and the DEMOVAR medium variant. In the High Migration variant, the TFR is assumed to be 2% higher compared to the Medium variant as this variant reflects a situation where immigrants come to Fryslân, possibly from backgrounds with higher fertility rates, which consequently impacts the Frisian TFR. Conversely, the Low Migration variant exhibits a TFR development that is 1% lower than the DEMOVAR medium variant. Since only a small proportion of national immigrants settle in Fryslân, as reflected in the DEMOVAR medium variant, further reductions in migration are expected to have minimal effects on the TFR within the Low Migration variant. Furthermore, in these demographic variants, it is assumed that any postponement effects in fertility will be compensated for by the period 2035-2040. However, thereafter, a slight decrease in the TFR is projected.

6.2.2 Life expectancy

Table 7 shows the assumptions of the development in life expectancy at birth (e0) for both males and females. As determined in Appendix E, the Frisian development in e0 follows mainly the same trend as the national development in e0 but fluctuates over time with yearly a few months. As those fluctuations are difficult to capture, it was assumed that the national development in e0 would fit the Frisian pathway in e0 as well. Thus, the values found in Table 6 are similar to the assumptions of e0 in the NIDI/CBS report. Life expectancy at birth within the Low Migration- and High Migration variant is assumed to be similar to the development within the Medium variant.

Table 7. Assumptions life expectancy at birth males and females (average 2045-2050)

Variant	e0 males	e0 females
Green	80.72	84.47
Growth	87.10	90.75
Medium	84.38	88.22
Decline	82.00	85.71
Grey	88.81	92.49

As visible in Figure 18, the Grey variant assumes the highest development in e0 which suits the situation of an ageing population. Within this variant several factors are assumed to contribute to the significant increase in e0. For instance, lifestyle habits such as the number of people smoking is assumed to decrease substantially within this variant. Earlier research by Sheldon (2001) concluded that the halt in increasing life expectancy at the end of the 20th century was caused by smoking. However, over the past few decades smoking has become less popular resulting in e0 increasing again. Hence, assuming that this decrease in number of people smoking accelerates contributes to the increase in e0 within the demographic variants. As previously mentioned, other lifestyle factors as diet and having enough exercise also contribute to e0 and thus within the Grey variant one of the consequences of diet and exercise, the share of overweight people within Fryslân, is expected to decrease. Moreover, the Growth variant

experiences similar trends compared to the Grey variant but at less extreme measures resulting in an assumed development of e0 of 88.9 in 2050. The Decline- and Green- variant depict different demographic situations in which the abovementioned factors such as smoking, diet, exercise but also access to healthcare and quality of healthcare is assumed to remain stable or worsen slightly causing only a slight increase in e0 to 83.9 years old in 2050 within the Decline variant and to 82.6 years old in the Green variant. Additionally, the average five-year period e0 is assumed to best describe the development in e0 as it accounts for fluctuations over the whole period.

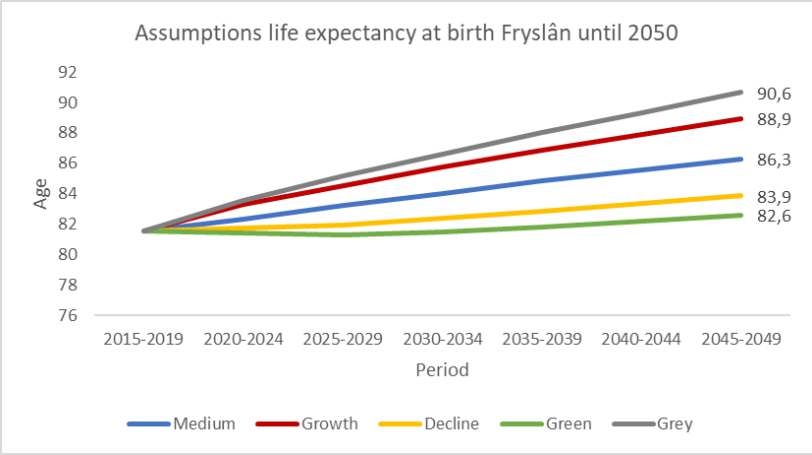

Figure 18. Assumptions for life expectancy. Source: Author.

6.2.3 Internal migration

The NIDI/CBS report did not incorporate internal migration, necessitating the use of expert judgments and trend analysis to determine future internal migration patterns. However, it is important to emphasize that migration patterns have exhibited significant fluctuations over time, making it challenging to predict future trends with certainty. In addition, when formulating the migration assumptions for all demographic variants, the focus is on ensuring the suitability of the scenarios and aligning them with the DEMOVAR medium variant, which represents the most probable future situation. To recap, the DEMOVAR medium variant assumes that within the upcoming years the absolute numbers of internal inflow will decrease which is an extension of the contemporary trend depicted in Figure 8 and also supported by the declining share of in-migration to Fryslân as a share of the total in-migration numbers within the Netherlands (see Figure 9). Simultaneously, the risk of internal outflow is assumed to increase for all age categories until 2030 and then decrease again. A development which can also be supported by the declining trend in the risk to relocate out of Fryslân as presented in Figure 10. Over the period 2045 to 2050 the DEMOVAR medium variant assumes that internal inflow will exceed internal outflow with 403 migrants.

The High Migration variant aims to depict a situation in which migration numbers grow significantly over the upcoming 30 years. It is assumed that within this situation in-migration exceeds out-migration due to an attractive living climate within the province. It is assumed that economic opportunities will grow due to investments in renewable energy, agriculture, tourism and water management. Moreover, the quality of life offered by the province has become more appealing to people living in other parts of the Netherlands especially urban centres. Additionally, it is assumed that people long to be closer to nature and peace which can be found in Fryslân. Another relevant premises within the High Migration variant is that people in the Netherlands long for affordable housing causing increasingly more people to move to the Northern provinces. On the contrary, the Low Migration variant illustrates the complete opposite demographic situation. Within this variant, Fryslân is considered

unappealing to people causing low migration flows to the province. In addition to a low inflow of migrants, the risk of population outflow is also low. This suggests a situation in which the province, which has witnessed increased diversity in recent years, is anticipated to undergo limited changes in its composition. On the contrary, within the High Migration variant the risk of leaving the population is expected to be high as well resulting in a continuously changing composition.

Moreover, the Growth and Decline variants specifically consider whether the population is projected to experience growth or decline, and this aspect is also taken into account when analysing internal migration patterns. It is assumed that within the Growth variant, that internal inflow exceeds internal outflow. Contrastingly, within the Decline variant internal outflow is expected to exceed inflow contributing to the decline in population numbers while the development in internal inflow is assumed to remain average. The Grey and Green variant assume both an average development in internal migration and thus follow the DEMOVAR medium variant internal migration assumptions. However, both variants focus on a changing age distribution causing migration patterns within the Grey variant to increase among the elderly population and within the Green variant among the young population. As determined by Kooiman (2020), it is not uncommon for elderly to move from urban centres to more quite places such as for instance Fryslân. This is taken into consideration within the Grey variant. Furthermore, within the Green variant, it is assumed that Fryslân will have a younger population and this is assumed to be reflected on the migration patterns as well. On the one hand, it is assumed that Leeuwarden becomes more of a student city with increased patterns of student mobility. On the other hand, it is assumed that due to the fact that Fryslân will have a younger population, more educational migration will occur, with young adults moving to different cities to take advantage of educational and labour possibilities. Moreover, it should be highlighted that migration patterns are extremely uncertain and therefore should be interpreted with care. Table 8 presents the internal migration assumptions for all demographic variants. The argumentation behind the quantification of those assumptions are explained in the following paragraphs.

Table 8. Assumptions internal migration 2045-2050 (total five-year period)

Variant	Inflow	Outflow	Net migration
Green	55,060	55,727	-1667
Growth	60,245	58,335	1910
Medium	53,330	52,927	403
Decline	57,883	60,677	-2794
Grey	53,415	54,041	-627
High Migration	68,273	65,118	3155
Low Migration	42,769	49,910	-7141

The quantifications of the assumptions for internal migration have been created based on the following methodology. Firstly, the trend analysis was considered which showed that since 1960, internal out-migration has limitedly exceeded internal in-migration indicating that for the foreseeable future the scenario of internal outflow exceeding inflow will happen in extreme situations. For instance, during the 1970s which is characterised by the economic crisis and the government actively engaged in de-urbanisation this resulted in an increase in inflow for Fryslân. Additionally, in 2021 after the pandemics and during the housing crisis, internal inflow to Fryslân increased significantly again also caused by an unexpected low development in internal outflow and the redistribution of asylum seekers in the Netherlands whom were accounted for as internal migration. Within the DEMOVAR medium variant it is therefore assumed that until 2040 the risk of leaving the province to other provinces will increase causing outflow to exceed inflow and from 2040 onwards this trend will stabilise and in-migration will slightly

exceed out-migration. With this, it is assumed that the risk of leaving the province will decrease to 16 out-migrants per 1000 individuals.

Furthermore, it was required to determine what a high and what a low development means in terms of internal migration. As shortly discussed in the paragraph above, this was done, by filtering the internal migration trends from large to small and subdividing this into three groups, each consisting of a third of the observations: a low, high, and average development (see Appendix I). Subsequently, the average numbers within those groups were chosen to represent the most feasible internal migration pathways as presented in Table 9.

When comparing the historical development outlined in Table 9 with the DEMOVAR medium variant, a slight disparity is evident. Within the DEMOVAR medium variant, the assumption is that between 2020 and 2050, Fryslân will undergo a transition in internal migration development. It is projected to shift from a state of high development (total net internal migration of 4394 individuals over the period 2020 to 2025) to an average development (net internal migration of -3500 individuals over the period 2025-2030), and subsequently back to a middle-high development, following the classification outlined in Table 9. Only within the period 2025 to 2030, the DEMOVAR medium variant projects a net migration of -3500 which is comparable to the past average development reflected in Table 9. After 2030, the DEMOVAR Medium variant projects a transition resulting in a total net migration of 403 individuals over the period 2045 to 2050. It is important to note that, while the Pearl regional projection informed the DEMOVAR medium variant its development, as opposed to the classifications in Table 9, a comparative analysis affords a more profound understanding of past patterns and potential trajectories for the future.

Table 9. Low, average, high development of internal migration (total five-year period)

Internal migration development	Internal inflow	Internal outflow	Net internal migration
High	68,273	65,116	3157
Average	53,291	57,238	-3947
Low	42,769	49,991	-7222

Therefore, in the High Migration variant, it was assumed that there would be a substantial increase in both in-migration and out-migration. According to Table 9, this would correspond to an inflow of 68,273 migrants and an outflow of 65,116 migrants. However, since the DEMOVAR model focuses on out-migration risks, adjustments were made to the age-specific risk rates to ensure that the total number of out-migrants would reach 65,118 by 2035. This is accompanied within the High Migration variant by a total of 18 internal out-migrants per 1000 inhabitants. Contrarily, the Low Migration variant represents a low development of migration. Therefore, it is assumed that there will be a modest development of 42,769 in-migrants by 2035, accompanied by a reduction in out-migration risks, resulting in an estimated total of 49,910 out-migrants by 2035. Similar to the DEMOVAR Medium variant, the risk of leaving the population within the Low Migration variant is approximately 16 persons per 1000 individuals.

Furthermore, the grey and green variants are projections that specifically consider the changing age composition of the population. In general, these variants assume an average development in internal migration, with the DEMOVAR medium variant serving as a reference point. However, within the Grey variant, it was assumed that migration among the older population would increase, leading to a 2% increase in the risk of individuals aged 65 and above to leave the population. The absolute number of in-migrants aged 65 and above was also adjusted by an increase of 2%. Consequently, these adjustments result in an estimated 53,415 in-migrants aged 65 and above by 2050, along with 54,041 out-migrants

aged 65 and above. This is accompanied by an assumed declining development in risk of leaving the province of 16 persons per 1000 inhabitants. A similar approach was taken to quantify the assumptions for the Green variant but internal migration was not increased with 2% but with 4% considering that young people are more mobile. Additionally, solely the share of migrants among the age groups 0-50 were increased with 4%. This resulted in an assumed number of in-migrants of 55,060 migrants and 55,727 out-migrants. Moreover, internal out-migration behaviour is expected to remain at 17 individuals per 1000 Frisian inhabitants.

The two final variants, namely Growth and Decline, were formulated differently due to contrasting assumptions regarding in-migration and out-migration patterns. In the Growth variant, a significant increase in in-migration was assumed, coupled with a slight decrease in the risk of out-migration. Conversely, the Decline variant posited a slight decrease in in-migration and a notable increase in the risk of out-migration. To establish these variants, internal migration figures from the period 2015-19 were utilized as a benchmark. Specifically, the Growth variant projected a 0.5% increase in in-migration every five years, while out-migration was expected to decrease by 0.5% over the same timeframe. These assumptions resulted in an estimated 58338 out-migrants and 60,245 in-migrants by 2050. Internal out-migration behaviour is within this variant is expected to decrease to approximately 15 persons per 1000 individuals. In contrast, the Decline variant accounted for a 0.5% decrease in in-migration and a 0.5% increase in out-migration every five years. Consequently, this variant projected a total of 60,677 out-migrants and 57,883 in-migrants by 2035 accompanied by a risk of internal out-migration of 20 persons per 1000 inhabitants. It is therefore assumed that within the Growth variant the out-migration rates will decrease while in the Decline variant the rates will increase.

6.2.4 International migration

The international migration assumptions are in turn created based on the NIDI/CBS report assumptions as presented in the table below.

Table 10. Assumptions international migration (total 2045-2050)

Variant	NIDI/CBS assumptions immigration	DEMOVAR Frisian assumptions immigration	NIDI/CBS assumptions emigration	DEMOVAR Frisian assumptions emigration
Green	1,501,685	29,822	1,303,954	23,261
Growth	1,771,010	35,171	1,344,472	23,996
Decline	1,259,600	25,015	1,146,367	20,460
Grey	1,484,598	29,483	1,274,253	22,749
High Migration[4]	1,709,046	33,941	1,399,247	24,929
Low Migration	987,355	19,608	919,625	16,412

Based on trend analysis, it was observed that approximately 2% of immigrants who come to the Netherlands choose Fryslân as their destination since 1960 (see figure 13 and Appendix G). Similarly, when considering emigration, an average of 1.78% of the total emigrants of the Netherlands originate from Fryslân. Given that international migration to the Netherlands and Fryslân generally follow similar trends, the values from the NIDI/CBS report presented in Table 9 were adopted. For each demographic variant, 1.78% of projected emigrants and 2% of projected immigrants were considered. As the DEMOVAR model

[4] High Migration variant in the NIDI/CBS report consisted out of two variants: labour migration and asylum migration. Both values of immigration and emigration were combined and the average was taken to represent High Migration within the projection for Fryslân (Labour immigration= 1,817,528 and Asylum immigration= 1,600,564 and Labour emigration = 1,458,759 and Asylum emigration = 1,339,734).

includes emigration as risk of leaving the population internationally rather than using absolute numbers, the age-specific emigration rates were adjusted in such a way that it matches the projected absolute emigration numbers. Moreover, in recent decades, immigration to the Netherlands has increased, and this trend is also evident in Fryslân. While there was a noticeable decline in immigration during the COVID-19 pandemic, the Ukrainian conflict led to an increase in numbers again. However, it should be noted that not all immigrants settle permanently, as research by CBS (2019) indicates that approximately 59% of labour migrants leave the Netherlands within six years. Therefore, it is reasonable to expect a substantial increase in emigration numbers in the coming years, a factor that is incorporated into all demographic variants.

Furthermore, Table 11 presents the assumptions made about the risk of international out-migration within the different variants. Appendix J further elaborates upon the calculations and numbers used which provided the emigration risks per 1000 individuals. Compared to figure 14, it is visible that for the Netherlands as well as for Fryslân the risk of emigrating is expected to increase substantially in the upcoming thirty years.

Table 11. Assumptions emigration risk 2050 (per 1000 individuals)

Variant	DEMOVAR assumptions emigration risk	NIDI/CBS assumptions emigration risk
Green	6.94	13.43
Growth	6.40	12.34
Decline	6.89	13.42
Grey	6.81	13.27
High Migration	6.97	13.80
Low Migration	5.49	10.43

Chapter 7: Demographic variants Fryslân

The different projections developed for the six demographic variants will be covered in detail in the following chapter. The age distributions and population size of the different demographic variants within the period 2045–2050 will be addressed first. Second, by taking into account the various life stages, such as the young life stage (0–20 years old), active life stage (20–65 years old), and the old life stage (65 years and older), the consequences under the various demographic variants will be explored.

7.1 Projected total population developments

The projected demographic variants for Fryslân until 2050 predominantly anticipate population growth compared to the estimated population of 650,000 inhabitants in 2020 (see Figure 19). Among these variants, the Growth variant stands out with its extreme projections in terms of total fertility rate (TFR), life expectancy, and migration. It forecasts a total population of 750,000 inhabitants, reflecting an approximate 17% increase compared to the Medium variant. In contrast, the Decline variant, characterised by low net migration, low fertility, and low life expectancy, projects a decline in the population to 594,000 inhabitants.

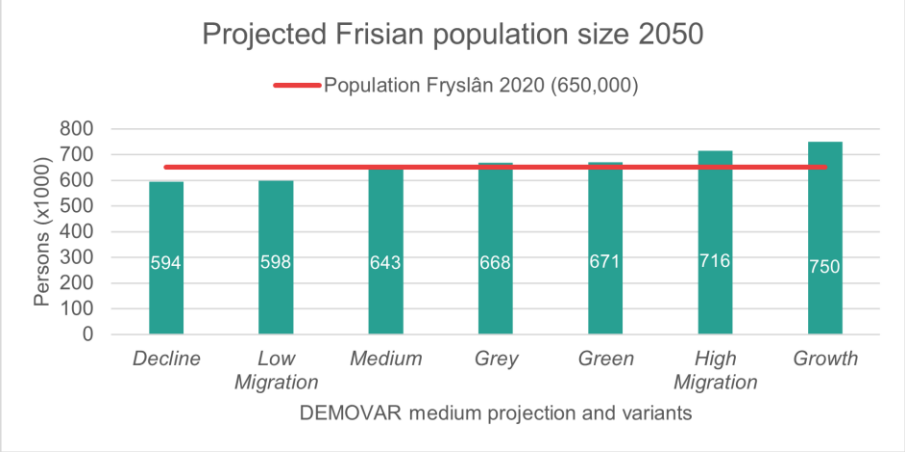

Figure 19. Projected Frisian population size 2050. Source: Author.

Figure 20 illustrates the significant influence of migration on population growth. Under average developments in life expectancy and fertility but with high net migration, Fryslân is projected to experience an increase of 66,000 individuals. Conversely, in scenarios with low migration patterns over the next three decades, the province is expected to decline by 54,000 individuals. Both Figure 20 and Figure 21 provide insights into the projected developments representing high and low growth situations, respectively. For insights into the development of the number of births and deaths among the different demographic variants it is recommended to consider Appendix K at the end of this report.

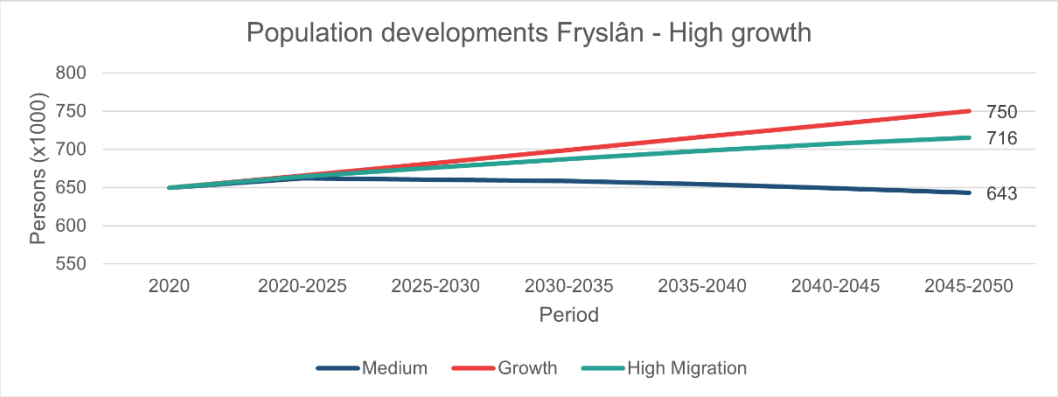

Figure 20. High growth population developments Fryslân 2050. Source: Author.

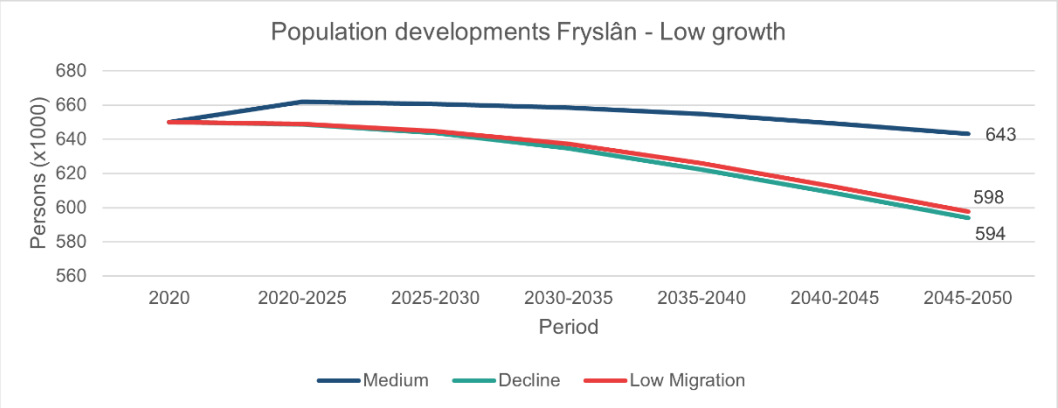

Figure 21. Low population developments Fryslân 2050. Source: Author.

In contrast to the demographic conditions observed in 2020, all projected demographic variants anticipate a growth in the elderly population in Fryslân. It is widely acknowledged that Fryslân, like the Netherlands as a whole, is experiencing rapid population aging. This demographic shift has significant consequences, including increased pressure on social welfare systems due to greater demands for elderly care and pension benefits, as well as changes in social dynamics. Family structures are evolving with a greater need for intergenerational support, while simultaneously, the risk of social isolation among the elderly is also increasing.

Figure 22 illustrates that the proportion of elderly individuals within the population is projected to experience the most substantial growth in the Grey variant, rising from 22% in 2020 to 32% in 2050. Both the Medium and Low Migration variants project that 30% of the Frisian population will be 65 years and older by 2050. Furthermore, the working-age population (individuals between the ages of 20 and 65) is expected to decline in nearly all variants, except for the High Migration and Growth variants. Nevertheless, when considering relative differences, even the Growth and High Migration variants exhibit a decline in the working-age population, as demonstrated in Figure 22.

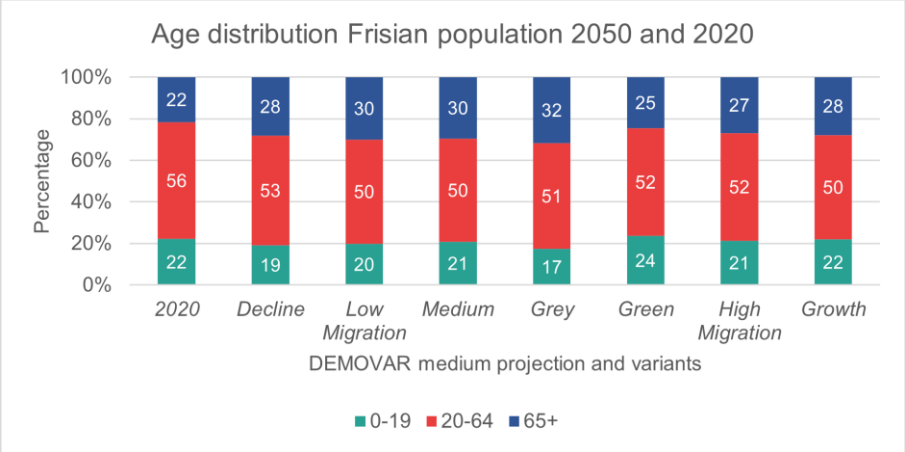

Figure 22. Age distribution Frisian population 2050 and 2020. Source: Author.

7.2 Young life stage (0-19 years old)

The subsequent paragraphs will examine the demographic implications of the different variants on the individuals being in their young life stage including babies, toddlers, children and teens. Only in the variants where fertility is high (Green and Growth) or where migration is high (High Migration), the absolute number of Frisian inhabitants aged 0 to 19 years old is expected to increase until 2050 compared to 2020 (see Figure 23). Developments within those age groups also impact society in various ways as an increase in toddlers or babies increases the need for child day care and nurseries while an increase in children and teens have mainly educational implications.

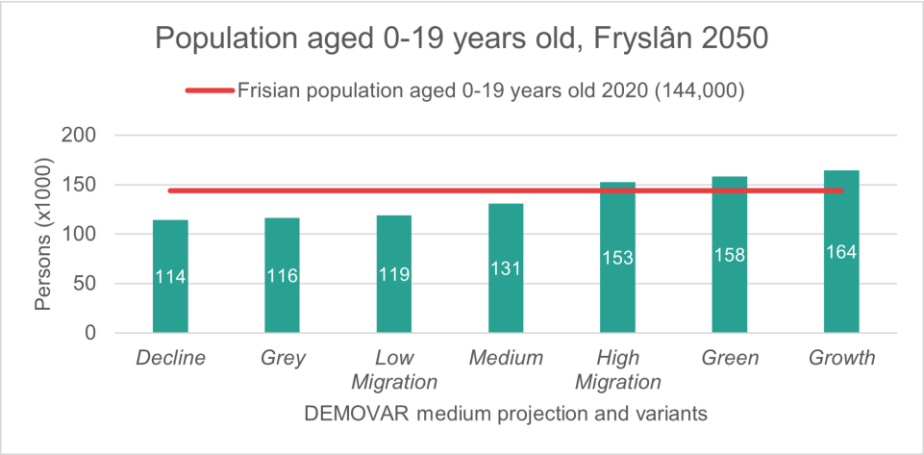

Figure 23. Population aged 0-19 years old in Fryslân 2050. Source: Author.

In the High Migration, Green, and Growth variants, there is an anticipated increase in the population aged 0-19 years old. This indicates that the demand for childcare and education will likely intensify in the future, particularly under conditions of high fertility and migration. To further examine the influence of fertility, mortality, and migration on the demand for childcare and education, Figure 24 was developed, presenting age categories based on the Dutch childcare and educational system. The number of students in primary education and secondary education is expected to increase under conditions of high fertility and/or migration, as will the demand for child support services (see Figure 24).

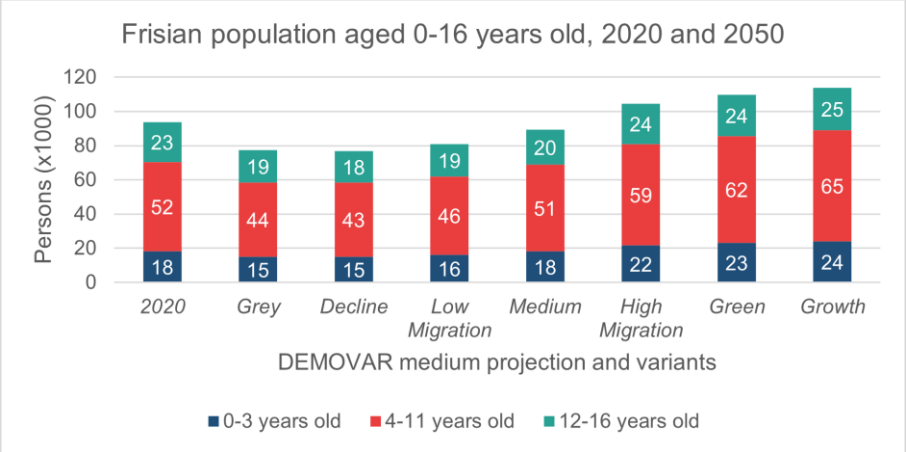

Figure 24. Frisian population aged 0 to 16 years old 2050. Source: Author.

The ratio of students in secondary education compared to the total population is expected to decline across all variants, except in the Green variant where high fertility rates keep the proportion constant at 3.6% of the total population of Fryslân (see Figure 25). Conversely, the number of students in primary education is projected to increase in the High migration, Growth and Green variants, which assume high migration and/or high fertility. This increase aligns with the expected rise in the number of babies and toddlers, resulting in a heightened demand for childcare services in these variants. Moreover, it is evident that fertility trends have a more significant impact on the growth or decline of the population aged 0-19 years old compared to migration, as observed when comparing the various variants.

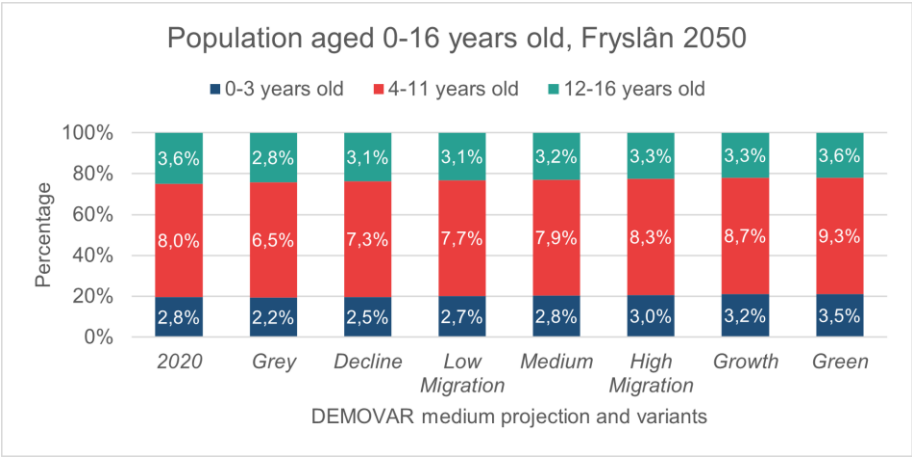

Figure 25. Population age distribution according to schooling system of the Netherlands. Source: Author. [5]

To analyse the potential implications of youth decline or growth on Frisian society across the different variants, the youth dependency ratio was considered. The youth dependency ratio measures the percentage of individuals aged 0-19 relative to the working-age population, while accounting for the state pension ages specific to each variant (see Figure 26). For most variants, a decrease in the youth dependency ratio is expected compared to the levels observed in 2020. However, this trend does not hold true for the Growth and Green variants. Particularly in the Green variant, characterised by a youthful

[5] The projections from the DEMOVAR model provide the projected population numbers per five-year age groups. Therefore, linear interpolation was used to calculate the different percentages within the age categories as presented in Figure 21. It must be acknowledged that in reality the population is not equally distributed across age groups and the results presented in the figure must thus be interpreted with care.

population, there is a projected 5% increase in the economic and social burden placed on the working-age population. Conversely, in an aging society such as the current situation in Fryslân, the youth dependency ratio is expected to decrease, as indicated in the Medium variant. The most notable impact is observed in the Grey variant, where low fertility rates and high life expectancy contribute to an increase in the working-age population and a decrease in the youth population. Consequently, the Youth dependency ratio is projected to decline by approximately 8% compared to the levels observed in 2020.

The youth dependency ratio provides insights into the potential changes in the economic and social dynamics of Frisian society under different demographic variants. It highlights the contrasting effects of population aging and youthful population structures on the dependency ratio contributing to the understanding of the potential burdens and implications associated with youth decline or growth in Fryslân.

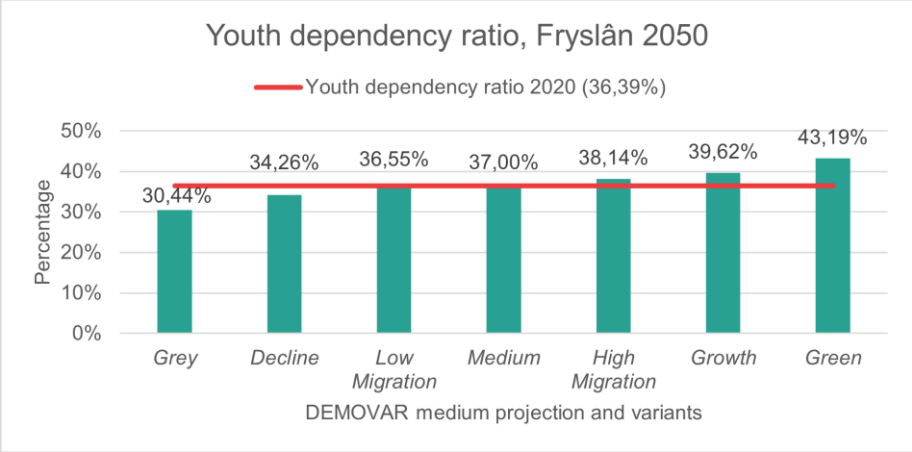

Figure 26. Youth dependency ratio Fryslân for all demographic variants 2050. Source: Author.

7.3 Active life stage (20-65 years old)

The population between the ages of 20 to 65, known as the active life stage, plays a pivotal role in the economic and social well-being of Fryslân. This segment is of great importance for several reasons. Firstly, it represents the portion of the population actively participating in the labour force, thereby contributing to economic prosperity. Moreover, these age groups play a vital role in supporting social welfare systems, such as healthcare and pension benefits, through the taxes they pay based on their income from employment. Consequently, the labour force engagement of individuals aged 20 to 65 provides for those who are not part of the workforce, including children and the elderly.

As of 2020, Fryslân had approximately 365,000 inhabitants within the active population group (see Figure 27). However, according to nearly all demographic variants, a decline in the active population is projected over the next three decades. The most substantial decrease is anticipated in the Low Migration variant, underscoring the importance of migration in maintaining a relatively stable segment of individuals aged 20 to 65 in Fryslân. In the High Migration variant, the active population is only expected to increase by approximately 5000 individuals. Notably, the Growth variant stands out as it predicts an increase in the active population by approximately 12,000 people. This indicates that only under a scenario with high life expectancy, high fertility, and high migration can the proportion of individuals aged 20 to 65 in Fryslân witness a growth until 2050.

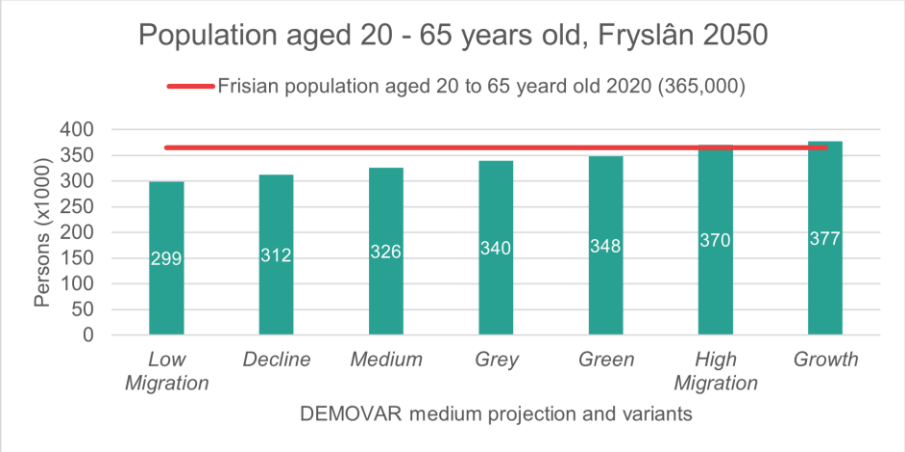

Figure 27. Population aged 20 to 65 years old Fryslân until 2050. Source: Author.

Furthermore, Figure 28 presents the proportion of the active population in relation to the total population across the different variants. The findings from this figure indicate a consistent decline in the share of active population, regardless of the developments in fertility, mortality, or migration. Notably, the Decline variant exhibits the smallest decrease in the proportion of the active population. This can be attributed to the relatively low levels of both fertility rates and life expectancy within this particular variant.

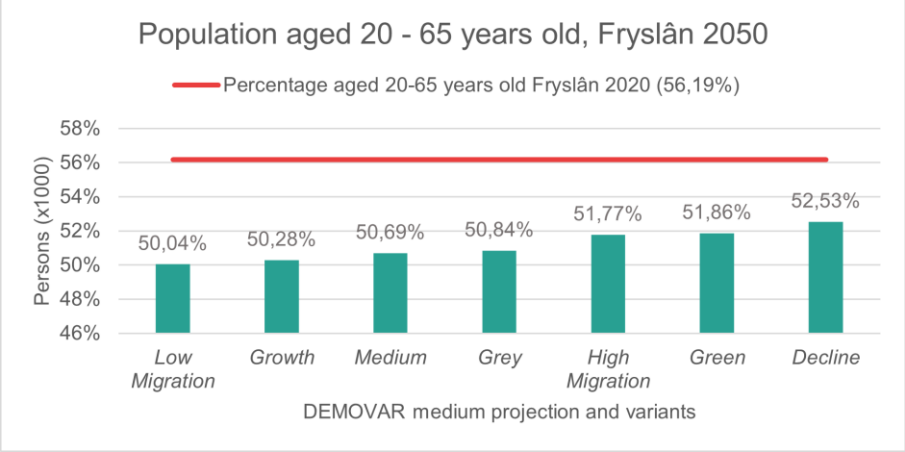

Figure 28. Proportion Frisian population aged 20 to 65 years old relative to the total population 2050. Source: Author.

7.3.2 Potential working population

The following paragraphs will provide more information about the working-age population, which is determined by the state pension age. In the Netherlands, the state pension age is known as the "AOW leeftijd." It is the age at which individuals are officially required to retire from work, and after reaching this age, they have the right to receive pension benefits. The determination of the state pension age in the Netherlands takes into account the life expectancy at 65 years old. According to the guidelines set by Rijksoverheid (2022), for every four and a half months increase in life expectancy among the Dutch population, the state pension age is adjusted by an increase of three months. Consequently, this leads to varying sizes of potential working populations across different demographic variants. It is important to note that the working-age population encompasses individuals from the age of 20 until they reach the prescribed state pension age. Figure 29, illustrates the variations in pension ages among different demographic groups based on assumptions about life expectancy at birth. It is worth noting that the Grey

variant, which projects the highest life expectancy, also predicts the highest pension age of 70.5 years. This would result in an increase of four years and two months over the next thirty years.

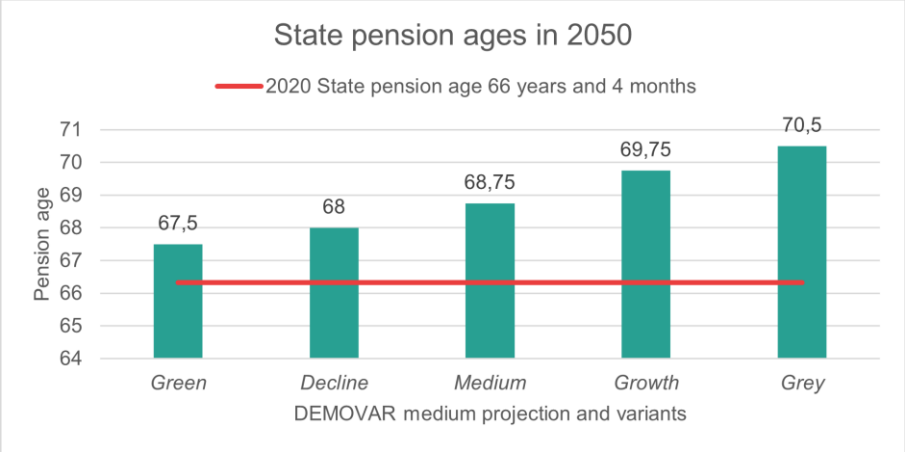

Figure 29. State pension ages for all demographic variants until 2050. Source: Author.

As a similar development in life expectancy is assumed for the Frisian demographic variants as the one assumed in the NIDI/CBS report for the Dutch population in general, the determined state pension ages from the NIDI/CBS report have been taken and applied to the Frisian context. Consequently, the projected working populations for each variant are presented in Figure 30. It is evident that the variants with substantial increases in life expectancy (i.e., the Growth and Grey variants) exhibit a rise in the working population compared to the year 2020. However, the Growth variant demonstrates a higher magnitude of increase in the working population compared to the Grey variant. This discrepancy can be attributed to the Growth variant its consideration of a more pronounced development in migration, as evidenced by the High Migration variant its expansion in the labour force compared to the year 2020. These findings underscore the significance of both migration and the state pension age in an aging population for the magnitude of the working population.

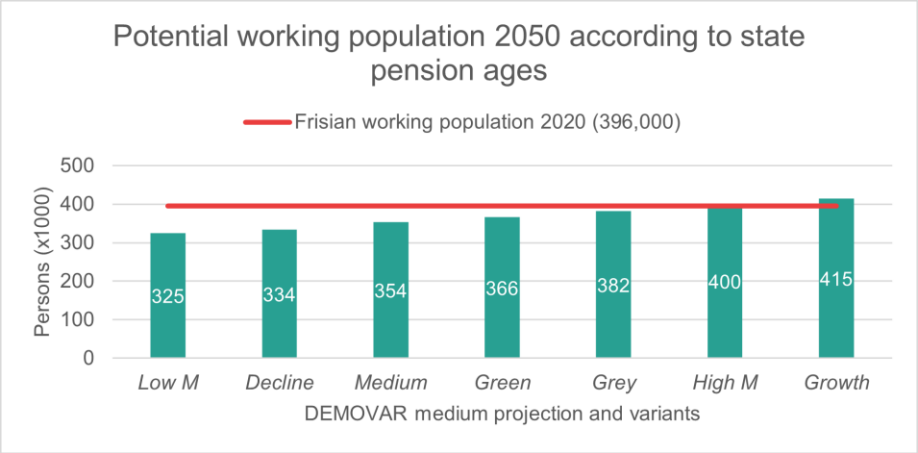

Figure 30. Potential working population Fryslân 2050 according to the state pension ages. Source: Author. [6]

[6] Linear interpolation was used to calculate the numbers as presented in figure 26 as they are based on the state pension ages. Thus, assuming that the population is equally distributed across the age categories and the results must be interpreted with care as this may not fully represent reality.

As previously mentioned, Fryslân is confronted with the challenges posed by its aging population. To ascertain whether this phenomenon extends to the working demographic, an examination of the age distribution within the potential workforce was undertaken. As depicted in Figure 31, it is evident that the proportion of individuals aged 50 years and above within the potential workforce will experience growth solely in the Grey, High Migration, and Growth variants. Similarly, the proportion of individuals aged 20 to 50 years is projected to increase only in the Green, High Migration, and Growth variants. Conversely, in situations characterised by population decline, such as the Low Migration and Decline variants, the overall potential working population is anticipated to diminish as well.

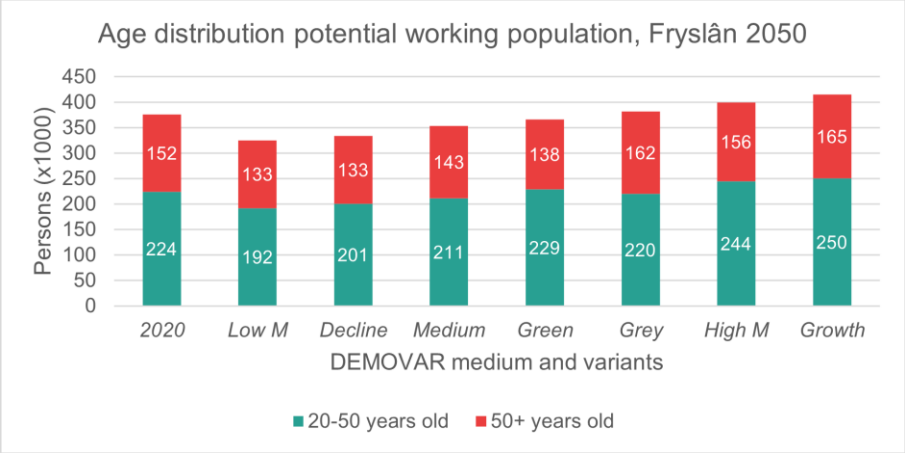

Figure 31. Age distribution potential working population Fryslân until 2050. Source: Author.

Moreover, in an effort to adopt a relative perspective that accounts for the proportion of individuals aged 50 years and above up to the state pension age relative to the total working population, it is evident that the Frisian workforce will not undergo an aging trend (see Figure 32). None of the considered variants indicate an increase in the share of individuals aged 50 years and older within the potential workforce in the next thirty years, in comparison to the situation in 2020. Hence, despite the aging of the overall Frisian population, the proportion of elderly individuals within the potential workforce will decrease. This is most probably caused by the fact that the baby boom generation and their second generation will exit the labour market within the upcoming 20 years.

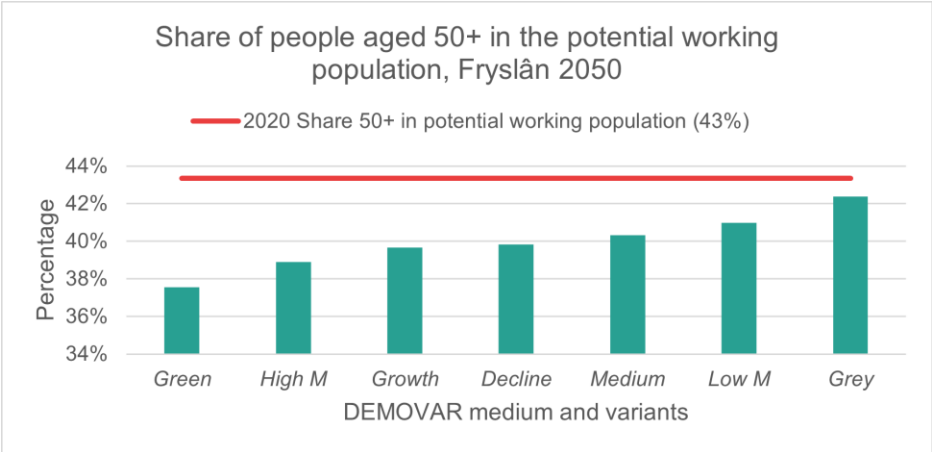

Figure 32. Proportion of people aged 50 years and older relative to the total potential working population Fryslân until 2050. Source: Author.

Furthermore, as illustrated in Figure 33, the share of people aged 20 to 50 years old, drawn from the potential workforce, displays an upward trend across all considered variants. This observation suggests a probable trend of workforce rejuvenation in the future, particularly in scenarios characterised

by higher fertility rates or increased migration flows. Subsequently, their second-generation counterparts, who have been shown to exhibit larger family sizes compared to contemporary norms, will constitute the elderly segment within the working population.

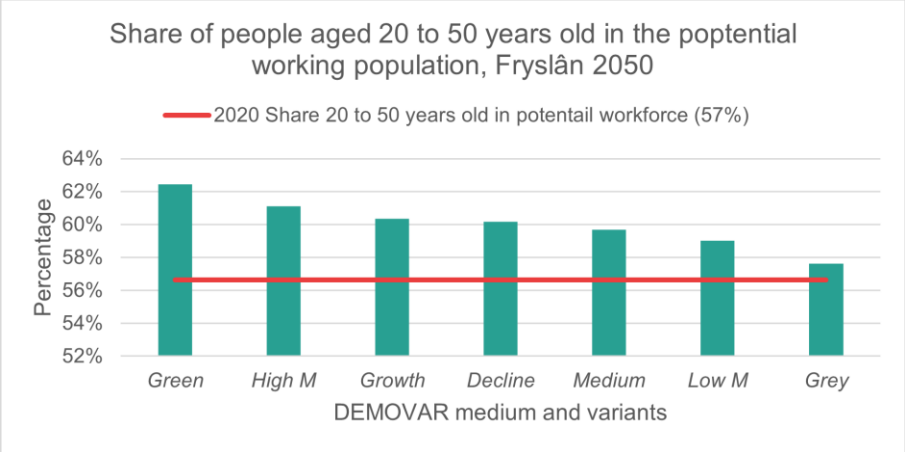

Figure 33. Proportion people aged 20 to 50 years old relative to the potential working population Fryslân until 2050. Source: Author.

Nevertheless, upon examining the ratio of the potential workforce in relation to the overall population, as depicted in Figure 34, it becomes evident that the proportion is projected to decline, possibly by 5% (Medium variant). Such a demographic shift could significantly impact the dependence of younger and older age groups on the economically active labour force. It is noteworthy that a high development in life expectancy is typically associated with a rise in the proportion of individuals capable of participating in the labour market.

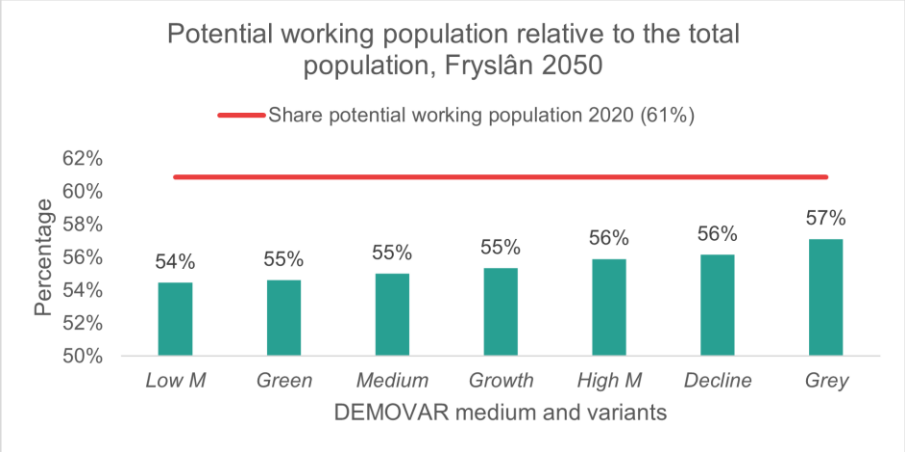

Figure 34. Potential working population relative to the total population Fryslân 2050. Source: Author.

7.4 Old life stage (65 years and older)

The share of elderly within the Frisian population will increase substantially in the upcoming thirty years due to the increase in life expectancy (see Figure 35). In 2020, there were approximately 141,000 Frisian inhabitants aged 65 years and older. The medium variant expects this proportion to increase to a total of about 186,000 people. Note that even within the Green variant which depicts a situation where the Frisian population is expected to become younger and in which life expectancy is assumed to have a low but rising development, the proportion of people aged 65 and over is expected to increase.

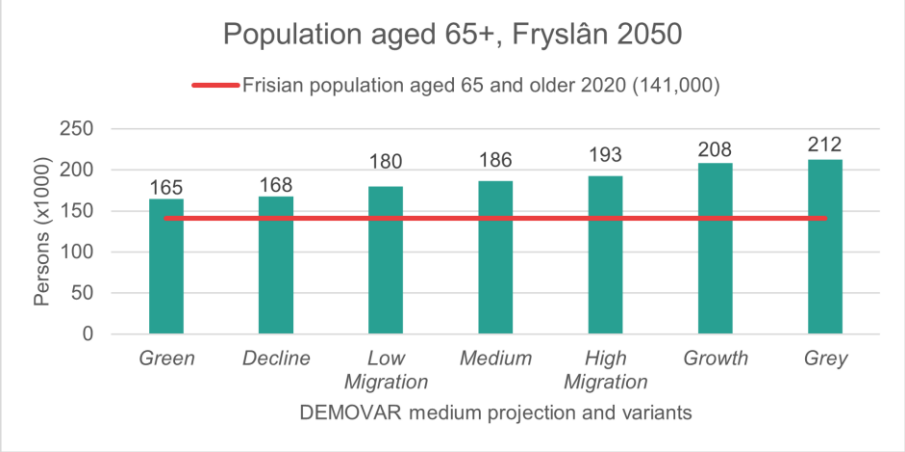

Figure 35. Population aged 65 years and older Fryslân until 2050. Source: Author.

However, alongside increasing life expectancy, there is also a notable improvement in healthy life expectancy, leading to an increase in the number of healthy life years experienced. This presents the possibility of mitigating the burden posed by heightened life expectancy on society, primarily concerning healthcare resources, by maintaining a relatively stable level of impact. This trend underscores the significance of governmental and municipal support for promoting healthy aging, thereby ensuring that the years lived in good health correspondingly increase in line with life expectancy. Additionally, the research by de Beer et al. (2021) expounds that advancements in health have resulted in older individuals retaining vitality and remaining active in the labour force, leading to a shift in the perception of those aged 65 years and older. Consequently, this demographic group is no longer uniformly classified as "elderly." Hence, when examining the concept of aging, it becomes imperative to consider the notion of "double aging," which pertains to the proportion of individuals aged 80 and above within the population.

As presented in Figure 36, the share of individuals aged 80 and above is projected to increase in the next three decades. According to the Medium variant, the percentage of the Frisian population aged 80 years or older is anticipated to reach 12%, a substantial increase from the 5% recorded in 2020. Furthermore, a low growth scenario in migration yields a projected 13% of inhabitants aged 80 or older, primarily due to the majority of migrants being below the age of 65, thus contributing to a younger demographic composition. The Grey variant, characterised by the highest life expectancy, exhibits the most prominent share of the 80+ age group within the Frisian population. Conversely, variants with higher projected fertility rates (Green and Growth) are associated with lower shares of individuals aged 80 and above. Notably, the Growth variant predicts the lowest increase in the share of individuals aged 80 and older in Fryslân, suggesting that during periods of elevated fertility and life expectancy, the proportion of the elderly may rise, but the share of younger individuals in the population is likely to be higher.

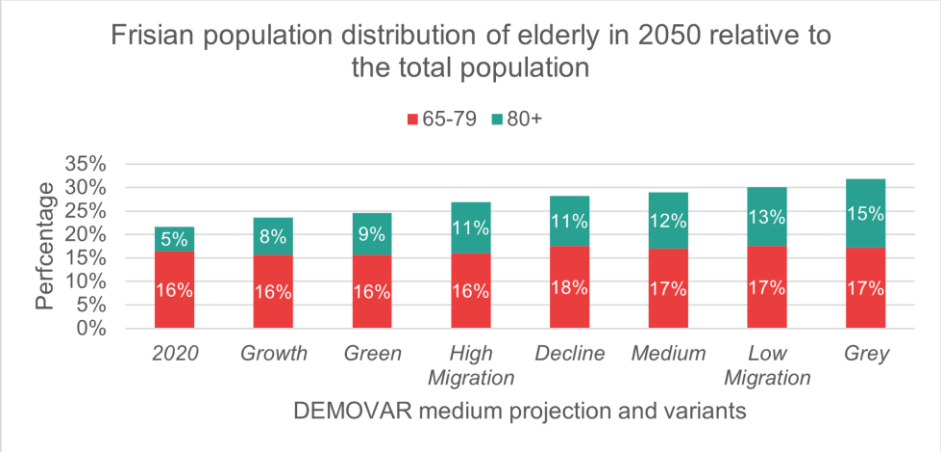

Figure 36. Frisian population distribution of elderly in 2050 relative to the total population. Source: Author.

Furthermore, Figure 37 presents the old age dependency ratio representing the share of pensioners relative to the working population. Exhibiting that in 2020 the ratio of inhabitants aged 80 years and older relative to the working population was 33%. In all variants this is expected to increase, with the highest growth within the Low Migration variant exhibiting again the relevance of migration within an ageing population. Nevertheless, as previously determined, people are more vital at older ages and thus it is important to consider the share of people aged 80 years and older relative to the working population as from that age onwards the burden on society and healthcare due to health implications and potential living independence of elderly decreases.

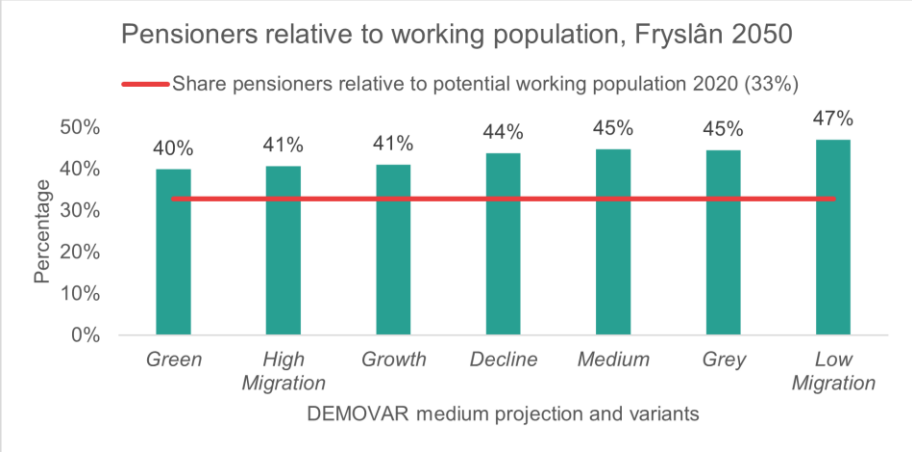

Figure 37. Pensioners relative to the potential working population in Fryslân until 2050. Source: Author.

Figure 38 illustrates the percentage of individuals aged 80 years or older among the Frisian population in relation to the potential labour force. The analysis reveals a notable increase in this proportion, particularly under the high life expectancy scenario (Grey variant). However, even within the Low Migration variant, where life expectancy and fertility show average trends, but migration is low, a substantial rise is observed. Furthermore, in scenarios with high fertility rates, as observed in the Green and Growth variants, the relative ratio of individuals aged 80 years and older to the potential working population exhibits the smallest growth compared to the baseline year of 2020.

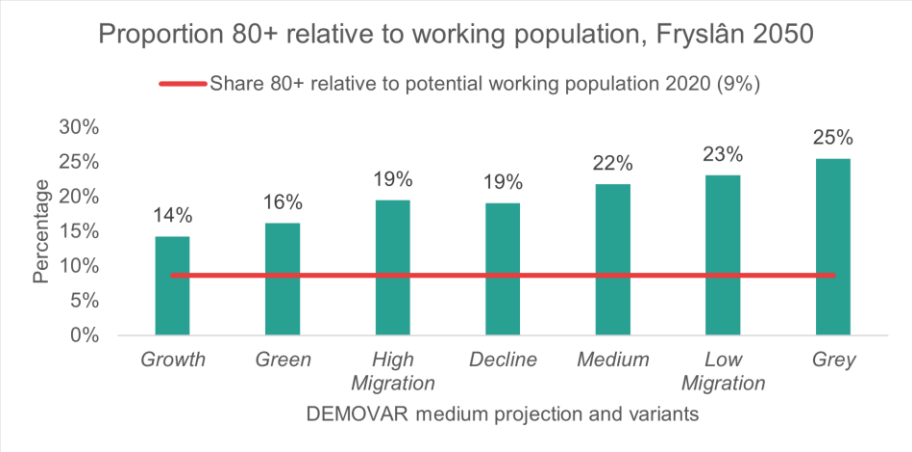

Figure 38. Proportion of Frisian inhabitants aged 80 years of older relative to the working population until 2050. Source: Author.

In recent times, there has been an observable trend of elderly individuals opting to remain in their own homes rather than moving to elderly care facilities, a notable departure from the practices of previous decades. This shift has implications for both formal and informal healthcare providers, as they experience increased pressure due to the rising proportion of elderly individuals in the population. Moreover, society at large faces the challenge of providing adequate financial support for the growing elderly population.

In the context of the Netherlands, informal care is frequently provided by individuals aged 50 to 75 years, underscoring the importance of assessing the ratio between people aged 80 years and those within the 50 to 75 age range to ascertain levels of dependence and potential burdens (see Figure 39). An examination of this ratio reveals a substantial and consistent increase across all projected scenarios in the next three decades. The Grey, Low Migration, and Medium variants demonstrate the most significant developments in this ratio, particularly in the Grey variant, where the dependence of 80-year-olds on informal care is projected to reach 50%.

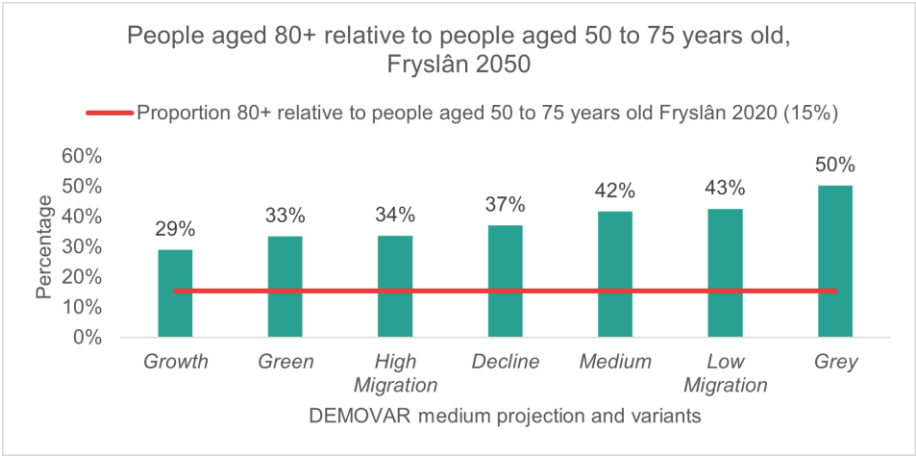

Figure 39. Population aged 80 years and older relative to the people aged 50 to 70 years old in Fryslân until 2050. Source: Author.

Chapter 8: Discussion

The following chapter will further discuss the findings and place them in a broader context by discussing the main differences and similarities of the DEMOVAR demographic variants (Green, Grey, Decline, Growth, High migration, Low migration) for Fryslân compared to the projections on a national level according to the report of de Beer et al. (2021). Furthermore, at the end of this chapter, the limitations of this thesis will be addressed.

8.1 Population size and composition

According to the Pearl regional projection and the DEMOVAR Medium projection, it is anticipated that the population of Fryslân will undergo a decline over the next three decades, giving rise to various implications for the province. Carbonaro et al. (2016) have examined the relationship between population decline and the out-migration of labour market participants, particularly among young individuals, which has been observed in Fryslân for several decades as evidenced by de Vries (2022). However, it is noteworthy that the proportion of young adults leaving the province is currently showing a diminishing trend. Furthermore, Carbonaro et al. (2016) have investigated the correlation between the pace of aging and interregional migration patterns. Fryslân has predominantly experienced periods of out-migration (as depicted in Figure 8), and as Hansen (2023) also points out, a decline in the number of births is contributing to the aging of the population in the region.

Additionally, upon closer examination of the developed demographic variants for Fryslân, it becomes evident that in the variants where migration developments are assumed to be minimal (i.e., the Decline- and Low Migration variants), the region's population is also projected to experience a decline. In comparing this observation with the findings presented in the report by de Beer et al. (2021), which focused on the national context, certain distinctions are visible. Specifically, it appears that at the national level, low migration patterns alone will not lead to population decline, as opposed to the situation observed in Fryslân. The Dutch Low Migration variant, in contrast, projects a small yet growing Dutch population.

When examining the age distribution as of 2020, it was observed that 22% of the population in Fryslân fell within the age group of 0-19 years, 56% within the age group of 20-64 years, and 22% within the age group of 65 years and above. In contrast, the age distribution in the Netherlands exhibited some variation, with approximately 2.8% more individuals within the age group of 20-64 years in 2020 compared to Fryslân. Consequently, this led to a relatively lower level of demographic pressure in the Netherlands compared to Fryslân. Moreover, the DEMOVAR medium projection indicates that by the year 2050, the proportion of people aged 65 and over in Fryslân will be approximately 5% higher than the corresponding share in the entire Netherlands. This observation underscores once again the relatively faster pace of population aging in Fryslân in comparison to the broader Netherlands. Moreover, the findings derived from the analysis of the DEMOVAR demographic variants, as elucidated in Chapter 7, reveal a consistent trend in Fryslân, wherein the proportion of active individuals aged 20-64 years relative to the dependent age groups is projected to approximate a 50/50 ratio across all demographic variants until the year 2050. Within the broader Netherlands, the share of people aged 20-65 years is also anticipated to diminish regardless of the developments in fertility, life expectancy, or migration. However, it is noteworthy that in all demographic variants considered, this proportion is projected to remain above 52.5% (de Beer et al., 2021).

8.2 Active life stage

The demographic variants formulated by de Beer et al. (2021) for the Netherlands demonstrate that the total population of individuals aged 20 to 65 years is expected to exhibit significant growth when net migration figures are high, as evidenced in the Growth- and High Migration variants. Conversely, a low net migration scenario leads to a decline in the number of individuals within the active life stage. These findings are consistent with the projections made for Fryslân. However, distinctions emerge in the Grey and Green variants. In Fryslân, a high fertility rate still results in a lower number of individuals within the active life stage compared to the baseline year of 2020. Additionally, a high life expectancy in Fryslân contributes to the same trend. In contrast, within the Netherlands, both the Grey and Green variants project an increase in the number of individuals within the active life stage.

The anticipated developments within the active life stage have its consequences for the potential working population. The potential working population was calculated by considering the state pension ages which differs per demographic variant as it is based on life expectancy. It was found that in Fryslân, the potential working population is expected to decrease among all demographic variants besides the Growth variant. Those findings do not correspond to the national context, for the Netherlands as a whole, only with low net migration numbers will the potential workforce decline. Remarkably, the investigation into the aging of the working population involved an assessment of the proportion of individuals aged 50 years and above within the potential workforce. In the case of Fryslân, irrespective of the projected changes in fertility, life expectancy, or migration, the share of individuals aged 50 years and over in the potential workforce remained constant. This finding suggests that the potential workforce in Fryslân will not undergo significant aging. In contrast, the Netherlands exhibits different patterns. Under scenarios characterised by a high development of life expectancy or a low development of migration, the Netherlands is anticipated to witness an increase in the number of individuals aged 50 years and older within the potential workforce. Furthermore, in all projected variants, Fryslân is projected to encounter a decline in the potential workforce ranging from 4% to 7%, relative to the overall population. Conversely, the Netherlands is also expected to experience a decline in the potential workforce, but to a lesser extent, ranging from 1% to 4%.

8.3 Young life stage

The young life stage pertains to the examination of the population structure and size of individuals aged 0 to 19 years old. This age group is reliant on support from the active age cohorts. Specifically, children aged 0 to 3 years old potentially require childcare services, while those aged 4 to 16 years old represent potential students, thereby influencing the demand for schooling services. Consequently, developments within these age cohorts can impact the pressure on the availability of childcare and schooling services. The DEMOVAR projections indicate that an increase in the potential demand for childcare services and the number of students relative to the year 2020 is only evident when either the fertility rate or migration is high. These findings align with the observations reported by de Beer et al. (2021) for the Netherlands. Furthermore, both for the Netherlands and Fryslân, the young age dependency rate is anticipated to increase solely in variants with high fertility rates.

8.4 Old life stage

The old life stage involves an examination of population developments among individuals aged 65 years and older across various demographic scenarios. This thesis reveals that the number of older individuals is projected to increase regardless of changes in fertility, life expectancy, or migration, though the magnitude of increase varies. High life expectancy conditions are associated with the most significant rise in the elderly population. The ratio between pensioners and the potential workforce shows higher values when life expectancy is high and migration is low, similar to observations in the Netherlands. However, the ratio is projected to be 7% higher in Fryslân by 2050 compared to the Netherlands.

Population aging in the Netherlands is anticipated to have several implications for public health, according to the National Institute for Public Health and the Environment (2019). Predictions suggest a 21% increase in people with chronic diseases and a 154% increase in deaths due to dementia by 2040, along with a 96% increase in people living with dementia, all compared to the year 2018. Given the accelerated aging in Fryslân, these consequences may manifest more rapidly in the province. Both the Netherlands and Fryslân are expected to experience a substantial increase in the proportion of individuals aged 80 years and above in the coming years, which will place pressure on informal and formal healthcare services. The National Institute for Public Health and the Environment (2019) projects a 92% increase in loneliness among people aged 75 years and older, a trend that aligns with observations made by Planbureau Fryslân (2023), indicating an increased prevalence of loneliness among the elderly in recent years. This has severe implications for both mental and physical health, underscoring the importance of addressing loneliness. The Green variant for the Netherlands predicts a dependency ratio of people aged 80 and older to the potential working population to reach 28%, while the Grey variant projects it to increase to nearly 48%, implying that higher fertility rates can mitigate pressure on informal healthcare. In contrast, for the Netherlands, the highest dependency ratio of 42% is projected in the Growth variant, indicating that a combination of high fertility, high life expectancy, and high migration leads to greater dependency. However, in Fryslân, the Growth variant exhibits the lowest dependency ratio (14%) among all variants, possibly due to the Fryslân its above-national-average fertility rates.

Another significant finding is that the share of people aged 80 years and over among the inhabitants aged 50 to 75 years old, who typically provide informal healthcare for the elderly, was 15% in 2020 for both Fryslân and the Netherlands. Nevertheless, under all demographic variants, this percentage is expected to substantially increase, with the Frisian Grey variant even reaching a dependency of elderly on the people aged 50-75 years old of 50%. The National Institute for Public Health and the Environment (2019) also notes a projected decrease of approximately 57% in potential caregivers for informal healthcare compared to the demand for such care in the coming years. These developments inevitably result in an increase in expenditure on elderly care within the Netherlands.

8.5 Limitations

Projections inherently entail a degree of uncertainty, as they involve forecasting future scenarios that have not yet occurred and therefore cannot be fully guaranteed. This aspect bears significant importance when interpreting the findings derived from the utilization of the DEMOVAR model. Throughout the process of developing demographic variants, several challenges were encountered, which consequently affected the accuracy of the results, thus being acknowledged as limitations in this thesis.

Primarily, the DEMOVAR model integrated data from multiple sources to fulfil the need for age and gender-specific data. This combination of data from diverse sources could introduce complexities, as different definitions or methodologies might have been employed in obtaining and processing the data, despite being on a similar scale. To mitigate potential impacts, efforts were made to ensure comparability of aggregated data. For example, when age-specific fertility rates were required, the total fertility rate provided solely by the CBS was matched with the age-specific fertility distribution obtained from EUROSTAT for Fryslân. Secondly, data related to migration within the DEMOVAR model necessitated transformations, owing to the limitation of CBS data only extending to the age category of 50+, whereas data up to the age category of 95+ was required. In this context, recourse was made to the EUROSTAT database. However, a constraint arose as EUROSTAT did not provide age-distributions on migration specific to Fryslân. As a result, Dutch age-distributions were used, which could potentially differ and thereby impact the reliability and accuracy of this thesis.

Furthermore, in estimating the potential working population within the various demographic variants, the state pension ages were utilised. However, it should be noted that the DEMOVAR model presents demographic data in five-year age groups, rather than per individual year. Consequently, linear interpolation was employed to calculate the potential workforce, assuming an equal distribution of individuals across all ages within the five-year age group. This method may not accurately capture the actual age distribution within each group. Recognizing this limitation, it is advisable for future research to conduct projections not in five-year age groups but rather for all individual ages. Another constraint of the DEMOVAR model is that it is more limited than for instance Pearl or Primos. Factors as ethnicity and housing market inputs are not included in the DEMOVAR model this causes migrants to have identical demographic behaviour as native Frisians.

Moreover, the Frisian DEMOVAR medium projection was based on the Pearl regional projection 2020-2050 which has been removed from the CBS Statline due to errors within the model. A factor considered a limitation of this thesis as the data and assumptions of the Pearl regional projection 2020-2050 were used to create the DEMOVAR medium variant. It is essential to recognise and account for these limitations while interpreting and drawing conclusions from the findings of the DEMOVAR model in this study.

Chapter 9: Conclusion

This thesis aimed to identify the feasible population developments for Fryslân until 2050. To achieve this objective, six distinct variants were created, each depicting feasible demographic trajectories for Fryslân. These variants encompassed the Grey and Green variants, which focused on the prospective age structure of Fryslân, the Growth and Decline variant, which focussed on the Frisian population size, and the High and Low Migration variants, which explored the feasible migration patterns of Fryslân. Additionally, a Medium variant was formulated to represent the most probable future pathway, drawing upon the Pearl regional projection 2020-2050.

To establish the feasible population developments for each demographic variant, this thesis employed trend analysis to investigate historical patterns in Fryslân concerning the components fertility, mortality, and migration. In relation to fertility, it was observed that the total fertility rate in Fryslân is structurally higher compared to the national average. Moreover, the financial crisis of 2010 had discernible postponement effects on fertility, but it is anticipated that these effects will be mitigated in the forthcoming years. Regarding mortality, life expectancy at birth exhibited an upward trajectory historically, although it exhibited slight fluctuations in comparison to the national trend. Additionally, it was noted that genetically and behaviourally determined life expectancy tends to be lower for males than females. Despite these differences, the overall trend in life expectancy at birth for Fryslân aligns with that of the Netherlands. Furthermore, an examination of internal migration patterns revealed a high degree of unpredictability and substantial fluctuations, largely influenced by the economic cycles. The analysis indicated that internal in-migration in Fryslân only slightly surpassed internal out-migration, and since 2019, this trend has reemerged, partially attributed to factors derived from the Ukrainian war. Furthermore, it was concluded that approximately 2% of international immigrants arriving in the Netherlands choose Fryslân as their destination, while 1.8% of all individuals emigrating from the Netherlands originate from Fryslân.

Based on the conducted trend analysis and expert judgements, comprehensive assumptions were formulated and presented in Chapter 6. It is evident from these assumptions that, until the year 2050, the Green variant is projected to exhibit the highest development in the total fertility rate, followed by the Growth, Medium, Decline, and Grey variants. Conversely, for life expectancy, the Grey variant is assumed to demonstrate the most substantial development until 2050, followed by the Growth, Medium, Decline, and Green variants. Regarding net internal migration, the High Migration variant is predicted to have the highest positive net migration until 2050, followed by the Growth variant. In contrast, the Decline and Low Migration variants are anticipated to exhibit negative net internal migration patterns similar to the Medium, Green and Grey variant. Furthermore, concerning net international migration, positive development is expected until 2050, with the Growth variant exhibiting the highest net international migration, succeeded by the High Migration, Grey, Green, Decline, and Low Migration variants. These assumptions served as a foundational basis for the projection and exploration of feasible demographic pathways in Fryslân until 2050.

Thus, answering the main research question: “What are the feasible population developments for Fryslân until 2050?”. It can be concluded that the Frisian demographic future shows large variation, both decline and growth are possible pathways. Under the DEMOVAR medium variant, it is projected that the Frisian population will continue to grow until 2035, after which it is expected to decline. Long-term population decline can have significant socio-economic consequences, including a decrease in employment opportunities and reduced consumption within local markets. Furthermore, the decline in population has implications for the housing market and social cohesion. However, it is worth noting that population decline can also be viewed as an opportunity, as it allows for the reassessment of

spatial planning, the promotion of sustainable development practices, and the preservation of cultural heritage. The challenges and opportunities associated with population decline in Fryslân are multifaceted, affecting various aspects of the socio-economic landscape. It is crucial to analyse and address these issues through informed policymaking, considering the potential consequences for employment, consumption, housing, social cohesion, and the preservation of cultural and natural assets in the region.

Focussing on the developed Frisian demographic variants, within a low development scenario (Decline and Low Migration variants) the population will decline with at least 52,000 individuals. On the contrary, within a high development scenario, the Frisian population is expected to grow with 66,000 (High Migration variant) to 100,000 (Growth variant) individuals. Nevertheless, it is important to acknowledge that historical patterns in internal migration have demonstrated significant variability. These fluctuations are not mirrored in the demographic variants due to practical constraints. Instead, continuous high or low values were employed to model migration, whereas in reality, it tends to fluctuate. Consequently, the high-growth and low-growth variants exhibit extreme population growth or decline values. While these extremes may not be highly probable, they do represent potential outcomes. Additionally, if life expectancy at birth were to improve significantly, the population is projected to grow to 668,000 individuals as of 2050 (Grey variant). If the total fertility rate would present a high development over the upcoming thirty years, the population would grow to 671,000 individuals (Green variant).

Moreover, this study investigated the consequences of the diverse demographic variants on population structures across distinct life stages, specifically categorized as Young, Active, and Old. Concerning the Young life stage (ages 0-19), it was deduced that in most variants the size of the young population, both absolute and relative, will decline. Only high developments in migration or fertility could potentially result in an expansion of the population within this age group compared to the baseline year of 2020. In these particular variants, the youth dependency ratio is anticipated to rise, indicating that elevated developments in fertility and migration would exert greater demands on childcare facilities and educational services.

In relation to the overall population, all demographic variants in Fryslân exhibit a decrease in the proportion of individuals aged 20 to 65 years old, relative to the year 2020. Given that this age group comprises the key financial contributors supporting both the younger and older segments of the population, this decline may entail significant implications. However, to assess the potential working-age population, an additional consideration was made, accounting for the state pension age in each demographic variant. Based on this analysis, it is evident that raising the official retirement age does have an effect on the size of the potential working-age population, although in most variants there is still a decline to be expected, except in the variants characterised by high migration or highly developed demographic components, as observed in the Growth variant. Nonetheless, when examining the relative share of the potential working-age population to the total population, this share is projected to decrease, although to the least extent within the Grey variant, followed by the Decline, High Migration, Growth, Green, and Low Migration variants. Furthermore, it is noteworthy that despite the aging of the Frisian population, the potential labour force is not subject to the same aging trend, as the share of individuals aged 50 and older within the potential working-age population is anticipated to be lower compared to the year 2020. This finding suggests a potential mitigation of aging effects within the labour force, despite the overall aging of the population in Fryslân.

Furthermore, irrespective of the developments in fertility, mortality, or migration, there is a consistent projected increase in the size and proportion of individuals aged 65 and older over the next three decades. When examining the age distribution, the most substantial growth is observed not within the age group of 65 to 79 years but rather among individuals aged 80 and above. Consequently, this

projection entails a rise in the number of pensioners relative to the potential working-age population, thereby placing mounting pressure on both informal and formal care services, including health care, in the coming thirty years. If life expectancy in Fryslân demonstrates a high level of development, the number of individuals aged 65 years old and above is estimated to reach 212,000 individuals by 2050, in comparison to 141,000 in the baseline year of 2020. Conversely, a low development in life expectancy would result in a range of 165,000 to 168,000 individuals aged 65 and above by 2050. Moreover, considering that informal care is predominantly provided in the Netherlands by individuals aged 50 to 75 years, and the ratio of such caregivers to individuals aged 80 and above was 15% in 2020, it is projected that this percentage will intensify to 50% by 2050 in the variant characterised by high life expectancy development (Grey variant). In conclusion, the prospective demographic trajectory of Fryslân displays significant diversity, both decline and growth are possible pathways. Furthermore, irrespective of the trajectories of fertility, mortality, or migration, Fryslân is confronted with an aging population. This demographic shift will strengthen the strain on informal care provisions over the next three decades, while simultaneously witnessing a decline in the potential working-age population.

9.1 Future research

This thesis gives rise to several recommendations for future research. While the DEMOVAR model serves as a useful tool for population projections, it is a simplified model which does not include influential factors as migration background or household structures. However, it is crucial to consider household structures, as this information encompasses various aspects, such as housing demand, housing types, and cohabiting arrangements among the population. Moreover, taking into account the migration backgrounds of future populations could play a significant role in addressing issues related to cultural diversity, integration, and social cohesion. As such, it is advisable for future research to incorporate investigations into the implications of the various demographic variants on household structures and migration backgrounds. By doing so, a more comprehensive understanding of the potential shifts in housing needs, family arrangements, and cultural dynamics can be achieved.

Moreover, it is advised to investigate the consequence of the diverse demographic variants on the labour market in Fryslân. This examination could encompass a comprehensive analysis of labour force participation among females, males, and the elderly, while also accounting for factors such as working hours and educational levels, as demonstrated in the report by de Beer et al. (2021) based on national projections. Furthermore, it is advised to consider the potential implications for the healthcare sector and housing market, mirroring the approach adopted in the report by de Beer et al. (2021). Such inquiries would offer a holistic understanding of the broader socio-economic impacts resulting from the demographic variations and provide valuable insights for policymaking and planning strategies in Fryslân.

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Appendices

Appendix A: Mean age at childbearing

The data presented in the Table was obtained from the EUROSTAT database (EUROSTAT, 2023).

Year	Netherlands	Fryslân
2017	31.4	30.7
2018	31.5	30.6
2019	31.6	30.8
2020	31.7	30.8
2021	31.8	30.9

Appendix B: Sex Ratio

The data presented in the Table shows the sex ratio which is calculated using the following formula: $Sex\ ratio = (Number\ of\ males / Number\ of\ females) * 100$. Additionally, the operational sex ratio is calculated using the subsequent formula: $Operational\ sex\ ratio = (Number\ of\ sexually\ active\ males / Number\ of\ sexually\ receptive\ females) * 100$. It was assumed that a female is sexually receptive from the age 15 until 50 and a male is sexually active from the age 15 until 50. The data was obtained from the CBS Statline (2022a).

	Fryslan			Netherlands		
Year	**Male**	**Female**	**Ratio**	**Male**	**Female**	**Ratio**
1996	305055	306973	99.375	7662289	7831600	97.84
1997	306651	308394	99.435	7696803	7870304	97.80
1998	308335	309780	99.534	7740074	7914118	97.80
1999	310038	311184	99.632	7793271	7966954	97.82
2000	311504	312996	99.523	7846317	8017633	97.86
2001	314591	315948	99.570	7909855	8077220	97.93
2002	317582	318602	99.680	7971967	8133318	98.02
2003	319483	320304	99.744	8015471	8177101	98.02
2004	320656	321410	99.765	8045914	8212118	97.98
2005	321235	321742	99.842	8065979	8239547	97.89
2006	320611	321619	99.687	8077407	8256803	97.83
2007	320383	321826	99.552	8088514	8269478	97.81
2008	321102	322087	99.694	8112073	8293326	97.81
2009	322015	322796	99.758	8156396	8329391	97.92
2010	322911	323394	99.851	8203476	8371513	97.99
2011	323439	323843	99.875	8243482	8412317	97.99
2012	323495	323719	99.931	8282871	8447477	98.05
2013	323442	323420	100.007	8307339	8472236	98.05
2014	323242	323075	100.052	8334385	8494904	98.11
2015	323398	322859	100.167	8372858	8527868	98.18
2016	323376	322664	100.221	8417135	8561985	98.31
2017	324048	322826	100.379	8475102	8606405	98.47

2018	324491	322777	100.531	8527041	8654043	98.53
2019	324666	323006	100.514	8581086	8701077	98.62
2020	325951	324006	100.600	8648031	8759554	98.73
2021	326788	324647	100.659	8686536	8788879	98.84
2022	328155	325864	100.703	8745468	8845204	98.87

Netherlands			Fryslân		
Age	Male	Female	Age	Male	Female
15-19	524244	501112	15-19	20647	19679
20-24	574952	557933	20-24	20563	18861
25-29	576937	557569	25-29	18714	17110
30-34	582953	565526	30-34	18750	17330
35-39	540219	531752	35-39	18366	17405
40-44	521310	522737	40-44	18275	17847
45-49	540923	547531	45-49	19897	19707
Total	3861538	3784160	Total	135212	127939
Ratio	102,0448		Ratio	105,6847	

Appendix C: Religion in Fryslân and the Netherlands

The data presented in the Table shows how many times a person visits a religious service and was obtained from CBS Statline (CBS, 2016).

	Netherlands					Fryslân				
Year	**1x a week**	**2-3x a week**	**1x a month**	**Less than once a month**	**Sometimes or never**	**1x a week**	**2-3x a week**	**1x a month**	**Less than once a month**	**Sometimes or never**
2010	10	4	4	8	74	11	5	4	5	75
2011	10	4	3	8	75	14	6	4	5	72
2012	10	3	3	7	76	13	5	3	6	73
2013	10	4	3	7	77	10	5	4	5	75
2014	10	3	3	7	77	10	4	3	6	77
2015	10	3	3	6	77	11	6	3	5	76

Appendix D: Average disposable income Fryslân and the Netherlands

The data presented in the Table below shows the average disposable income in the Netherlands and Fryslân and is obtained from the CBS Statline (2022b).

Year	**Netherlands (x1000)**	**Fryslân (x1000)**
2018	43.5	40

2019	46.8	42.4
2020	47.5	43.4
2021	49.4	45.1

Appendix E: Time trends in life expectancy

The data presented in the Tables below is obtained from the RIVM Statline (2022b) and CBS Statline (2022c).

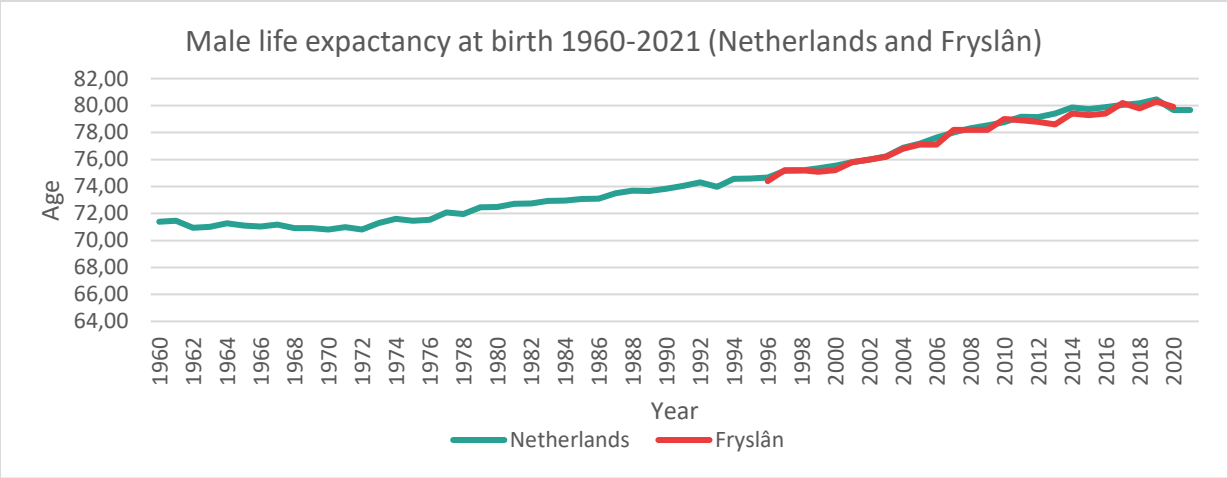
Male life expectancy at birth

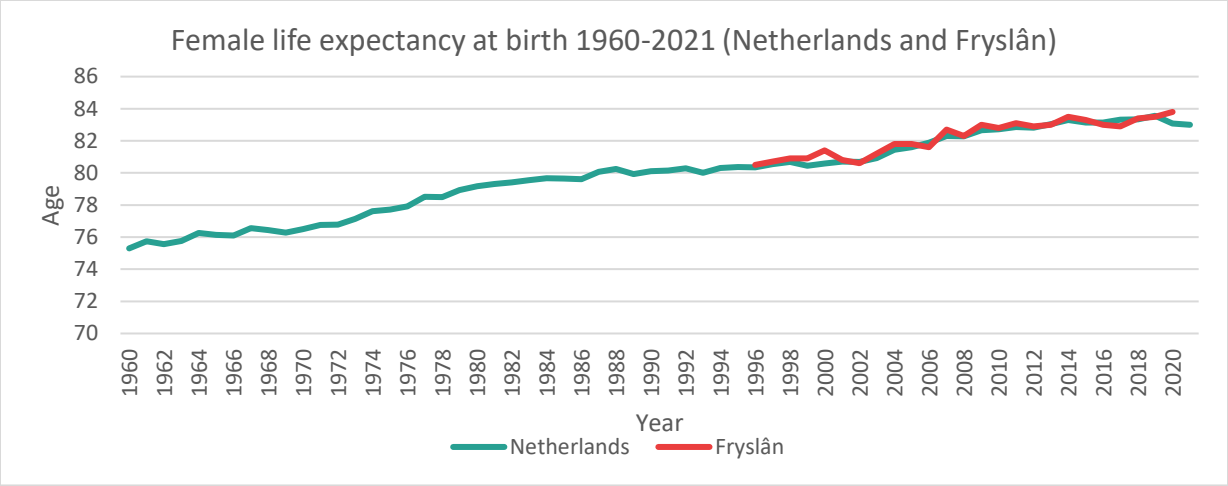
Year	Netherlands	Fryslân	Δ (FR-NL)
1996	74.66	74.40	-0.26
1997	75.16	75.20	0.04
1998	75.19	75.20	0.01
1999	75.34	75.10	-0.24
2000	75.54	75.20	-0.34
2001	75.80	75.80	0.00
2002	75.99	76.00	0.01
2003	76.24	76.20	-0.04
2004	76.87	76.80	-0.07
2005	77.19	77.10	-0.09
2006	77.63	77.10	-0.53
2007	78.01	78.20	0.19
2008	78.32	78.20	-0.12
2009	78.53	78.20	-0.33
2010	78.77	79.00	0.23
2011	79.18	78.90	-0.28
2012	79.14	78.80	-0.34
2013	79.41	78.60	-0.81
2014	79.87	79.40	-0.47
2015	79.73	79.30	-0.43
2016	79.88	79.40	-0.48
2017	80.06	80.20	0.14
2018	80.16	79.80	-0.36
2019	80.46	80.30	-0.16
2020	79.67	79.90	0.23
		Average Δ	**-0.18**

Female life expectancy at birth

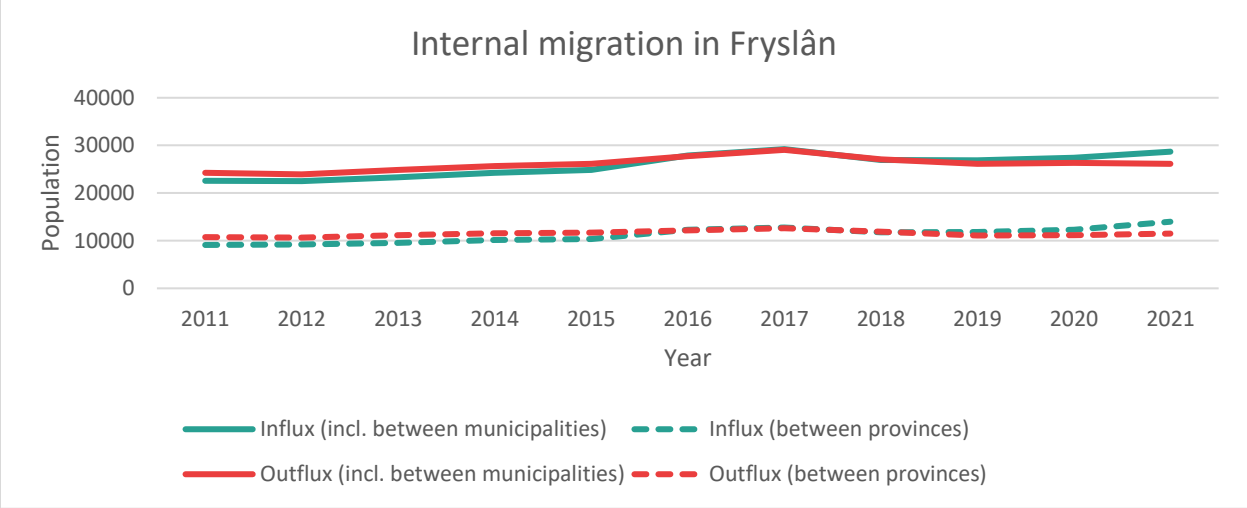
Year	Netherlands	Fryslân	Δ (FR-NL)
1996	80.35	80.50	0.15
1997	80.55	80.70	0.15
1998	80.69	80.90	0.21
1999	80.45	80.90	0.45
2000	80.58	81.40	0.82

2001	80.71	80.80	0.09
2002	80.69	80.60	-0.09
2003	80.93	81.20	0.27
2004	81.44	81.80	0.36
2005	81.60	81.80	0.20
2006	81.89	81.60	-0.29
2007	82.31	82.70	0.39
2008	82.28	82.30	0.02
2009	82.65	83.00	0.35
2010	82.72	82.80	0.08
2011	82.85	83.10	0.25
2012	82.82	82.90	0.08
2013	83.04	83.00	-0.04
2014	83.29	83.50	0.21
2015	83.13	83.30	0.17
2016	83.13	83.00	-0.13
2017	83.32	82.90	-0.42
2018	83.33	83.40	0.07
2019	83.56	83.50	-0.06
2020	83.08	83.80	0.72
		Average Δ	**0.16**





Appendix F: Time trends internal migration



Internal in- and out-migration trends, including between municipality moves and trends solely focussing on moves between provinces.

Appendix G: Time trends international migration

The data presented in the Table below is obtained from CBS Statline (2023c) and exhibits the time trends in international migration to the Netherlands and Fryslân. Additionally, the share of immigrants/emigrants moving to Fryslân taken from the total number of immigrants/emigrants coming to the Netherlands is provided as well as the average share over time.

Immigration

Year	Netherlands	Fryslân	Share Fryslân to national
1960	45407	803	1.8
1961	55082	931	1.7
1962	66035	1383	2.1
1963	55127	759	1.4

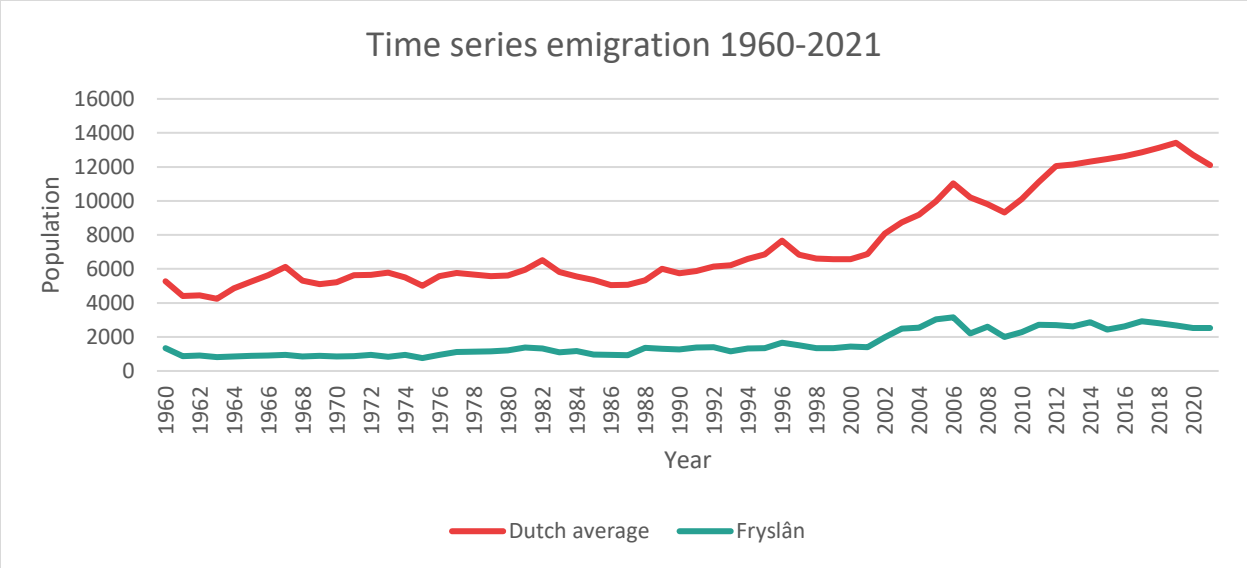
1964	67079	895	1.3
1965	76572	1017	1.3
1966	81842	818	1.0
1967	55784	726	1.3
1968	64486	741	1.1
1969	76359	882	1.2
1970	90829	1044	1.1
1971	95054	1212	1.3
1972	81329	1140	1.4
1973	84691	1167	1.4
1974	93796	1336	1.4
1975	127264	2452	1.9
1976	82953	1358	1.6
1977	83899	1382	1.6
1978	89184	1591	1.8
1979	104553	2049	2.0
1980	112504	2074	1.8
1981	80183	1397	1.7
1982	70740	1221	1.7
1983	66762	1175	1.8
1984	66907	1197	1.8
1985	79362	1194	1.5
1986	87387	1293	1.5
1987	95935	1371	1.4
1988	91238	1640	1.8
1989	98914	1800	1.8
1990	117350	2289	2.0
1991	120249	2408	2.0
1992	116926	2206	1.9
1993	119154	3031	2.5
1994	99311	2245	2.3
1995	96099	2460	2.6
1996	108749	3511	3.2
1997	109860	3819	3.5
1998	122407	4310	3.5
1999	119151	4069	3.4
2000	132850	5266	4.0
2001	133404	5020	3.8
2002	121250	4398	3.6
2003	104514	2990	2.9
2004	94019	2273	2.4
2005	92297	1914	2.1
2006	101150	2256	2.2
2007	116819	2742	2.3

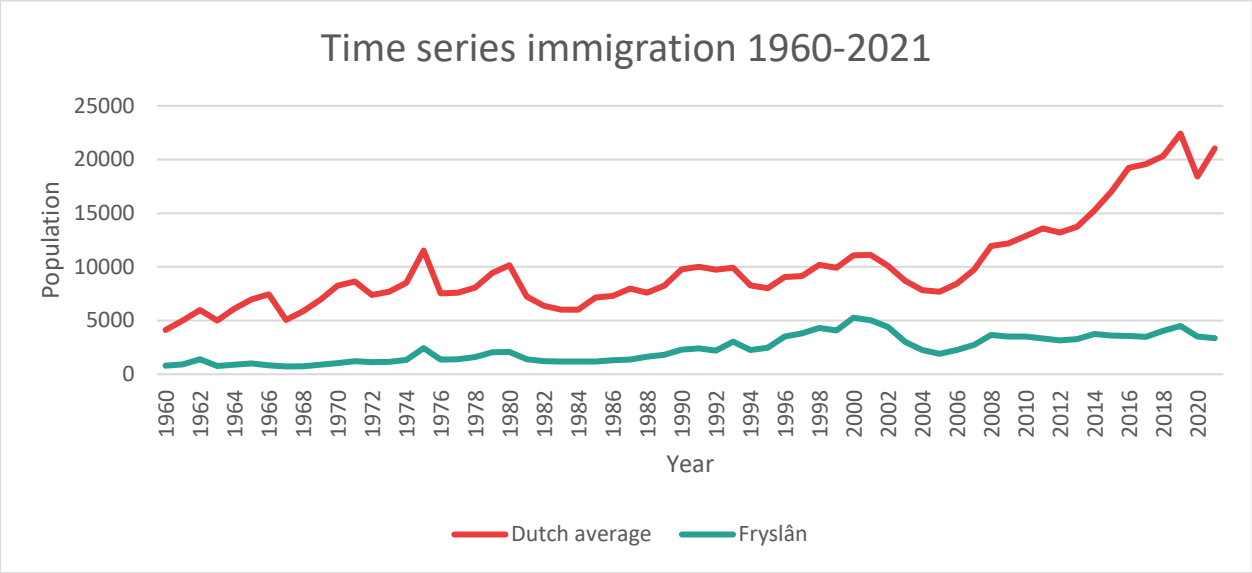
2008	143516	3671	2.6
2009	146378	3524	2.4
2010	154432	3525	2.3
2011	162962	3324	2.0
2012	158374	3146	2.0
2013	164772	3259	2.0
2014	182949	3743	2.0
2015	204615	3590	1.8
2016	230739	3583	1.6
2017	234957	3469	1.5
2018	243737	4040	1.7
2019	269064	4497	1.7
2020	220853	3513	1.6
2021	252528	3349	1.3
		Average share	**2.0**

Emigration

Year	Netherlands	Fryslân	Share Fryslân to national
1960	58226	1333	2.289
1961	48670	868	1.783
1962	49082	903	1.840
1963	46691	816	1.748
1964	53419	854	1.599
1965	57808	894	1.546
1966	61892	908	1.467
1967	67292	938	1.394
1968	58479	859	1.469
1969	56176	888	1.581
1970	57375	857	1.494
1971	62040	870	1.402
1972	62200	948	1.524
1973	63623	833	1.309
1974	60655	941	1.551
1975	55209	759	1.375
1976	61530	946	1.537
1977	63555	1123	1.767
1978	62579	1137	1.817
1979	61517	1149	1.868
1980	61948	1206	1.947
1981	65814	1374	2.088
1982	72024	1324	1.838
1983	64431	1089	1.690
1984	61774	1178	1.907

1985	59475	957	1.609
1986	60607	954	1.574
1987	60844	935	1.537
1988	63996	1359	2.124
1989	72063	1297	1.800
1990	68939	1261	1.829
1991	70639	1380	1.954
1992	73808	1406	1.905
1993	74788	1154	1.543
1994	79228	1328	1.676
1995	82195	1341	1.631
1996	91945	1663	1.809
1997	81973	1514	1.847
1998	79289	1339	1.689
1999	78779	1347	1.710
2000	78977	1442	1.826
2001	82566	1389	1.682
2002	96918	1985	2.048
2003	104831	2496	2.381
2004	110235	2542	2.306
2005	119725	3028	2.529
2006	132470	3155	2.382
2007	122576	2204	1.798
2008	117779	2608	2.214
2009	111897	2002	1.789
2010	121351	2285	1.883
2011	133194	2709	2.034
2012	144491	2706	1.873
2013	145669	2621	1.799
2014	147862	2867	1.939
2015	149509	2435	1.629
2016	151545	2627	1.733
2017	154292	2924	1.895
2018	157366	2813	1.788
2019	161029	2676	1.662
2020	152494	2532	1.660
2021	145330	2520	1.734
		Average share	**1.78**





* The size of provinces has not been taken into account solely the number of provinces and total number of immigrants/emigrants.

Appendix H: Time series TFR

The data presented in the table below originates from the CBS Statline (2022e) and presents the total fertility rate for the Netherlands and Fryslân as well as the difference between those and the year over year change.

Year	Netherlands	Fryslân	Δ (FR-NL)[7]	Year-over-year change[8]
1988	1.55	1.67	0.13	
1989	1.55	1.70	0.15	0.03
1990	1.62	1.68	0.06	-0.02
1991	1.61	1.76	0.15	0.08
1992	1.59	1.70	0.11	-0.06
1993	1.57	1.70	0.13	0.00
1994	1.57	1.67	0.10	-0.03
1995	1.53	1.69	0.16	0.02
1996	1.53	1.66	0.13	-0.03
1997	1.56	1.70	0.14	0.04
1998	1.63	1.75	0.12	0.05
1999	1.65	1.80	0.15	0.05
2000	1.72	1.86	0.14	0.06
2001	1.71	1.86	0.15	0.00
2002	1.73	1.91	0.18	0.05
2003	1.75	1.93	0.18	0.02
2004	1.73	1.89	0.16	-0.04
2005	1.71	1.90	0.19	0.01
2006	1.72	1.91	0.19	0.01
2007	1.72	1.91	0.19	0.00
2008	1.77	1.95	0.18	0.04
2009	1.79	2.00	0.21	0.05
2010	1.80	2.00	0.20	0.00
2011	1.76	1.91	0.15	-0.09
2012	1.72	1.89	0.17	-0.02
2013	1.68	1.84	0.16	-0.05
2014	1.71	1.86	0.15	0.02
2015	1.66	1.78	0.12	-0.08
2016	1.66	1.79	0.13	0.01
2017	1.62	1.77	0.15	-0.02
2018	1.59	1.71	0.12	-0.06
2019	1.57	1.75	0.18	0.04
2020	1.55	1.70	0.16	-0.05
2021	1.62	1.83	0.21	0.13
		Average Δ	**0.16**	**0.0048**

[7] Δ (FR-NL) is the difference in TFR between Fryslân and the Netherlands.

[8] Year-over-year change is the TFR at time t of Fryslân minus the TFR at time t+1 of Fryslân.

Calculations TFR DEMOVAR Medium variant

The Pearl regional projection 2023-2050 was used to obtain the TFR values for the DEMOVAR medium projection 2020-2050. The subsequent calculations will show how the TFRs provided in Table 2 are obtained. As the CBS does solely provide information on the total number of births, some calculations were necessary to obtain the ASFRs. First, the average age distribution of births over the period 2015-2019 were determined by obtaining the share of births per age group as opposed to the total number of births: $Age-specific\ share\ of\ births = births\ in\ age\ group/\ total\ number\ of\ births$. Subsequently, the average was taken to ensure that fluctuations over time were taken into account as well.

Births Fryslân

	2015	2016	2017	2018	2019
<20	37	44	49	40	42
20-25	588	526	506	487	463
25-30	1959	1972	1870	1911	1888
30-35	2240	2283	2251	2140	2309
35-40	984	994	1089	1014	1054
40-45	195	183	189	181	190
45+	8	15	13	6	11
Total	6011	6017	5967	5779	5957

Age distribution 2015-19 births

	2015	2016	2017	2018	2019	Average share period 2015-2019
<20	0,006	0,007	0,008	0,007	0,007	0,007
20-25	0,098	0,087	0,085	0,084	0,078	0,089
25-30	0,326	0,328	0,313	0,331	0,317	0,324
30-35	0,373	0,379	0,377	0,370	0,388	0,375
35-40	0,164	0,165	0,183	0,175	0,177	0,172
40-45	0,032	0,030	0,032	0,031	0,032	0,031
45+	0,001	0,002	0,002	0,001	0,002	0,002

Secondly, this distribution was used to obtain the age-specific birth numbers using the projected total number of births provided within the Pearl model. The equation used to obtain the age-specific birth numbers is as follows $Age\ distribution\ births\ 2020-2050 = age\ specific\ average\ share * Pearl\ projected\ total\ number\ of\ births$. Providing the subsequent Table:

Projected age distribution births

	2025	2030	2035	2040	2045	2050
15-20	91	235	245	240	227	217
20-25	1125	2914	3029	2976	2808	2684
25-30	4120	10674	11095	10901	10284	9830
30-35	4761	12334	12822	12597	11885	11360

35-40	2181	5649	5873	5770	5443	5203
40-45	400	1035	1076	1057	997	953
45-50	22	58	60	59	56	53
Pearl total births	**12700**	**32900**	**34200**	**33600**	**31700**	**30300**

Furthermore, to obtain the TFR, the total number of women per age group was also required which was also provided within the Pearl model and can be found in the Table below:

Projected number of women in Fryslân age group 15-50

	2025	**2030**	**2035**	**2040**	**2045**	**2050**
15-20	38400	91300	83200	79500	83200	87900
20-25	39500	94900	88300	81400	78800	82100
25-30	34600	91700	90300	84000	78300	76000
30-35	35100	89400	94600	92800	86700	81400
35-40	35100	90700	93500	98600	96400	90300
40-45	35700	89400	93200	95500	100800	98400
45-50	36900	89800	90100	93700	96000	101300

To following formula has been used to obtain the TFRs: $TFR = 5 * \sum(\frac{Number\ of\ births\ women\ aged\ 15-19}{Number\ of\ women\ aged\ 15-19} + \cdots + \frac{Number\ of\ births\ women\ aged\ 45-49}{Number\ of\ women\ aged\ 45-49})$

Applying this equation, first the age-specific fertility rates were required which are shown in the Table below as well as the TFR in the bottom row.

Age-specific fertility rates and TFRs

	2025	**2030**	**2035**	**2040**	**2045**	**2050**
15-20	0,002	0,003	0,003	0,003	0,003	0,002
20-25	0,028	0,031	0,034	0,037	0,036	0,033
25-30	0,119	0,116	0,123	0,130	0,131	0,129
30-35	0,136	0,138	0,136	0,136	0,137	0,140
35-40	0,062	0,062	0,063	0,059	0,056	0,058
40-45	0,011	0,012	0,012	0,011	0,010	0,010
45-50	0,001	0,001	0,001	0,001	0,001	0,001
TFR	**1,798**	**1,811**	**1,853**	**1,877**	**1,869**	**1,859**

Appendix I: Assumptions internal migration

The subsequent table presents the internal in-migration and out-migration numbers sorted from high to low for the period 1960 to 2021. Additionally, the averages representing the periods high, average and low are presented. Data is obtained from CBS Statline (2023c).

In-migration		Out-migration	
17774		14902	
17094		14373	
16334		14287	
14871		13874	
14524		13831	
14398		13730	
14354		13710	
13985		13253	
13647		13084	
13335		13053	
13214		12739	
13082		12551	
12748		12470	
12721		12413	
12596		12353	
12426		12260	
12235		12259	
12211		12199	
11771		12172	
11763		12036	
11663	13654,57 High	11938	13023,19 High
11442		11905	
11405		11714	
11404		11686	
11271		11662	
11105		11622	
11027		11555	
10954		11537	
10937		11493	
10922	10658,1 Average	11489	11447,65 Average
10829		11473	
10815		11464	
10723		11462	
10672		11460	
10224		11446	
10145		11400	

10055		11192	
9924		11173	
9863		11139	
9837		11110	
9608		10971	
9590	8553,762 Low	10944	9982,714 Low
9569		10885	
9532		10880	
9486		10785	
9441		10513	
9259		10505	
9109		10439	
8894		10415	
8853		10155	
8599		10107	
8598		10107	
8569		10081	
8363		9749	
8310		9741	
8248		9538	
8186		9338	
7865		9247	
7812		9231	
7681		9145	
7125		8986	
6540		8846	

Appendix J: Emigration assumptions risk calculations

The following table presents the numbers used to calculate the emigration risks per variant. First column presents the absolute total emigration numbers over the period 2045 to 2050, the second column presents the average total emigration numbers per variant, the third column the total population and the fourth column the emigration risk which is calculated by the following formula:

$$Emigration\ risk = \frac{Total\ number\ of\ emigrants\ at\ time\ t}{Person\ years\ lived\ at\ time\ t} * 1000$$

DEMOVAR Frisian variants emigration risk

Variant	Emigrants 2045-2050	Average emigrants per five-year period	Frisian population	Em risk
Green	23261	4652	670785	6,935453
Growth	23996	4799	749970	6,399191
Decline	20460	4092	594073	6,888042
Grey	22749	4550	668166	6,809388
High Migration	24929	4986	715545	6,967838
Low Migration	16412	3282	597553	5,493068

Variant	Emigrants 2045-2050	Average emigrants per five-year period	Dutch Population	Emigration risk
Green	1303954	260791	19425639	13,4251
Growth	1344472	268894	21784430	12,3434
Decline	1146367	229273	17084345	13,4201
Grey	1274253	254851	19207312	13,2684
High Migration	1399247	279849	20272485	13,8044
Low Migration	919625	183925	17627856	10,4338

Appendix K: Births and deaths within the demographic variants